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# DESIGN THINKING:

## SCIENCE, ENGINEERING, AND MANAGEMENT IN ACTION

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# PREFACE

In the ever-evolving landscape of innovation, the convergence of disciplines has become the heartbeat of progress. "Design Thinking: Science, Engineering, and Management in Action" encapsulates this contemporary paradigm, where the intersection of science, engineering, and management finds its most potent expression in the art of design thinking. In an age where challenges transcend the confines of single domains, a holistic approach becomes imperative. This book is a tribute to the synergy that emerges when diverse fields harmonize. Through a rich tapestry of real-world examples, theoretical insights, and practical applications, this volume unveils the transformative power of design thinking. Within these pages, readers will embark on a journey through the corridors of innovation. We explore the dynamic arc of design thinking, from empathetic problem identification to iterative solution refinement. This journey spans scientific breakthroughs, engineering marvels, and effective management strategies, all interwoven by the common thread of human-centered design. As global issues continue to intensify, the significance of a comprehensive problem-solving methodology has never been more evident. This book underscores the urgency of embracing a mindset that values empathy, embraces ambiguity, and cherishes collaboration. It is a testament to the pioneers who have harnessed design thinking to pioneer solutions that reshape industries and touch lives. We extend our gratitude to the brilliant minds whose contributions enrich this volume, and to the readers who embark on this odyssey of discovery. "Design Thinking: Science, Engineering, and Management in Action" is an invitation to challenge conventions, dissolve boundaries, and unlock the potential of multidisciplinary collaboration. *Welcome to a world where creativity knows no bounds, and innovation is the currency of transformation.*

# Chapter: 1

# Empowering Educators: The Crucial Role of Soft Skill Training in Teacher Education for Holistic Student Development

Rachna Sharma, Associate Professor (Applied Science) JB Institute of Technology, Uttarakhand Technical University, Dehradun, Uttarakhand

"**It is not the strongest or most intelligent who will survive but those who can best manage change.**" – Charles Darwin, scientist.

**ABSTRACT**

The role of educators extends beyond imparting academic knowledge; they play a crucial role in shaping the holistic development of their students. To fulfil this responsibility effectively, teachers require more than just subject expertise. Soft skills, such as communication, empathy, problem-solving, and adaptability, are essential attributes that enable teachers to create a nurturing and inclusive learning environment. This research paper explores the significance of incorporating soft skill training in teacher education programs to empower educators in fostering holistic student development. By investigating existing literature, case studies, and expert opinions, the paper highlights the benefits of integrating soft skills training in teacher preparation, the impact on student outcomes, and strategies to implement effective soft skill training. The findings emphasize that by equipping teachers with soft skills, educational institutions can create a positive ripple effect on students' personal growth, emotional intelligence, and future success. The paper concludes by underscoring the urgency of prioritizing soft skill training in teacher education to nurture a generation of well-rounded and socially competent individuals.

**KEYWORDS:** Soft skills, teacher education, holistic student development, communication, empathy, problem-solving, adaptability, emotional intelligence.

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**Research objectives:** The research objective is to examine the value and function of soft skill development in teacher education and its impact on student development. The following objectives are explored by the study:

• To investigate the place of soft competencies in teacher preparation

• To learn more about the value of soft competencies in the training of teachers.

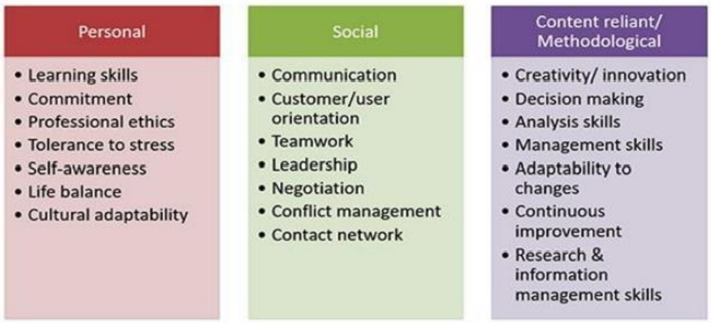
**Scope and limitations:** The scope of this research paper is to explore the significance of soft skill training in teacher education and its crucial role in fostering holistic student development. The study aims to provide an in-depth understanding of how soft skills impact educators' abilities to create a nurturing and inclusive learning environment, positively influencing student outcomes. The research will primarily focus on the benefits of integrating soft skill training into teacher education programs, and the impact on students' academic performance, social-emotional development, and long-term success. The findings of the research may have limitations regarding generalizability due to the varied nature of teacher education programs and the cultural context of different educational institutions. Access to resources, funding, and professional development opportunities for educators may pose challenges for some institutions in implementing comprehensive soft skill training. Despite these limitations, the research paper aims to shed light on the crucial role of soft skill training in teacher education and its potential impact on fostering holistic student development.

**INTRODUCTION:** The non-technical, intangible traits and talents that allow people to work well with others and successfully traverse various social and professional circumstances are referred to as soft skills, commonly referred to as people skills or communication abilities. These abilities are critical for both professional and personal growth since they support hard skills (technical abilities) and are essential for developing successful relationships, promoting efficient communication, and attaining success in a variety of spheres of life.

Benefits of Soft Skill Training in Educator's Education

- Improved Communication and Interpersonal Skills
- Enhanced Empathy and Emotional Intelligence
- Effective Problem-Solving and Critical Thinking
- Adaptability and Resilience
- Cultivating Positive Classroom Culture

**TAXONOMY OF SOFT SKILLS**




(ADAPTED FROM Haselberger, Oberheumer, Perez, Cinque & Capasso as cited in Succi, 2015, pp. 252-254)

**Communication Skills:** The ability to communicate effectively in both their original language and English is demanded of all future teachers. Both in writing and speaking, they should be capable of confidently communicating their ideas. Along with effectively replying, they must also actively listen. Additionally, they must be comfortable using technology and making presentations. In today's interconnected world, professionals often work with diverse teams or engage with clients and stakeholders from different cultural backgrounds. Effective communication skills allow professionals to adapt their communication styles, be sensitive to cultural differences, and bridge potential gaps in understanding. It enables them to collaborate across borders and leverage global opportunities. A healthy and effective office environment depends on clear communication. Interaction in any career; communication is one of the most critical interpersonal skills. You must be able to express yourself well both orally and in writing, regardless of your line of work—whether it's in IT, customer support, building construction, or another industry. Employers need candidates with great oral, written, and nonverbal communication abilities.

**Adaptability Skills:** The capacity to adapt to and succeed in shifting conditions, surroundings, or situations is referred to as having adaptability abilities, often referred to as flexibility or resilience. It entails being receptive to fresh perspectives, picking up lessons from past mistakes, and resolving problems and uncertainties in a productive manner. Educators that are adaptable are willing to integrate new electronic and technological tools into their pedagogical strategies.

**Critical thinking and Problem-solving skills:** Future educators should possess the capacity to think strategically, with creativity, and analytically and to use knowledge in these ways. They must be able to recognize, assess, and make appropriate decisions in complex situations for this component to work. They must be able to widen and improve their capacity for thought as well as provide advice and other approaches.

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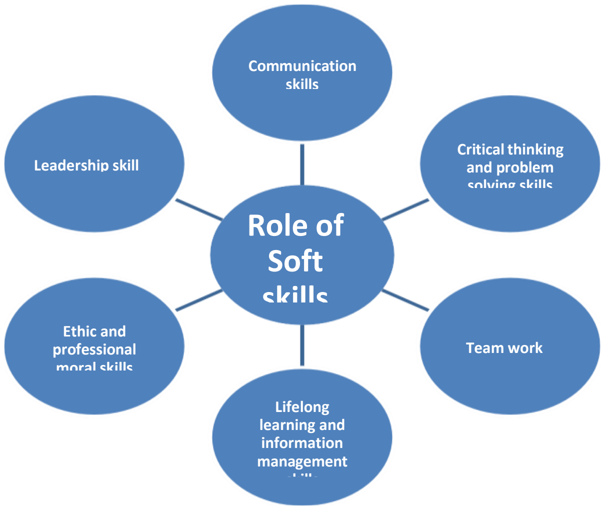
**Teamwork:** Educators must be able to work well in a team since they frequently collaborate with other teachers, executives, staff members, and parents to establish a safe and productive learning environment for their kids. Shared tasks and mutual support are essential components of teamwork. Educators ought to be eager to contribute to the objectives of the team and take on assignments that play to their abilities.

**Lifelong learning and information management skills:** Future educators must be able to control their own learning while acquiring information and abilities. They must also be able to find and organize important information from many sources. Additionally, they must have the capacity to have an open mind and be receptive to new ideas. Lifelong learners must be adept at carrying out educational research, interpreting data, and implementing strategies that are supported by the best available scientific evidence.




**Ethic and professional moral skills:** A high level of integrity and truthfulness must be upheld by educators. They ought to conduct honorably in all of their professional dealings and show consistency throughout their words and deeds. All students, coworkers, and other members of the community at school should be treated with respect and decency by teachers, regardless of their backgrounds, skills, or views. Genuinely caring about and empathizing with pupils promotes trust and a great learning environment.

**Leadership Skills:** The term “leadership ability” describes a new teacher's capacity to take the initiative in a variety of situations. Trainee instructors need to be familiar with basic leadership concepts in order to lead a project. Additionally, it's critical that they understand how to function both as a group member and as a leader. In order to effectively guide their pupils, influence other educators, and shape the culture of the school, educators must possess strong leadership abilities.

**Essential Soft Skills for Educator’s Training:** Soft skills training for educators ensures that instructors are prepared to manage the intricacies of educational settings and foster a supportive and encouraging learning environment. These abilities enhance teaching efficacy while also promoting the general success and well-being of both instructors and pupils. Educators can better comprehend students' needs, issues, and viewpoints by developing soft skills such as compassion, attentive listening, and patience. In managing diverse classes with a range of learning capacities and behaviors, soft skills like adaptation, resolving issues, and handling disputes are crucial. In order to meet the different backgrounds and requirements of students, soft skills that encourage cultural awareness and tolerance are essential.

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**Designing Curriculum to Promote Soft Skills for Educators:** Effective teaching strategies are founded on a foundation of soft skills. They improve instructors' capacity to engage with students, run a productive classroom, and provide all students with a rewarding learning experience. The development of successful teachers and the creation of a healthy learning environment both heavily rely on soft skills. Teachers with soft skills can better comprehend the varying needs, talents, and difficulties of their pupils. This knowledge enables teachers to modify their teaching strategies in order to meet various learning preferences and levels of proficiency. By incorporating the acquisition of soft skills into the educational program, educators may provide students with a well-rounded education that will prepare them for higher learning as well as success in their professional and personal lives. Any well-designed curriculum must include soft skills since they are crucial to students' overall development and future success. For a while now, educators have been seeking ways to incorporate soft skills into teacher preparation programs for upcoming students. In order to better prepare future educators for their futures in the classroom and the workplace, they are developing initiatives to revitalize the curriculum, improve classroom instruction, and tighten standards.

**Recommendations:** In light of the study's findings, this article may provide suggestions for how educational officials and institutions might better include the growth of soft skills in educator preparation programs. It might also suggest further research areas to explore the specific impacts and methods of incorporating soft skills training into existing teacher education curricula. To discover areas for growth and development in their soft abilities, encourage educators to get involved in reflective activities.

**CONCLUSION:** Soft skills are personality traits that enhance an educator's abilities, productivity, and career prospects. In various ways, personality traits, social grace, linguistic ability, individual preferences, friendliness, and optimism are all considered interpersonal abilities in the context of teacher education. Effective educators should be driven by their own goals and committed to their work. To properly carry out classroom tasks, teaching is a multifaceted performance that calls for a wide range of knowledge and talents, including both hard and soft skills.

## REFERENCE:

[1] Brophy, J., (1988). Educating teachers about managing classrooms and students. Teaching and Teacher Education, 4(1), 1-18.
[2] Jacobs, H. H. (2010). Curriculum 21: Essential education for a changing world. ASCD.
[3] Leitch, C. M., & Harrison, R. T. (1999). A process model for entrepreneurship education and development. International Journal of Entrepreneurial Behavior & Research.
[4] MacBeath, J. (2011). Education of teachers: The English experience. Journal of Education for Teaching, 37(4), 377-386.
[5] Morgan, G., & Adams, J. (2009). Pedagogy first! making web technologies work for soft skills development in leadership and management education. Journal of Interactive Learning Research, 20(2), 129-155.
[6] Padhi, P. K. (2014). Soft skills: Education beyond academics. IOSR Journal of Humanities and Social Science, 19(5), 1-3.
[7] Zhang, A. (2012). Peer assessment of soft skills and hard skills. Journal of Information Technology Education: Research, 11(1), 155-168.
[8] Hrazdil, K., Novak, J., Rogo, R., Wiedman, C., & Zhang, R. (2020). Measuring executive personality using machine-learning algorithms: A new approach and audit fee-based validation tests. Journal of Business Finance & Accounting, 47(3–4), 519–544. https://doi.org/10.1111/jbfa.12406

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# Chapter: 2

# Empowering Engineers: The Vital Role of Effective Communication in Today's Job Market

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**ABSTRACT**

Every organization depends on effective communication. Nowadays, getting the job done well is more vital than being the most knowledgeable. Employers place a high emphasis on graduates who have developed a variety of abilities in a variety of employment settings. The most important characteristics for engineers are those that go beyond analytical and problem-solving abilities, such as subject-specific knowledge, research skills, and enhanced decision-making abilities. These characteristics also include managerial abilities, an awareness of various cultures, confidence, and competency to operate in an international setting. However, successful communication skill is at the core of them. Students' knowledge may be compromised if they overlook communication skills and fail to perceive the bigger picture of the business world. Over the past two and a half decades, companies worldwide have underlined the increased value put on oral communication abilities. Knowledge and technical expertise are undoubtedly crucial, but they must be delivered with quality. Positive perceptions of the engineer are reinforced by effective communication. The poor visibility of engineering in the general population is a result of a lack of effective communication abilities. For people, a more proactive and approachable communication style may be more interesting. Indeed, oral and presenting abilities are among the finest career enhancers and the single biggest determinant in predicting whether a student will succeed or fail in their profession.

**KEYWORDS:** Empowering Engineers, Employment Settings, Subject-specific Knowledge, Managerial Abilities, Cultural Awareness, International Setting, Technical Expertise, Career Enhancers, Professional Success

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**INTRODUCTION:** Technical communication is now at the forefront of academics and business thanks to the IT revolution and commercial globalization. Technocrats and professionals are constantly confronted with new communications issues as the globe has become a single market and businesses have become more varied and goal-oriented. Success in this cutthroat environment depends not just on gaining information and practical skills, but also on honing your technical communication abilities. This essay attempts to educate and motivate rural engineering students to develop their communication abilities. Managerial abilities, cross-cultural awareness, confidence, and the capacity to thrive in an international setting stand out among the key qualities for engineers. Effective communication, however, is one essential quality that resides at the very heart of these attributes. Students should not disregard this crucial component in their quest for engineering excellence since businesses all over the world have realized the value of oral communication skills. Their capacity to see the wider picture of the changing corporate environment may be compromised if they neglect their communication abilities.

### Why English Language is important?

The most significant language in the world is English. English was disseminated throughout the British Empire, including to South Asia, Africa, Australia, New Zealand, and America. It first arrived in these nations as the language of trade, exploration, and travel before taking over as the only language of education. The United Nations, world finance, international trade, air traffic control, shipping, science and technology, academic study, space travel, and worldwide computers all use it as their official language today. It serves as the primary medium for publication, education, and international negotiations. It is perhaps the most adaptable language there is. Therefore, English is extensively used by individuals from all over the world. It serves as the global tongue. In terms of science and technology, the globe is developing. No language other than English allows for the transmission of scientific discoveries from Germany, France, and Russia to India. Therefore, by the time a scientific discovery from Germany or Russia reaches Indian experts through translation, it will already be old and out of date. English has taken on a greater significance in education as a result of colleges using it as a common language for instruction and communication. The Constitution, the Supreme Court, the High Court, and government departments all speak English as a second language. India is where English has deep roots. An individual in Tamil can comprehend English but cannot speak Hindi. English is a connection language as a result. With the use of English, many individuals may converse with one another. English is a language that inspires confidence. You can get any place with it. If you speak English well, that translates to being good overall. Engineers must thus communicate in English.

**Importance of Communication:** The English term "communication" is gaining popularity at the moment. It has the ability to turn the entire globe into a revolver. It serves as the hub of all endeavours. Everyone wants to communicate more effectively now that they are aware of its significance. It has impacted every industry, whether it is in the fields of medicine, engineering, the arts, law, sports, or even music. It has become a requirement in business or commerce. If you disregard communication in the classroom, you will utterly fail. You must develop your communication skills if you want to make a living. You must develop your communication skills if you wish to express your needs. Learn to demonstrate your suitability and aptitude for a position if you want to land a decent career. Impress your manager with your great communication if you desire a promotion. Learn how to cajole people into doing what you want to be done if you want your task to be done. The notion of teamwork was born out of the changing environment. It demonstrates the importance of fostering a sense of unity and working together. You must respect other people's viewpoints. We must be aware of both our own and other people's emotions. To avoid misunderstanding, you must express your personal viewpoints in a direct and truthful manner. In your conversation, you must uplift individuals, give them praise, and convey that you value and appreciate them. Others are more inclined to provide their best effort if you make them know that you value them. A superficial level of comprehension may be put in jeopardy if students fail to grasp the bigger picture of the business world and overlook communication skills. Over the past two and a half decades, companies worldwide have underlined the increased value put on oral communication abilities. Technical expertise and knowledge are undoubtedly crucial, but they must be presented with quality. Effective communication reinforces the engineer's favorable reputation. The negative public perception of engineering is partly due to a lack of effective communication abilities. People may respond better to communication that is more proactive and approachable. As one of the finest career enhancers and the single biggest element in deciding a student's job success or failure, oral and presentation abilities are indeed valued highly.

**Nature of Technical Education: T**echnological communication may be defined as the dissemination of scientific and technological knowledge from one person or organization to another. Professionals may share straightforward definitions of equipment, intricate descriptions of machinery and processes, or nuanced explanations and interpretations of scientific concepts. A comprehensive grasp of scientific and technical topics may be necessary for effective technical communication, which involves a dynamic exchange.

Effective technical communication requires three key components: subject expertise, linguistic proficiency, and organizational proficiency.

**Subject expertise:**

Technical communication's initial prerequisite is subject competence. It is the presence of extremely advanced technical or professional abilities as well as the requisite understanding of a certain technical subject area. Communication that is incomplete and ineffective may result from a lack of information or a lack of prior knowledge on the issue.

**Linguistic proficiency**: The capacity to communicate effectively and objectively while using suitable language is known as linguistic competence, on the other hand. Language proficiency encompasses a number of practical abilities since technical communication requires the technical presentation of data in reports, proposals, research papers, technical bulletins, manuals, and handbooks. A lack of these abilities might result in insufficient or poor communication. The capacity to analyze facts or information for a clear presentation is one of these talents.

- Analyze facts or information for clear presentation,
- Use appropriate rhetorical devices to present scientific data,
- Use graphs, charts, and diagrams systematically.

**Organizational proficiency:** Technical communication is a process of logical and thematic arrangement since it is a systematic and structured presentation of information. The capacity to arrange technical knowledge logically and formally is known as organizational competence. It entails a variety of abilities, including the capacity to structure sentences according to the reader's demands and the subject at hand, employ suitable logical sequencing, and give expression a thematic coherence. Communication in the workplace has altered as a result of the rapid advancement of technical knowledge and information technology. To conventional and sluggish modes of communication like letters, memoranda, newsletters, and so forth, we choose quick, interactive, and result-oriented forms of communication like voice mail, email, video transmission, teleconferencing, videoconferencing, intranet transmission, and so forth.

**Importance and Need for Technical Communication:** It is challenging to overstate how crucial technical communication is for a person working within an organization. You need good technical communication skills to be successful whether you're an executive working for a global corporation, an engineer working on the shop floor, a scientist working in a top-tier scientific lab, or a technical student at a professional school. The transmission of technical information is a critical component of economic growth and transformation, and its significance has grown as a result of the information revolution and socioeconomic changes of the new millennium. The world has become a global market, and effective technical communication skills are now even more crucial. The value of technical communication skills keeps growing as the professional world grows more varied, competitive, and goal-oriented.

Technical communication tasks are being significantly impacted by the information technology revolution, and new types of communications tasks or abilities will be needed in the altered technological environment. These abilities include the capacity to comprehend and communicate difficult technical knowledge in a clear and approachable manner, the capacity to comprehend and communicate quantitative data, the capacity to recognize cultural contexts, and the capacity to prioritize and evaluate information. The advancements in science and technology have had an impact on how technical communication abilities are perceived in a

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number of ways. In reality, there has been a paradigm change in favor of communication abilities above technical and professional abilities. There is no denying the need of strong speaking and writing abilities for professional success. It's also true that some technical skills are just as crucial as communication skills, but having technical or professional knowledge is useless if you don't know how to convey the information and get the desired outcome from using and applying these skills.

**Remedies:**

- **Development of Inner Urge:** In general, engineering students seem to place more weight on technical courses than they do on communication abilities. Students disregard it. If they feel that they should improve their communication abilities in light of the business environment, they will advance.
- **Need to Enrich Vocabulary and Sentence Construction:** In general, engineering students appear to give technical courses more weight than communication skills. The students ignore it. They will advance if they believe that, given the work climate, they should enhance their communication skills.
- **Listening:** During tutorials, practical sessions, seminars, technical presentations, academic debates, and other academic exchanges, students need to cultivate the habit of paying close attention to the English news, lectures, and explanations. All of their demands are met by contemporary language labs. They must maximize their gains. good listening is a prerequisite for good communication.
- **Speaking:** An individual's professional survival and development depend greatly on their speaking abilities. It helps with word articulation practice and increases speaking confidence. Since they are afraid of making a mistake or doing something incorrectly, rural students must be encouraged to ask inquiries in order to allay their fears. They must be given the chance to express their thoughts, agreements, disputes, and ideas, and they must receive credit for taking part in debates and presenting projects, products, graphs, tables, charts, maps, and other visual aids. They must guarantee that the single most crucial factor in recruiting specialists is speaking ability.
- **Reading:** Effective communication depends on reading just like it does on listening and speaking. Students must study reports, proposals, magazine articles, letters, and instruction manuals as well as other technical and business materials. It is difficult to think of any academic, professional, or business endeavour that does not call on effective reading abilities.
- **Writing:** “Reading makes a complete man, speaking makes a ready man, and writing makes a perfect man,” is a proverb about writing. Writing is crucial for both students and professionals across all industries. Writing project reports, lab reports, summaries, synopses, ABSTRACTs, and topic notes are all things they should get experience with. They will need to manage communication autonomously as they climb the professional ladder. It will be necessary for them to write business letters, memos, emails, proposals, minutes, notes, reports, professional summaries, and so on. There is barely any academic or professional activity that does not need writing abilities, thus both professionals and students need outstanding writing skills to survive and flourish in their endeavours.

## CONCLUSION

The maxims “Success often comes to those who try” and “Where there is a will there is a way” should be ingrained in the minds of students. They may encounter obstacles along the way, but they are there to help them become more excellent rather than to discourage them. Excellence is seldom the product of luck, but rather of earnest and persistent work. Modern technology is available to them at this time. Who is at responsibility if they fail to gain from it? A good engineer's toolset is built on effective communication. Engineers need to be able to communicate clearly, work well with a variety of teams, and present their work in an engaging way in addition to having the knowledge necessary to develop and innovate. Engineering professionals may bridge the gap between technical and commercial goals by having the ability to convey complicated technical ideas to non-technical audiences. In order to enable engineers to become well-rounded professionals who can drive innovation, manage projects, and have a good influence on society, it is important to engage in strengthening communication skills in addition to fulfilling the needs of the modern labour market. Effective communication skills will remain a critical difference as engineering disciplines continue to intersect with other areas, assuring engineers' sustained relevance and success in a world that is always evolving. Engineers may really empower themselves to prosper and make a lasting influence in the 21st-century employment market by realizing the importance of excellent communication and actively developing this ability.

## REFERENCE:

[1] K.K. Sinha, Business Communication (Galgotia Publishing Company, 2002).
[2] Andrea J. Rutherford, Basic Communication Skills for Technology (Addison Wesley Longman, 2001).
[3] R.K. Chadha, Communication Techniques and Skills (Dhanpatrai Publications, 2001).
[4] Garavan, Thomas (1997) Interpersonal Skills Training for Quality Service Interactions", Industrial and Commercial Training, Vol. 29 Iss 3 pp. 70 – 77
[5] Matin, Hassan & Jandaghi, Golamreza & Karimi, Fateme & Hamidizadeh, Ali (2010) Relationship between Interpersonal Communication Skills and Organizational Commitment (Case Study: Jahad Keshavarzi and University of Qom, Iran), European Journal of Social Sciences – Volume 13, Number 3 (2010) 387
[6] Mast, Marianne & Kleinlogell, Emmanuelle & Tur, Benjamin, & Bachman, Manuel (2018) The future of interpersonal skills development: Immersive virtual reality training with virtual humans Human Resource Development Quarterly. 2018;1–17.
[7] Pellack, Lorraine (2003) Interpersonal Skills in the REFERENCE Workplace, Iowa State University Digital Repository
[8] Pope, Sharon (2015) Strategies for Developing Interpersonal Communication Skills for Business Students Walden Dissertations and Doctoral Studies Collection
[9] Brimhall, A., Wampler, K., & Kimball, T. (2008). Learning from the past, altering the future: A tentative theory of The effect of past relationships on couples who remarry. Family Process, 47(3), 373–387.

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# Chapter: 3

# Enhancing English Language Learning: The Significance of Language Games in Fostering Engagement, Proficiency, and Cross-Cultural Understanding

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**ABSTRACT**

Language learning tools that are both effective and pleasant have become more popular. These games give students fascinating, interactive experiences. This study investigates the value of language games for English language acquisition. The study emphasizes the advantages of using language games in language courses by drawing on a thorough literature assessment and empirical studies. The study explores the ways in which language games boost students' enthusiasm, vocabulary development, grammatical mastery, speaking and listening abilities, and general confidence in using English. The study also explores how culture affects language acquisition through games, promoting intercultural understanding. The study also investigates the usefulness of language games in different age groups, from young learners to adults, and their integration with multimodal learning methodologies. It also acknowledges the difficulties and constraints associated with utilizing language games, and it suggests solutions. The study concludes by making suggestions for improving language games in English learning, arguing for their inclusion in language curricula, and outlining potential research trajectories. This study highlights the critical function of language games as a necessary element in the process of learning English, increasing learner engagement, competency, and cross-cultural understanding via a thorough investigation.

**KEYWORDS:** Language games, English language learning, Learner Engagement, Interactive experiences, Vocabulary acquisition, Grammar proficiency

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## INTRODUCTION

Learning English has a rich history that is shaped by colonial influences, globalization, technical improvements, and historical changes. The demand for learning English is still being driven by the language's broad use as a world tongue, making it a necessary ability for people and communities in the contemporary day. Interactive, educational games that promote language acquisition and practice are called language games. They are frequently employed in language instruction to improve learning outcomes and make it more pleasurable. Language games provide students with a fun and context-rich setting in which to utilize the target language, allowing them to apply grammar, vocabulary, and language structures in everyday contexts. Language learning games have a variety of benefits, including improving communication, vocabulary, grammar, and language proficiency, as well as motivating and enthusing language learners. Learners must actively participate in language games to be motivated to actively use the language in relevant circumstances. These increase listening and speaking abilities while boosting fluency in the target language. Language games help students become more proficient, self-assured, and motivated in their use of the target language via repetition, practice, and active engagement. Language games continue to be useful tools for educators and students in the quest for efficient language learning because of their adaptability and versatility.

**Theoretical Foundations of Language Games in Language Learning:** The foundations of language learning games come from a variety of linguistic and pedagogical philosophies. The foundations of language learning games come from a variety of linguistic and pedagogical philosophies. Communication and language use in real-world settings are given top priority in the CLT method of teaching languages. Language games support the principles of CLT because they encourage communication by having students use the target language in a variety of authentic contexts.

**Effectiveness of Language Games in Enhancing Language Skills:** In multiple domains of language learning, language games have been shown to be incredibly successful in improving language abilities. Language games give students useful opportunities to put their language abilities to use and practice in circumstances that matter to them since they are interactive and entertaining.

**Role of games in language education:** There are many ways in which games may be used to teach language, and they can have a big influence on how well students learn the language and how they learn in general. There are several advantages to including games in language teaching and learning, and the process becomes more entertaining, efficient, and engaging. Language games engage students' interest and passion, enhancing the learning experience and fostering interaction. By promoting active involvement and a lively atmosphere in the classroom, they help to establish a good and inspiring learning environment. In a setting that seems natural and relevant to learners, these activities provide an opportunity to practice a variety of language abilities, including speaking, listening, reading, and writing. This constant repetition aids in retaining linguistic structures and concepts.

Games can introduce and reinforce vocabulary and grammar in a contextualized manner. Learners may more easily comprehend and retain new words and structures when they use the language in authentic contexts and circumstances. Some games test players' problem-solving and strategic thinking abilities while encouraging them to use their linguistic skills in novel ways. Their linguistic versatility and cognitive ability are improved by this. Digital language learning games and applications have gained popularity as a result of developments in educational technology. These systems frequently offer real-time feedback and tailored educational opportunities.

**Language games used in English language learning:** Language games are adaptable and may be used to achieve a variety of language learning goals and competence levels. The learning process is made more pleasurable by these language games, which also give students beneficial chances to practice various language abilities, reinforce language concepts, and have meaningful conversations. They may be applied in a range of language learning settings, including classrooms, language clubs, and online learning environments. Language games commonly used in English language learning are:

- **Word Bingo:** Create bingo cards with words instead of numbers. The teacher calls out definitions or uses the words in sentences, and students mark the corresponding words on their cards. This game helps reinforce vocabulary and listening skills.
- **Taboo:** In this game, students take turns describing a word without using specific "taboo" words. Their classmates try to guess the word based on the description. It promotes vocabulary usage, speaking, and communication skills.
- **Sentence Scramble**: Provide jumbled sentences, and students work individually or in groups to rearrange the words to form correct sentences. This game focuses on grammar and sentence structure.

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- **Charades:** Students act out words or phrases without speaking, and their classmates try to guess what they are portraying. Charades encourage non-verbal communication and vocabulary recall.
- **Pictionary:** Similar to charades, but instead of acting, students draw the words or phrases on the board. Classmates must guess the correct words based on the drawings.
- **Story Cubes**: Use dice with images on each side. Students roll the dice and use the images that come up to create a story. This game enhances creativity and storytelling skills.
- **Role-Play:** Assign students' different roles or scenarios, such as ordering food at a restaurant or resolving a problem at the airport. Role-playing fosters real-life language use and communication.
- **Crossword Puzzles:** Provide crossword puzzles with clues in English, and students fill in the correct words based on the given clues. This game reinforces vocabulary and spelling.
- **Grammar Auction:** The teacher presents sentences with grammar mistakes, and students must correct them. This game helps reinforce grammar rules.
- **Song Lyrics Fill-in-the-Blanks:** Play a popular English song, but with some words missing. Students listen and fill in the missing words on their handouts. This activity improves listening skills and vocabulary.
- **Board Games:** Adapt classic board games like Scrabble, Monopoly, or Snakes and Ladders to incorporate English language elements. For example, students must form words using their tiles or answer questions to advance on the board.
- **Memory Match:** Create cards with word pairs (e.g., word and corresponding picture, word and definition). Students take turns flipping cards to find matching pairs, helping with vocabulary retention.

**The connection between language games and engagement, proficiency, and cross-cultural understanding:**

The distinctive qualities and advantages that games have to offer in the process of language learning are the foundation of the association between language games and involvement, proficiency, and cross-cultural understanding.

**Engagement:**

- **Intrinsic Motivation:** The intrinsic motivation of learners to actively engage in the learning process is increased by the natural enjoyment and excitement of language games. Playfulness encourages better levels of engagement by making learning a language less intimidating and more enjoyable.
- **Active Participation:** Students must actively utilize the language during games in order to play and connect with others. As a result of their active involvement, language learners become more devoted to their studies.
- **Positive Learning Environment:** Games lessen learners' anxiety and dread of making errors by fostering a low-stress environment. This supportive environment for learning allows learners to take chances and try new things with the language, which increases interest and confidence.

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**Proficiency:**

- **Language Practice**: Many chances exist in language games for students to develop their language abilities in relevant and authentic circumstances. Learners receive significant practice, which improves their language skills, whether it is through speaking, listening, reading, or writing.
- **Contextualized Learning:** Games frequently feature language in genuine and contextualized contexts, which helps learners comprehend how to use language abilities in everyday settings. Learners' capacity to use the language correctly and efficiently is improved by this contextual learning.
- **Repetition and Reinforcement:** The repetition of language components in games helps learners grasp and remember vocabulary, grammar, and other language components.

**Cross-Cultural Understanding:**

- **Cultural Content:** Language games frequently include cultural components including traditions, conventions, and cultural rituals. Learners develop comprehension of the culture of the target language through interacting with these components, promoting cross-cultural understanding.
- **Intercultural Communication:** Multiplayer or team-based language games promote communication between students from various cultural backgrounds. This exposure to other viewpoints fosters cross-cultural cooperation, empathy, and tolerance.
- **Empathy through Role-Playing**: Role-playing games provide students with the chance to assume the identities of numerous characters from various cultural backgrounds. Learners get more empathy and an understanding of cultural variety as a result of this immersive experience.

## CONCLUSION

Language games provide a conduit for introducing students to the language they are learning, the target culture, and their fellow classmates. Language games help people become linguistically proficient and cross-culturally competent by delivering fun and interactive learning experiences. The likelihood that language learners will remain motivated, persevere in their language learning process, and improve their language competency increases as they get more involved with the language and culture. The multicultural elements of language games also enable students to develop into more tolerant, flexible, and considerate citizens of the world.

## REFERENCE

[1] Alfulaih, W. K. (2017). The impact of using games on developing Saudi female EFL students’ speaking skills. English Language and Literature,1 -98.

[2] Amal, A. M., Majeda, A. N. (2014). The effect of using Word games on primary stage students' achievement in English language vocabulary in Jordan.American International Journal of Contemporary Research,4(9),144-152.

[3] Amrullah, A. Z. (2015). Developing language games to teach speaking skills to Indonesian Senior High School Learners. JEELS, 2 (2), 13-33.

[4] Baker, S. C., MacIntyre, P. D. (2003). The role of gender and immersion in communication and second language orientations. In Z. Dörnyei (Eds.), Attitudes, Orientations and Motivations in Language Learning. Malden, MA: Blackwell Publishing.

ISBN: 978-81-961781-9-2

[5] Baker, J., & Westrup, H. (2003). Essential Speaking Skills: A Handbook for English Language Teachers. London: Continuum.

[6] Bamford, K. W., & Mizokawa, D. T. (1991). Additive-Bilingual (Immersion) Education: Cognitive and Language Development. Language Learning, 41 (3), 413–429.

[7] Biloon, A. S. (2016). Different reasons to play games in an English language class. Journal of Education and Training Studies, 5(1), 84-93.

[8] Cheng, Y-C. (2018). The effect of using board games in reducing language anxiety and improving oral performance. Electronic Thesis and Dissertations: University of Mississippi.

[9] Chirandon, A., Laohawiriyanon, C., & Rak Thong, A. (2010). The effect of teaching English through games. The 2nd International Conference on Humanities and Social Sciences.

# Chapter: 4

# Exploring the Impact of Artificial Intelligence Integration on Relationship Satisfaction and Uncertainty

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**ABSTRACT**

This study investigates the effects of artificial intelligence (AI) integration on relationship satisfaction and uncertainty. It is critical to look at how these developments can impact close relationships as AI technologies grow more pervasive in many facets of everyday life, such as task management and communication. The survey included a broad group of couples who admitted to deploying chatbots or AI-powered products for tasks connected to their relationships. The study also revealed possible moderating factors including participant's technical familiarity, attachment types, and views about AI integration in interpersonal interactions. Participants' assessments of how AI affected their relationship dynamics were influenced by these factors. Understanding the influence of artificial intelligence (AI) on the dynamics of relationships is more important as human-machine interaction practices change. It is advised that further longitudinal research be conducted in order to examine the long-term effects of AI integration on relationship satisfaction and uncertainty.

**KEYWORDS:** Artificial Intelligence, Integration, Relationship Satisfaction, Uncertainty, Human-Machine Interaction, Chatbots, Task Management, Communication, Close Relationships

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## INTRODUCTION:

Artificial intelligence can potentially play a role in relationship maintenance by assisting in communication, providing reminders, and automating certain tasks. AI-powered chatbots, for instance, might assist couples in organizing their time and activities or serve as a reminder for crucial anniversaries and occasions. Depending on the partnership, AI may have a different effect on relationship satisfaction. The support and convenience that AI products offer certain couples can increase their contentment. Some people, on the other side, could believe that AI ruins the intimate and emotional components of their relationship, which lowers levels of enjoyment. The INTRODUCTION of AI into a relationship can cause ambiguity and doubt regarding the place of technology in their union. The purpose of the article is to investigate how AI integration affects the degree of relationship ambiguity that people feel. Uncertainty may be caused by worries about how AI affects emotional connection, how it affects relationship dynamics, and what it may mean for the future of the partnership. The goal of the study is to locate and examine possible moderating variables that affect the satisfaction/uncertainty of relationships and their link to AI integration. It aims to comprehend the factors that underlie people's favourable or unfavorable opinions about AI integration and how these opinions influence their actions and feelings in the context of interpersonal relationships.

### The growing influence of AI technologies in various aspects of everyday life:

A key trend in recent years has been the expanding use of AI technology in many facets of daily life. A subfield of computer science called artificial intelligence is concerned with creating intelligent computers that can carry out activities that ordinarily call for human intellect. The integration of AI technologies into a wide range of fields and their fast advancement have had an influence on how people live, work, and engage with their environment. Virtual assistants with AI capabilities, like Siri, Alexa, and Google Assistant, have ingrained themselves into many people's everyday lives. These helpers are capable of doing things like setting reminders,

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responding to inquiries, operating smart home appliances, and even making tailored suggestions. AI is transforming healthcare by assisting with illness diagnosis, examining medical imagery, and forecasting patient outcomes. Applications that use AI to monitor patients' health problems can also make tailored therapy recommendations.

AI algorithms are also used to assess client preferences, forecast purchasing patterns, and provide tailored product suggestions. Other well-liked solutions for offering consumer support and help include chatbots and virtual shopping assistants. The development of autonomous drones and self-driving vehicles is a ground-breaking use of AI in the transportation industry that has the potential to revolutionize how people move and how commodities are transported. Machines can now comprehend, decipher, and produce human language thanks to AI technology. Speech recognition, machine translation, and sentiment analysis have all benefited from this development. To increase productivity, decrease mistakes, and improve safety, AI-powered robots and automation systems are being employed more and more in industrial operations.

**The relationship between AI integration and relationship satisfaction:**

**Relationship Satisfaction and AI Integration:** Some individuals might indicate higher relationship satisfaction as a result of the comfort and assistance provided by AI-powered products. AI may assist with time management, reminders, and activity coordination, lowering stress and increasing relationship efficiency. However, if some people believe that AI is displacing or weakening human connection, they may feel less relationship happiness. They could believe that AI falls short in its ability to assist and intimately connect with them on the same level as human connection.

- **Uncertainty and AI Integration:** The use of AI could reduce uncertainty by bringing regularity and structure to relationship maintenance. A sense of control and stability in the relationship might result from using AI-powered reminders and task management tools. Integration of AI can increase uncertainty for certain people. Feelings of concern over the relationship's use of AI might result from worries about privacy, data security, and the possibility of AI misreading emotions or intentions.
- **Moderating Factors:** People who are more comfortable with technology and AI may be more likely to see improvements in relationship satisfaction and less uncertainty. They could view AI as a useful tool rather than as a danger to their relationship. How AI integration affects relationship happiness and uncertainty may depend on attachment patterns. While people with anxious or avoidant attachment types could respond more strongly to how integrating AI will affect their relationships, those with secure attachment patterns may find it easier to adjust. Positive views regarding the use of AI in interpersonal interactions may make people more receptive to its advantages, which might improve relationship satisfaction and lessen uncertainty.

**The effects of AI on relationship dynamics, satisfaction, and uncertainty:** The effects of AI on relationship dynamics, satisfaction, and uncertainty are influenced by how AI technologies are integrated into the context of intimate relationships.

- **Relationship Dynamics:** Communication between partners can be facilitated by chatbots and virtual assistants powered by AI. They could facilitate regular encounters by helping to plan events, remind people, and organize tasks. Applications for artificial intelligence are made to be a friend and a support system. In some circumstances, they could provide solace and engagement, even if they cannot take the place of genuine emotional ties. Changes in how couples communicate might result from using AI in maintaining relationships. For instance, the way they divide up work and communicate may change as they depend increasingly on AI for some activities.

- **Relationship Satisfaction:** Integration of AI can facilitate and improve the management of everyday tasks and obligations, which for some people results in improved relationship satisfaction. By preventing forgetfulness and missed meetings, AI technology might lessen sources of conflict in romantic relationships. The apparent effort couples put out to keep the relationship going may have an impact on relationship satisfaction. It may cause feelings of neglect and unhappiness if one spouse believes the other depends too heavily on AI.
- **Uncertainty:** Reminders and organizing tools enabled by AI may reduce uncertainty by fostering predictability and confidence in the upkeep of relationships. If AI systems are used to evaluate intimate data, the application of AI in relationship dynamics may give rise to concerns about data security and privacy. Uncertainty regarding AI's role in close relationships may grow as a result of its failure to completely grasp and address complex emotional demands.
- **Challenges and Risks:** Artificial intelligence (AI) systems may misread feelings or intentions, resulting in misunderstandings and even conflicts. Over-reliance on AI for emotional support or decision-making may result in a decline in real human relationships, which will exacerbate relationship unease and uncertainty.

**Recommendations for individuals and professionals involved in relationship counselling or technology development:**

**For Individuals:**

- The effects of AI integration may differ depending on the particulars of each interaction. Avoid overly depending on technology for emotional support or decision-making by customizing the usage of AI to your shared requirements and preferences.
- To keep a healthy balance between human connections and technology in your relationship, establish explicit boundaries about the usage of AI. Make sure AI technologies enhance your relationship dynamics rather than taking the place of or weakening true human ties.
- Develop mutual trust in your connection as well as in the AI systems you are using. By choosing AI solutions with robust security safeguards and open data handling methods, you may address concerns about privacy and data.
- Monitor the relationship dynamics, satisfaction, and uncertainty on a regular basis in light of the integration of AI. To guarantee the greatest results, be willing to modify your strategy as necessary.

**For Professionals Involved in Relationship Counseling:**

- Keep up with the changing role of AI in maintaining relationships to better grasp how it may affect couples seeking counselling.
- During counselling sessions, ask clients about the role that AI technologies have had in their interpersonal dynamics.
- Examine the effects of AI use on communication styles, uncertainty, and relationship satisfaction.

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- Encourage partners to communicate openly about their integration of AI experiences. As they consider how AI may affect their relationship, assist them in expressing their thoughts and feelings.
- Be aware of potential difficulties with AI integration, such as misunderstandings brought on by AI errors or excessive dependence on technology for emotional support. Make tailored suggestions to couples on how to incorporate AI into their union in a way that fits with their individual requirements and ideals.

## CONCLUSION

Technology and intimate relationships connect in an elaborate manner, which has been made clear by research on the effects of artificial intelligence integration on relationship satisfaction and uncertainty. The study's CONCLUSIONs showed that various factors, including personality variations, attitudes toward technology, and the context in which AI is used, impact the effects of AI on relationship dynamics, satisfaction, and uncertainty. The study found that humans' perceptions and experiences of AI integration are moderated by characteristics including technical knowledge, attachment patterns, and views toward AI. Whether AI improves or complicates relationship dynamics depends in large part on these aspects. To leverage the benefits of AI integration while keeping genuine human relationships, couples can benefit from open conversation, trust-building, and maintaining a balanced approach.

## REFERENCES

[1] Amato, P. R. (2010). Research on divorce: Continuing trends and new developments. Journal of Marriage and Family, 72(3), 650–666.
[2] Amato, P. R., & Booth, A. (1991). The consequences of divorce for attitudes toward divorce and gender roles. Journal of Family Issues, 12(3), 306–322.
[3] Amato, P. R., & Booth, A. (1997). A generation at risk: Growing up in an era of family upheaval. Cambridge, MA: Harvard University Press.
[4] Amato, P. R., Booth, A., Johnson, D. R., & Rogers, S. J. (2007). Alone together: How marriage in America is changing. Cambridge, MA: Harvard University Press.
[5] Amato, P. R., & Hohmann-Marriott, B. (2007). A comparison of high- and low-distress marriages that end in divorce. Journal of Marriage and Family, 69(3), 621–638.
[6] Amato, P. R., Kane, J. B., & James, S. (2011). Reconsidering the "Good Divorce". Family Relations, 60(5), 511–524.
[7] Amato, P. R., Loomis, L. S., & Booth, A. (1995). Parental divorce, marital conflict, and offspring Well-being during early adulthood. Social Forces, 73(3), 895–915.
[8] April 2014 JOURNAL OF MARITAL AND FAMILY THERAPY 229 Blow, A. J., Davis, S. D., & Sprenkle, D. H. (2012). Therapist–worldview matching: Not as important as matching to clients. Journal of Marital and Family Therapy, 38, 13–17.
[9] Booth, A., & Amato, P. R. (2001). Parental pre divorce relations and offspring postdivorce well-being. Journal of Marriage and Family, 63(1), 197–212.
[10] Booth, A., & Edwards, J. N. (1992). Starting over – why remarriages are more unstable. Journal of Family Issues, 13 (2), 179–194.
[11] Brimhall, A., Wampler, K., & Kimball, T. (2008). Learning from the past, altering the future: A tentative theory of the effect of past relationships on couples who remarry. Family Process, 47(3), 373–387.
[12] Brown, S. L. (2004). Moving from cohabitation to marriage: Effects on relationship quality. Social Science Research, 33(1), 1–19.
[13] Brown, S. L., & Booth, A. (1996). Cohabitation versus marriage: A comparison of relationship quality.

# Chapter: 5

# Green Synthesized of Sulphur Nano-particles using Mangifera Indic Leaves Extract

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**ABSTRACT**

A huge variety of fungi is present in the ecosystem; some of them are useful while others are responsible for some catastrophic diseases in crops. The diseases that are common in fruits and vegetables are mostly fungi originated. In the present work, an attempt has been made to synthesize the sulphur nanoparticles (SNPs) via green route. Sulphur is an essential component in both agriculture and technology. Mangifera indica(mango) leaves extract has been used as a surfactant in an acidic medium to synthesize Sulphur nanoparticles. Oxalic acid is a weak acid that meets the requirement of green synthesis fairly. Different characterization techniques such as XRD and UV-Vis have been employed to assess the nanoparticles. Uv-Vis spectrum shows a peak at 298nm, which confirms the formation of Sulphur nanoparticles. A highly crystalline nature with crystalline size 68nm has been revealed by the XRD analysis. The adsorption of biomolecules on the surface is responsible for ceasing the agglomeration process and increasing their adaptability with nature.

**KEYWORDS:** Green synthesis; Oxalic acid; Sulphur nanoparticles.

## INTRODUCTION

For a long time, sulphur has been used as a fungicide and antimicrobial against different pathogens. It is used to control apple scab diseases in cold weather and also used in various crops such as grapes, strawberries and many other vegetables as an antifungal agent [1].

Over the decades, sulphur has proven its importance in both agriculture and industrial field due to its enormous attributes and functionality. It is one of the most important macro nutrients needed by crops to ensure food sustainability. It is an essential component for the production of some metabolites such as enzymes, proteins, amino acids and vitamins in plants as well as in living beings. It also helps the plants to fight against abiotic stress and diseases [2-4]. Nowadays, we are dealing with an era of nanoparticles and nanotechnology. Nanoparticles have always surprised human beings due to their magnificent properties and applications. Sulphur nanoparticles have gained popularity in the past few years due to their vast use in almost every field like agriculture, high specific capacity sulphur-lithium batteries, industries, for carbon nanotubes modification, pharmaceuticals, antibacterial efficacy and catalytic properties [5-7]. Lots of literature is available for the green synthesis of metal nanoparticles such as gold, silver and copper etc. [8-9]. But, only a few works has been done for the synthesis of sulphur nanoparticles despite their magnificent applications and essentiality. Paralikar and Rai used Mangifera indica (Vinca), Azadirachta indica (Neem) and Polyalthia longifolia (Ashoka) with precursor sodium polysulphide to synthesize sulphur nanoparticles [10]. The present work focuses on green synthesized sulphur nanoparticles using Catharantheus roseus (Mango) leaves extract as a surfactant. It has proven its essence as a medicinal plant all over the world. Oxalic acid (organic acid) has been used throughout the process to provide acidic medium.

### Materials and Methods

**Materials:** Oxalic acid dihydrate ($C_2H_2O_4.2H_2O$) and Sodium thiosulphate pentahydrate ($Na_2S_2O_3.5H_2O$, 99.5%) have been purchased from Himedia. Fresh Mangifera indicaleaves have been taken from the surroundings of the university campus. Deionized double distilled water has been used as a solvent throughout the process.

**Preparation of aqueous extract of Mangifera indica leaves:** Firstly, the collected Mangifera Indica leaves have been washed using tap water about a couple of times and thereafter, they have been cleaned using deionized double distilled water 5-6 times. All the dust particles and physical impurities have been washed off. After drying them for about an hour, they are finely chopped into small pieces. 50g of these has been dissolved in 500mL of distilled water and boiled for 25 minutes. The cooled-down mixture has filtered using filter paper Whatman No-1 to pull out the undesired part. Thereafter, the extract has been centrifuged at 5000 rpm for 10 minutes in order to remove any biological impurities present. The extract has been stored in freeze for further use.

**Synthesis of sulphur nanoparticles:** The present work deals with a safe and environment-friendly method to synthesize the SNPs as given by Khairan et al. with some modest changes [16]. 24.8g of precursor $Na_2S_2O_3.5H_2O$, 99.5% has been mixed up with 250mL of Mangifera indicaleaves extract and sonicated for 40 minutes at 300C. The uniform sonicated solution has been further diluted using 250mL of deionized double distilled water with mild stirring. Thereafter, 10% oxalic acid has been added to the solution drop-wise under continuous stirring and a yellow precipitate is observed. The mixture has been centrifuged at 6000 rpm for 5 minutes. The precipitate has been collected and washed repeatedly using double distilled water to remove any impurity. It has been placed in a hot air oven to dry at 50$^o$C for 8 hours and collected for further use. The possible disproportion reactions involved in this instance is as follows:

$$\mathbf{Na_2S_2O_3.5H_2O + C_2H_2O_4 \rightarrow Na_2C_2O_4 + SO_2 + S (\downarrow) + H_2}$$

**Results and Discussion:** For the sustainable development of science and technology, harmony between nature and science/technology is a must. Green synthesis of nanoparticles has emerged as a steppingstone to accomplish this goal. Green synthesis of Sulphur nanoparticles is a simple and one-step process. Mangifera indica leaves extract has been used as a green surfactant throughout the process and Oxalic acid has been used as a reducing agent to synthesize SNPs.

**Uv-Vis analysis:** UV-Vis spectrum for the synthesized nanoparticles shows a peak at 298nm as shown in figure 1. It confirms the availability of Sulphur nanoparticles as the optical spectrum for Sulphur nanoparticles lies between 245-300nm. The sharp peak indicates that the SNPs have a small range for particle size distribution.

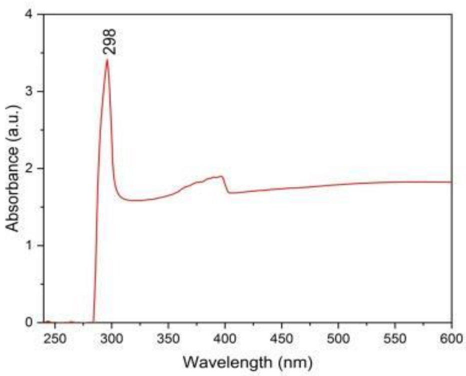


**Figure 1: UV-Vis spectrum of Sulphur nanoparticles**

**X-ray Diffraction analysis:** XRD technique has been employed to study the crystal nature of SNPs. The diffraction pattern shows a strong peak at 23.140 corresponds to the crystallographic plane 222 as shown in figure 2.

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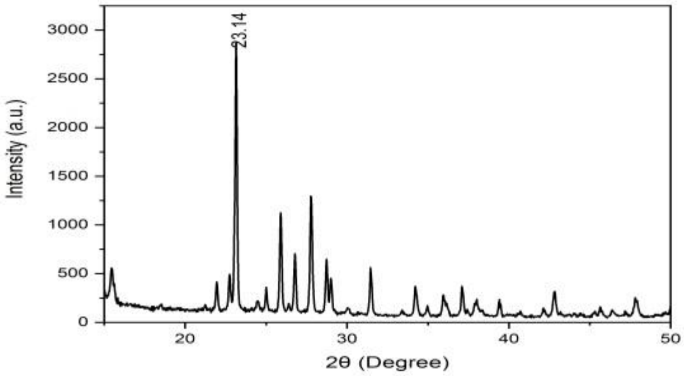


**Figure 2: XRD spectrum of Sulphur nanoparticles**

This data is consistent with the data given by pdf no 00-008-0247, International Centre for Diffraction Data (ICDD) for the standard Sulphur pattern. The average crystalline size 58nm is calculated using the Debye-Scherrer formula given as:

$D=K.\lambda/\beta.\cos\theta$

Where D stands for the diameter of nanoparticles, λ represents the wavelength of X-ray radiation source given as 0.1546, β is FWHM (full width at half-maximum value), θ is the half diffraction angle in radian and K is the Scherrer constant with a value of 0.9. The small crystalline size specifies that the Mangifera indicaleaves extract works exquisitely as a surfactant and oxalic acid is responsible for the fast nucleation process.

## CONCLUSION

Sulphur nanoparticles play an inconceivable part in agriculture and industrial development. Green synthesis of Sulphur nanoparticles is considered as a boon to the agriculture as they do not possess any toxic effect. Highly crystalline orthorhombic SNPs have been synthesized in the present work using Mango leaves extract as surfactant with crystalline size 58nm. There is no additional layer of any harmful chemical at the surface of nanoparticles is observed, only the biomolecules are available.

## REFERENCE

[1] H.W.Scherer, European Journal of Agronomy 14 (2001) 81–111.
[2] P.H . Dubuis., C. Marazzi, E. Städler and F. Mauch, J Phytopathol, 153(1)(2005) 27–36.
[3] N.M Salem, L. S. Albanna, A. M. Awwad, Q. M. Ibrahim and A. O. Abdeen. Journal of Agricultural Science, 8(2008) 188-194.
[4] M.A. Ellis, D.C. Ferree, R. C. Funt and L.V. Madden. The American Phytopathological Society, 82(1998) 428-433.
[5] Suleiman, M. Al-Masri,A. Aref, A. Hussein, I. Saadeddin and I. Warad. J. Mater. Environ. Sci. 6 (2)( 2015) 513-518.
[6] J. Barkauskas, R. Jusˇke˙nas, V. Mileriene and V. Kubilius.Materials Research Bulletin, 42 (2007) 1732–1739.
[7] S.R. Choudhury, S. Roy, A. Goswami and S. Basu. J AntimicrobChemother, 67 (2012) 1134–1137.
[8] S.S. Dash and B.G. Bag. Applied Nanoscience, 4(2014) 55-59.
[9] N. Krithiga, A. Rajalakshmi and A. Jayachitra. Journal of Nanoscience, 2015(2015) 928204(1-8).
[10] P. Paralikar and M. Rai. IET Nanobiotechnol., 12 (2017) 25-31.

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# Chapter: 6

# A Review on Synthesis of Synthetic Graphite Using Biomass Waste

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**ABSTRACT**

Commercial graphite is one of the most valuable products that is used in a large number of applications. The huge increase in demand, especially in customizing properties for certain utilization have led to researches on possible alternative that is low-cost, and eco-friendly synthetic graphite production. Biomass wastes are among attractive carbon precursor that has been extensively investigated as raw material for graphite production. The synthesis and application of biomass as carbon precursor have drawn attention due to it availability, sustainability and cost effective. In this critical review, an extensive list of production of graphite from biomass waste is presented. The effects of various process parameters on properties of synthetic graphite are also discussed. This study reviews previous study on different feasible method in synthesizing graphitic carbon.

**KEYWORDS:** Preparation and synthesis; Synthetic graphite; biomass waste.

## INTRODUCTION

Graphite is anisotropic material with good thermal and electrical conductor within the layer (due to in-plane metallic bonding) and poor electrical and thermal conductor to the layers (due to weak van der Waals forces between the layer) [1].Having both metal and non-metal properties making graphite as interesting material in wide application. Graphite is suitable to be used as electrochemical electrodes and brushes, as it possess good electrical conductors properties[2]. Additionally, graphite is also suitable material for casting and moulding industry due to its high melting point properties. Ability of carbon layer in graphite to slide within the layer making it convenient to be apply as lubricant and pencil material [3]. Although graphite has such a large variety of applications, but still there are supply risk issues. It has a vast demand and reserved supply. So, synthetic graphite will be a better alternative to solve this problem.

Production of synthetic graphite has attracted tremendous interest in recent years considering on increasing demand each year. Recently biomass waste has been identified as potential precursor for graphite production due to it omnipresent, environmentally benign and low cost. It has the merits for being abundant, cheap and clean with high utilization potential [4]. A key aspect of graphite production is using high carbon content material as feedstock. A number of researchers have investigated on numerous numbers of biomass as precursor in graphitic carbon synthesis. To date, various approaches have also been utilised to synthesizing synthetic graphite such as laser ablation, arc discharge, chemical vapor decomposition, thermal heating, microwave heating and Joule heating. After all, not every method is suitable to be implement in biomass feedstock.

The usage of biomass in energy generation and another chemical production will help in economic growth for agriculture based country. It help reducing dependency toward fossil fuel and producing more job opportunity in agriculture, forest management, oil and chemical industry [5]. Biomass play a vital role in energy supply as approximately 25% of global energy demand were generated by biomass waste. However, there is still an issue arise on food vs fuel controversy, the usage of edible biomass such as sugars, starches, and vegetable oil for large scale production of fuel have cause tremendous issue on food supply shortage [6]. The usage of biomass in green and effective way will definitely give significant impact on environment [7].Various process has been employed to convert biomass into fuel and chemical including gasification, pyrolysis and hydrolysis. Gasification process are used for fuel production, meanwhile another routes are used for other biomass derivative product. Renewable raw material was viable alternative to produce synthetic products. If special functional properties of biomass such as biocompatibility, biodegradability and carbon contents are being utilize fully, biomass end product definitely can be utilize in wide industrial application[8].

List of different agricultural wastes that can be used as raw materials for the production of synthetic graphite is given as list 1.

**List 1: Agricultural wastes.**

| S.N. | Agricultural Waste |
|---|---|
| 1 | Softwood sawdust |
| 2 | Wood derived scaffolds |
| 3 | Hemp grass |
| 4 | Seafood waste |
| 5 | Chitosan |
| 6 | Bamboo |
| 7 | Wood |
| 8 | Coconut shell |

**Synthesis methods for the production of carbon graphite**

One of feasible pathway to prepared carbon material is via thermal heating method[56]. Thermal heating method is the process that utilized heat to transform biomass into energy or chemical product. In thermal heating method, the process will result in most carbon stay and other element ejected. In fact most of carbon product used today was derived from carbon-rich organic precursor treated at elevated temperature in inert gas flow [9]. Hydrothermal treatment of biomass contains five procedure including hydrolysis, dehydration, decarboxylation, polymerization and aromatization.

Microwave heating have attract lot of interest in carbonaceous material synthesis due to its rapid heating, low synthesis temperature, and environmental friendly [10].This process used electromagnetic wave to deliver energy in form of radiation. Previous research reported that graphitic carbon from biomass can be fully synthesis via microwave assisted method. Microwave heating is new developing method that will help reducing time consumption and energy consumption. It can be considered a new energy-efficient graphitization method. Another method is ultra-sonic assisted method .Ultrasonic wave is high frequency mechanical wave that come from transducer that usually made from piezoelectric crystal [11-12].Among important ultrasonic wave effect is mechanical, thermal and cavitation. The huge energy generated from ultrasonic method can cause separation of fibre, degradation and even changing crystalline degree.

Beside conventional thermal treatment and microwave heating another method proposed by Xu and team on producing graphite via ultrasonic-assisted method using wheat straw [13]. Ultrasonic method was proposed as considering on high pyrolysis temperature and high energy consumption on conventional method nowadays that are not suitable for industrial application. Ultrasonic assisted method involves three main process which is degradation of lignin, graphene formation and graphitization process. The experimental part starts by cutting the wheat straw. Then raw-material will be processed using ultrasonic reactor, and

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ultrasonically reacted for 30 min and repeated for 3 times. Xu et al. reported that graphite material was found unexpectedly in the ultrasonic-assisted pulp (UP) of wheat straw. Feng et al introducing new method in transforming lignin-based biomass into highly crystalline graphitic carbon by Joule heating process. Graphitic carbon from biomass can be synthesis via various methods including graphitization via heat treatment, microwave heating and Joule heating method.

## CONCLUSION

The transformation of biomass waste to valuable carbon material were successfully obtain, the addition of chemical treatment before heating process will enhance the physical structure of graphitic carbon structure depending on the application desired. Among all method microwave heating were determine as method that required less energy consumption. However, most of the researcher also successfully obtains graphitic carbon at lower temperature by introducing catalyst. Besides enhancing the process catalyst during pyrolysis can also influence in formation of mesopores that help enhancing capability both in adsorption and electron transfer. It can be concluded that biomass derived graphitic carbon is new material that can be widely utilized in different application.

## REFERENCES

[1] R. S. Kalyoncu, U.S. Geol. Surv. Miner. Yearb. Vol . I (2000) 1076.
[2] D. D. L. Chung, J. Mater. Sci. 37(8) (2002) 1475–1489,.
[3] R. J. King. Blackwell Publishing Inc., 22 (2) (2006) 71–77.
[4] British geological, “Risk list 2012,” British Geological (2012).
[5] J. Hoekstra, A. M. Beale, F. Soulimani, M. Versluijs- Helder, J. W. Geus, and L. W. Jenneskens. (2015).
[6] K. Tekin, S. Karagöz, and S. Bektaş. Renew. Sustain. Energy Rev. 40 (2014) 673–687,
[7] J. C. Serrano-Ruiz, R. M. West, and J. A. Dumesic, Annu. Rev. Chem. Biomol. Eng., 1(1)(2010) 79–100.
[8] E. Kuna, R. Behling, S. Valange, G. Chatel, and J. C. Colmenares. Curr. Chem., 375(2) (2017) 41.
[9] J. Vanneste, T. Ennaert, A. Vanhulsel, and B. Sels. Chem Sus Chem, 10(1) (2017) 14–31.
[10] J. Deng, M. Li, and Y. Wang, Green Chem, 18 (2016) 4824.
[11] R. Li, Z. Wang, D. Shen, C. Wu, and S. Gu, Green chemistry (2018)
[12] S. Tong-Qi Yuan, R.-C. Sun, W. Fang, S. Yang, X.L.Wang, and T.-Q. Yuan, Green Chem, 19 (2017), 1794. doi: 10.1039/c6gc03206k.
[13] Y. Liu et al., “Cascade utilization of lignocellulosic biomass to high-value products. 21(2019) 3499. doi: 10.1039/c9gc00473d.

# Chapter: 7

# Green Synthesis of Nanoparticles: A Benign and Ecofriendly Method

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**ABSTRACT**

In the recent years, nanoparticles have emerged as a new hope in the field of material sciences. They have captivated the attention of a large research community due their astonishing properties and a variety of applications in different fields like medicine, industries, pharmaceuticals, textile and agriculture etc. Over the time, lots of chemical, physical and biological synthesis methods have been opted to produce excellent nanoparticles. Chemical and physical synthesis methods require harsh conditions and toxic chemicals to produce nanoparticles. To overcome these drawbacks, green synthesis of nanoparticles has played a vital role. Use of plant extracts and biological entities to synthesize nanoparticles is coined as green synthesis of nanoparticles. Green synthesis of nanoparticles enables the science and nature to work in harmony.

**KEYWORDS:** Nanoparticles, synthesis methods, green synthesis.

## INTRODUCTION

The human race has always been curious to develop new science and technology. The outcome of human aspiration and insight has led us toward one of the most fascinating aspects of material science known as “Nanoscience”. It is defined as the study and understanding of materials at the atomic and molecular levels. The tools that are used to understand and gain control at the atomic and molecular levels are known as nanotechnology. Nanotechnology provides a way to deal with devices and the structures at the nanoscale with completely new properties than bulk. Nanoparticles (NPs) are the foundation of nanoscience and nanotechnology. The word “nano” is obtained from the Greek language which means “dwarf”. Nanomaterials are those materials whose at least one dimension is in the nanometer range (1-100nm). Numerically 1 nanometer equals to $10^{-9}$ m (**Feyman, 1960; Hulla et al., 2015**). Nanoparticle shows distinctive chemical and physical properties than their bulk counterpart; such as optical, electrical, mechanical, biological, and thermal properties. This remarkable difference in the properties of nano and bulk arises due to the shape and size of nanoparticles. At nanoscale (1-100nm) the properties of the material started to change from the bulk. On the basis of dimensionality nanoparticles can be divided into four different parts as shown in the table 1.

**Table 1: Classification of nanomaterials on the basis of dimensionality**

| Classification of nanomaterials | Description | Examples |
|---|---|---|
| 0 Dimensional | Nanomaterials having all their dimensions in the nanoscale. | Spherical nanomaterials, Quantum dots, Polygon, Hollow sphere etc. |
| 1 Dimensional | Nanomaterials having two dimensions in nanoscale while the one is not. | Nanotubes, Nanorods, Nanofibres, Nanowires etc. |
| 2 Dimensional | Nanomaterials having one dimension in nanoscale while the two are not. | Thin films, Nanoplates, Nanocoating etc. |

| | | |
|---|---|---|
| 3 Dimensional | Nanomaterials having all dimensions in beyond nanoscale. | Foams, Carbon Nanobuds, Polycrystals, Fullerene etc. |

**Synthesis of nanoparticles:**

Different applications require different kinds of characteristics of nanomaterials. Shape and size play a significant role in various applications. In order to obtain the nanoparticles of desired size and shape, lots of chemical and physical methods have been introduced by the researchers in the last few years. All these methods are necessary to produce nanoparticles for specific applications. There are mainly two approaches to synthesize nanoparticles: top-down process and bottom-up process. Milling, sol-gel method, solvothermal method, metal reduction, pyrolysis and micro emulsion methods etc. are primarily used to produce nanoparticles. All the above-discussed methods have their own merits and demerits. They have been used enormously in various industrial, household, and agricultural product developments. The demand for nanoparticles in multiple fields is increasing rapidly. Also, the number of nanotechnology-based goods and services accelerating swiftly and attracting mankind. The most important attributes of nanoparticles are shape, size, composition, and type of materials which rule over the selection of applications. Purity and homogeneity are a must in the medical and cosmetic industry. A little bit of impurity in nanoparticles can cause severe harm. Likewise, high-quality performance goods also require uniformity and purity. For the mass production of such kinds of nanoparticles using any of these traditional methods requires lots of uncompromising conditions such as highly reactive substance, high temperature, harsh reducing agents, extensive use of energy and controlled pressure, etc. which are not eco-friendly. Most of these methods are complicated to perform and expensive. The adsorption of toxic chemicals on the surface of nanoparticles leads to various harmful effects as in the cosmetic industry it can show a devastating effect on the skin. In agriculture, the continuous evolution of these harmful chemicals leads to many health problems in living beings as they move from one step to another through the food chain. Waste management and extensive use of heat are emerging as one of the major stumbling blocks in the path of development. As we are moving forward with advanced science and technologies, we are facing more frightening environmental conditions like heavy pollution, health problems, climate change, and resource depletion, etc. Now, it's high time where we should start thinking/working on restoring our priceless environment. To develop some methods that allows mankind to embrace the advancements of technology along with environmental safety.

**Green synthesis of nanoparticles:**

The green synthesis of nanoparticles has emerged as a stepping stone to overcome all these problems and connect technology with environmental safety. The use of plants and micro-organisms for the synthesis of nanoparticles is collectively known as green synthesis or biosynthesis of nanoparticles. Various bacteria, viruses, fungi, and plants are used for this purpose. Synthesis of nanoparticles using plants is more effective than the one using bacteria. Nanoparticles synthesized using plant extract are more stable and uniform with respect to the ones synthesized using micro-organisms. Numerous bio-molecules such as enzymes, carbohydrates, proteins, vitamins, amino acids, glucose, and polysaccharides present in plant extract are responsible for the production of nanoparticles. They behave as a reducing agent as well as capping and stabilizing agents. This method is cost-effective, easy to perform, and environment-friendly. It does not require any kind of harsh chemical conditions and extensive

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use of heat. The main aspects of green synthesis are: solvent medium, non-toxic reducing agents, and environment-friendly capping and stabilizing agents. Plants have been used for detoxification and heavy metal accumulation over the years. Green synthesis of nanoparticles using plant extract is still under exploration and requires lots of studies to understand the chemical procedure of the reaction. Plenty of metal nanoparticles such as gold, silver, copper, zinc oxide, and titanium dioxide have been synthesized using the green method (Peralta-videa et al., 2016; Iravani, 2011). Some of the plant extracts used for the synthesis of different nanoparticles have been listed in table 2. Different parts of the plants like leaves, stems, roots, flowers, and seeds have been used in various reactions as surfactants. Different parts of plants play different roles in the synthesis of nanoparticles and produce nanoparticles with varying characteristics.

**Table 2. List of different plant extracts used for the synthesis of nanoparticles**

| S.N | Material | Precursor | Plant extract | Size and Morphology | Applications | REFERENCE |
|---|---|---|---|---|---|---|
| 1. | Gold | $HAuCl_4$ | Punica granatum juice | 23nm, Different shapes (triangular, pentagonal, hexagonal and spherical) | Catalytic activity | Dash and Bag, 2014 |
| 2. | Gold | $HAuCl_4$ | Cinnamon bark | 35nm, spherical | Fluorescence activity | EIMitwali et al., 2020 |
| 3. | Gold | $HAuCl_4$ | Mimosa tenuiflora bark | 20nm-200nm, Different shapes | Cytotoxicity, Cellular uptake, catalysis | Rodriguez et al., 2019 |
| 4. | Gold | $HAuCl_4$ | Stevia rebadiauna leaf | 20nm, spherical | ----- | Sadeghi et al., 2015 |
| 5. | Gold | $HAuCl_4$ | Coffea arabica seed | 5-40nm, quasi-spherical | Catalysis | Bogireddy et al., 2018 |
| 6. | Silver | $AgNO_3$ | Clitoria ternatea leaves and Solanum nigrum leaves | 20nm and 28nm, spherical | Antibacterial | Krithiga et al., 2015 |
| 7. | Silver | $AgNO_3$ | Azadirachta indica leaves | 34nm, spherical | -------------- | Ahmed et al., 2015 |

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|---|---|---|---|---|---|---|
| 8. | Silver | $AgNO_3$ | Tectona grandis seeds | 10-30nm, spherical | Antimicrobial | Rautela et. al., 2019 |
| 9. | Silver | $AgNO_3$ | Lysiloma acapulcensis | 62nm, quasi-spherical | Antimicrobial | Garibo et al., 2020 |
| 10. | Copper | CuCl | Jatropha curcas leaves | 12nm, spherical | CT-DNA binding and photocatalytic | Ghosh et. al., 2020 |

## CONCLUSION

A variety of nanoparticles synthesis methods such as chemical and physical have been introduced by the researchers over the decades. All these methods have their own merits and demerits. These methods give desired results in the terms of particle size, morphology and uniformity. But, these methods are not environment friendly. So there is need of green environment safe synthesis methods. Green synthesis of nanoparticles is the best option we have.

## REFERENCES

[1] R. Feynman, Caltech Eng. and Sci., 23(5) (1960) 22-36.
[2] J.E. Hulla, S.C. Sahu, and A.W Hayes Hum. Exp. Toxicol., 34(12) (2015) 1318-1321.
[3] S. Iravani Green Chem., 13 (2011) 2638-2650.
[4] J.R. Peralta-Videa, , Hernandez-Viezcas, J.A., Zhao, L., Diaz, B.C., Yuan G., Priester, J.H., Holden, P.A. and J.L. Gardea-Torresdey Plant Physiol. Biochem., 80 (2014) 128-135.
[5] Dash, S.S. and Bag, B.G.. Appl. Nanosci., 4(2014) 55-59.
[6] O.S. ElMitwali, O.A Barakat, R.M. Daoud, S. Akhtar and F.Z. Henari J Nanopart. Res., 22(2020) 309(1-9).
[7] E. Rodriguez-Leon, Rodriguez-Vazquez, B.E., Higueral, A.M., Beas, C.R., Rodriguez, E.L., Navarro, R.E., Esparzal, R.L. and R.A.I. Palomares Nanoscale Res. Lett., 14 (2019) 334(1-16).
[8] B. Sadeghi, M. Mohammadzadeh and B. Babakhani J. Photochem. Photobiol. B, Biol.. (2015).
[9] N.K.R Bogireddy, Pal, U., Gomezc, M.L. and V. Agarwal. RSC Adv., 8 (2018) 24819(1-8).
[10] N. Krithiga, A. Rajalakshmi and A. Jayachitra. J. Nanosci., 2015 (2015) 928204(1-8).
[11] S. Ahmed, S., Ullah, S., Ahmed, M., Swami, B.L. and Ikram J. Radiat. Res. Appl. Sci., 173(2015) 1-7.
[12] A. Rautela, A., Rani,J. and Debnath, M. 2019. Green synthesis of silver nanoparticles from Tectonagrandis seeds extract: characterization and mechanism of antimicrobial action on different microorganisms. J. Anal. Sci. Technol., 10: 5(1-10).
[13] D. Garibo, Borbón-Nuñez, H.A., Jorge N. Díaz León, J.N.D., Mendoza, E.G., Estrada, I., Magaña, Y.T., Tiznado, H., Marroquin, M.O., Ramos, A.G.S, Blanco, A., Rodríguez, J.A., Romo, O.A., Almazán, L.A.C. and A.S. Arce. Sci. Reports, 10 (2020) 12805 (1-11).
[14] M.K. Ghosh, S. Sahu, S. Gupta and T.K. Ghorai. RSC Adv., 10 (2020) 22027(1-9).

# Chapter: 8

# Effect of Shape on Volume Thermal Expansion of Nanomaterials

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**ABSTRACT**

Nanomaterials are the building block of nanotechnology and they exist in different dimensions, shapes and sizes in nature. A simple theoretical method has been developed to study the thermal behaviour of nanomaterials by modifying the He and Yan model. This behaviour give vital information about their intrinsic structural characteristics. As external parameters like temperature, pressure, shape, size and dimensionality of nanomaterials change, their behaviour changes. He and Yan proposed an equation of state (assuming that Anderson–Grüneisen parameter ($\square_T$) to be independent of temperature) for the study of temperature effects on interatomic separation and bulk modulus of the bulk materials. In the present study, the He–Yanmodel has been modified by introducing the volume thermal expansion coefficient for nanomaterials ($\square_{on}$) in place of its bulk equivalent ($\square_0$). The modified equation of statehas been applied to silver nanomaterials. The calculated results are compared with available experimental data and their bulk counterparts. It was found that the size- dependent properties of nanomaterials changes with the relative number of atoms present at the surface. Hence the energy linked with the atoms also changes.Consistency with experimental data supports the validity of the proposed model.

**KEYWORDS:** Anderson–Grüneisen parameter, equation of state, nanoparticles, nanotechnology, thermal properties.

## INTRODUCTION:

The considerably diverse properties of nanomaterials have attracted researchers for decades. Atthe nanoscale, the properties of elements depend on material size, shape and dimension (cf. changes in properties of semiconductors due to electronic confinement and of metals due to surface effects). Nanomaterials have been used in many fields, including medicine, biology, engineering, agriculture, physics and chemistry due to the peculiar characteristics engendered by their significantly small size, and are having a great impact on both basic sciences and industrial applications. As object size decreases, thermal properties of the material also change; e.g., the surface energy of a crystal increases and in consequence the melting temperature decreases [1–3].

In the present work, we have developed an equation of state to study the thermal and dimension-dependent properties of nanomaterials by modifying the He and Yan equation [4]. Thermal studies of nanomaterials yield important information regarding interatomic separation and structure. Many effects have been observed, such as transformation of the nanoscale components and their interactions due to a change in temperature [5].

### Theoretical approach

The relationship between system variables like pressure, temperature and volume is known as the equation of state; it provides basic information about the system. An isobaric equation of state provides the relation between temperature and volume at constant pressure. He and Yan [1] have proposed a model to study the relative volumetric thermal expansion ($V/V_0$) of materials assuming that the Anderson–Grüneisen parameter ($\square_T$) is independent of temperature T:

$$V/V_0 = \exp[á\ (T - T\ )\{1 + (1/2)á\ ä\ (T - T\ ) + (1/3)\ á^{2}\ ä^{2}(T - T\ )^{2}\}] \qquad (1)$$

where $T_0$ is a REFERENCE temperature. Eqn (1) can be modified for nanomaterials by incorporating the size and dimension effect on the volume thermal expansion coefficient $\square_\square$ as suggested by Kumar et al. [12]. For spherical nanoobjects (i.e., nanoparticles) the volume

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thermal expansion is given as:

$$\alpha_{0n} = \alpha_b (1 - (2d/D))^{-1} \quad (2)$$

where d and D denote, respectively, the atomic diameter and particle size. The modified He–Yan equation for spherical nanoparticles can therefore be written as:

$$V/V_0 = \exp[\alpha_b (1 - (2d/D))^{-1}(T - T_0)\{1 + (1/2)\,\alpha_b(1 - (2d/D))^{-1}\delta_T(T - T_0) + (1/3)\,\alpha^{2}(1 - (2d/D))^{-2}\,\delta^{2}(T - T\ )^{2}\}] \quad (3)$$

Using eqn 3 the relative volume thermal expansions of silver (20 nm) have been studied. The Anderson–Grüneisen parameter $\delta_T$ is taken to have a value of 4 [13].

**Results and discussion**

Relative volume thermal expansion ($V/V_0$) have been calculated for spherical nanoparticles using eqn (3) and compared with bulk data using eqn (1) (Fig. 1). The expansion of the nanomaterials is greater than that of their bulk counterparts at all temperatures. The explanation is that there are relatively more atoms present at the surface of nano objects compared with the bulk, as a result of which the surface energy of nanomaterials is higher, and it expands more than the bulk. It indicates that there are relatively more atoms present at the surface of spherical particles than at the surface of nanowires and nanofilms. Hence, less thermal energy is required to expand the spherical nanomaterial in comparison with the nanowires and nanofilm. The experimental data best fitted matches the calculated results for the spherical nanomaterial, indicating that the most abundant shape of practically available nanomaterials is spherical.

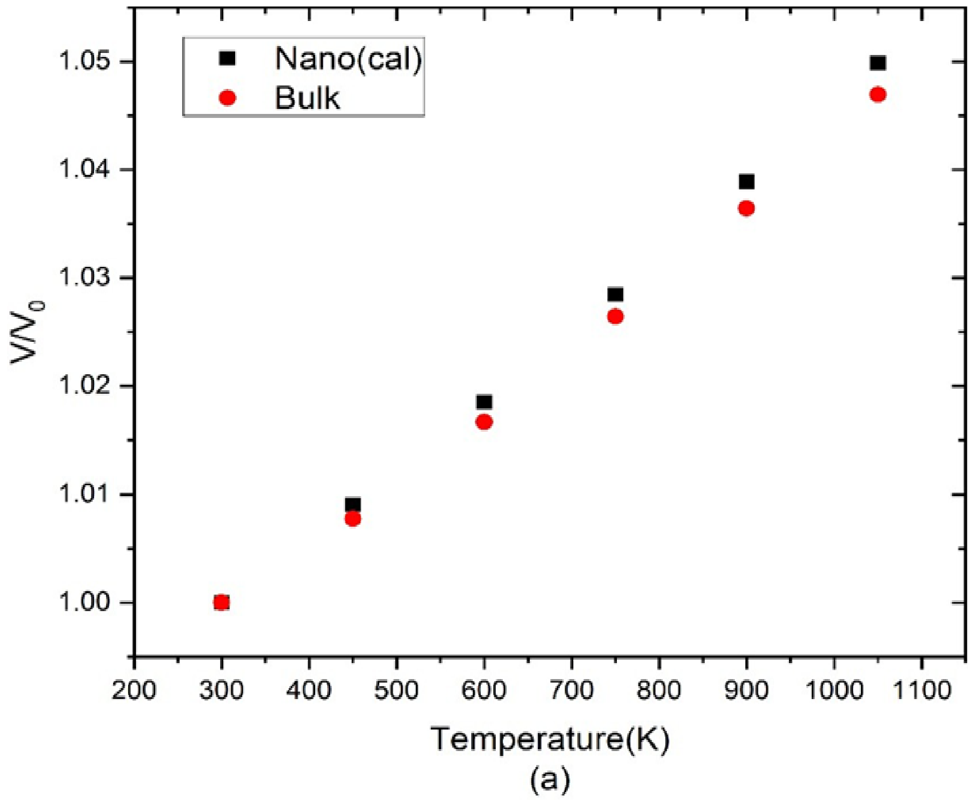


Figure 1. Temperature variation of volume thermal expansion V/V0 for silver (20 nm).

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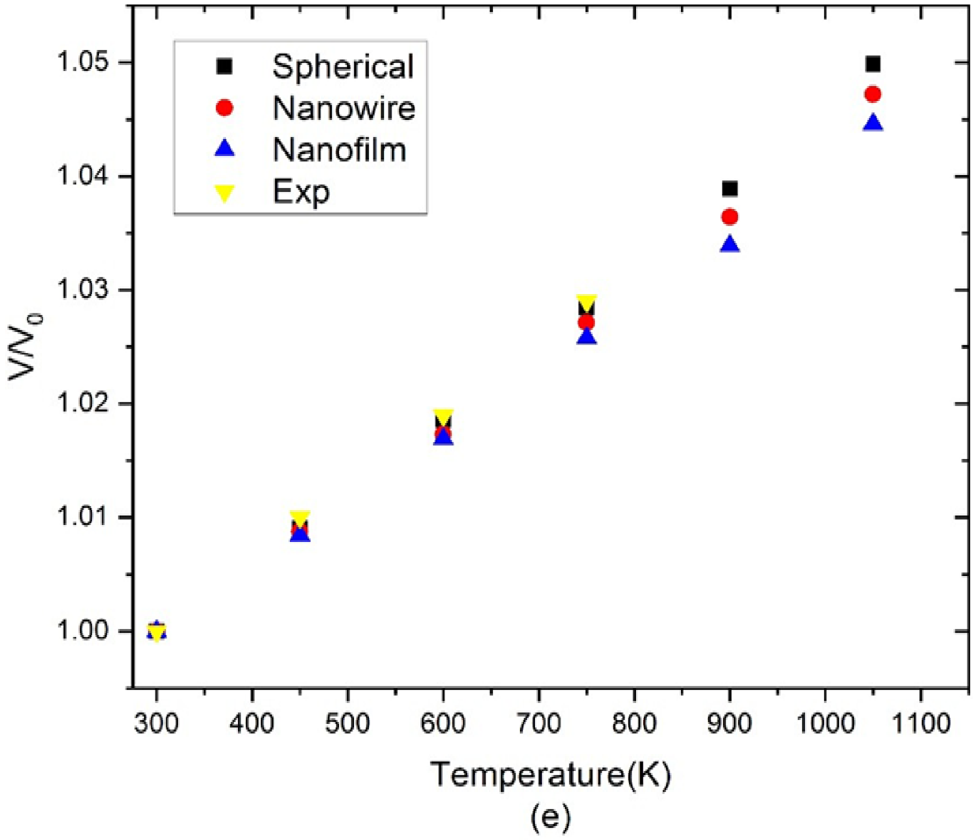


Figure 2. Volume thermal expansion V/V0 for (e) silver (20 nm)4.CONCLUSIONs

Nanomaterials show greater volume thermal expansion in comparison to their bulk counterparts. The expansions of materials having different numbers of dimensions in the nanoscale, hence different surface-to-volume ratios, are commensurate with the relative numbers of surface atoms, which are bound with lower energy and hence easier to expand. Agreement with available experimental results supports the validity of the proposed equations.

## REFERENCES


[1] Roduner, E.. Chem. Soc. Rev. 35 (2006) 583–592.

[2] Eustisa, S. & El-Sayed, M.A.. Chem. Soc. Rev. 35 (2005) 209–217.

[3] Koole, R., Groeneveld, E., Vanmaekelbergh, D., Meijerink, A. & Donegá, C. de M. 13–51. Springer (2014).

[4] He, Q. & Yan, Z.T.Physica Status Solidi B223 (2001) 767–771.

[5] Chandra, K., Singh, M., Kush, L. & Singh, M.. Intl J. Adv. Res. Sci. Engng 3 (2014) 100–108.

[6] Sahu, R.K. & Somashakher, S.H. IOP Conf. Series: Mater. Sci. Engng 225 (2017) 012257.

[7] Zhang, X.F., Liu, Z.G., Shen, W. & Gurunathan, S.. Intl J. Mech. Sci. 1534 (2016) 17.

[8] Singh, M. & Gupta, B.R.K. Intl J. Adv. Res. Engng Technol. 6 (2014) 2514–2523.

[9] Zhang, W.F., He, Y.L., Zhang, M.S., Yin, Z. & Chen, Q.. J. Phys. D: Appl. Phys. 33 (2000) 912–916.

[10] Borse, P.H., Kankate, L.S., Dassenoy, F., Vogel, W., Urban, J. & Kulkarni, S.K.. J. Mater. Sci. 13 (2002) 553–559.

[11] Seelaboyina, R., Pathak, N., Gulve, R.P., Leirmann, H.P. & Saxena, S.K. Thermal Conductivity 27 (2005) 647–666.

[12] Kumar, R., Sharma, U.D. & Kumar, M. Mod. Phys. Lett. B26 (2010) 26–47.

[13] Anderson, O.L., pp. 362–370. Oxford: University Press (1995).


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# Chapter: 9

# Lithium-Sulphur Batteries: A Reliable Energy Source

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**ABSTRACT**

Energy is the core of the entire phenomenon happening around us. To keep the world moving and performing outstanding deeds energy is a must. But the sources for the energy are limited so, there is always a need of better performing energy sources. To meet the demands of an electric future, new battery technologies will be essential. The research and development of advanced energy-storage systems must meet a large number of requirements, including high energy density, natural abundance of the raw material, low cost and environmental friendliness, and particularly reasonable safety. As the demands of high-performance batteries are continuously increasing, with large-scale energy storage systems and electric mobility equipment, lithium–sulfur batteries have become an attractive candidate for the new generation of high-performance batteries due to their high theoretical capacity (1675 mA h $g^{-1}$) and energy density (2600 Wh $kg^{-1}$).

**KEYWORDS:** Energy; Lithium –sulphur batteries, energy density.

## INTRODUCTION

The increasing use of fossil fuels has inevitably generated environmental pollution issues, and therefore alternative sustainable and clean energy options need to be researched and developed. Recently, much attention has been paid to solar and wind energy; however, these are both intermittent and uncontrollable. In this context, and with the continuous development of science and technology and improvements in people's living standards, higher demands are being made with respect to the performances of batteries. Among various types of batteries, lithium–sulfur (Li–S) batteries have received particular attention because of their fairly low cost, and high theoretical specific capacity (1675 mA h $g^{-1}$) and energy density (2600 Wh $kg^{-1}$)[1-2].

Lithium sulfur (LieS) battery has been studied for almost 50 years since Herbt and Ulam first introduced the concept of elemental sulfur as a positive electrode material in 1962. However, the spotlight hasn't returned to this battery system until there is a renewed interest in electric vehicles in recent years. The major impediments to the development of Li-S battery are low active material utilization rate, poor cycle life and low coulombic efficiency [3-4]. The insulating nature of sulfur and lithium sulfides decreases the utilization rate of active material. And the high solubility of lithium polysulfides generated during the electrochemical-reduction reaction process, results in severe capacity loss. The so called shuttle mechanism resulting from the migration of lithium polysulfides in the liquid electrolyte, even penetrating through the separator, followed by immediate reaction with metallic-lithium anode and the formation of Li-S, is considered as the major reason for the low coulombic efficiency. Moreover, the gradually deposition and aggregation of insulating $Li_2S$ on the cathode's surface results in a poor high-rate capacity and cycle stability.

An Li–S battery generally comprises a cathode, binder, separator, electrolyte, anode, and collector. Elemental sulfur is the main cathode material of batteries, and this is closely related to its structure and electrochemical properties. Elemental sulfur has a crown-like structure comprising eight sulfur atoms and possesses outstanding thermodynamic stability. The high capacity and charge–discharge performances of elemental sulfur are achieved through S–S bond electrochemical fracture and linkage in the $S_8$ molecule.5 In the discharge process, every sulfur atom transfers two electrons, which is a greater quantity compared to a metal ion (one or less than one electron per atom). Furthermore, sulfur has many other advantages, such as abundance in nature, non-toxicity, and low cost. Hence, elemental sulfur is considered to be one of the optimal cathode materials for a rechargeable battery.

Although an Li–S battery has a very high specific capacity and energy density in theory, capacity attenuation is extraordinarily quick during the cycle process. This makes Li–S battery commercialization a real challenge. The issues causing capacityattenuation in Li–S batteries include the low electrical and ionic conductivity of elemental sulfur and the discharge product, Li2S, the "shuttle effect" caused by the dissolved polysulfide species (PS), lithium anode deterioration due to surface passivation, an unstable solid-electrolyte interphase, and the huge volume change in the conversion reaction and associated safety concerns. Because of these limitations and challenges, further development is needed to improve the electrochemical performance of Li–S batteries.

In this review, the principles and characterization of charge–discharge processes for Li–S batteries are presented and discussed. Particular attention is paid to the selection of cathode materials, as well as the other components, and the structural designs for Li–S batteries. Various strategies for structural design and modification, as well as configurational innovations of Li–S batteries, are presented and introduced.

## Principle of Lithium-Sulphur batteries

Because sulfur is in a charged condition during the operation of a battery, and a potential difference exists between the elec -trodes, the batteries start to work in a discharged state. In the battery system, the lithium ions diffuse from the anode to the cathode and react with cathode materials during the discharge process. Meanwhile, the flowing electrons deliver power through the external circuit. During the charge process, lithium ions and electrons return to the anodes in the opposite direction, and they store chemical energy through the transformation of electrical energy.

## Sulphur as a cathode material

Sulfur is one of the main cathode materials in Li–S batteries, because it has an excellent theoretical specific capacity(1675 mA h g−1) and energy density (2600 Wh kg−1). Although sulfur is a suitable cathode material, it is an insulator of electrons and ions, which makes the cathode conductivity poor. Furthermore, the charge-transfer resistance of sulfur is quite large, and a serious "shuttle effect" of PS still exists in the utilization of Li–S batteries. As a result, suitable conductive materials are necessary to enhance the electronic conduction of battery electrodes.

## Sulphur/Carbon composite

Due to being ultra-lightweight, and having a high specific surface area and a stable and open framework, leading to intimate contact between the sulfur and highly porous base material, porous three-dimensional carbon–sulfur cathodes are the focus of many studies in battery research. The size of the sulfur crystals in the synthesis process was on the nanoscale, and the framework of the graphene aerogel was stable and open, leading to intimate contact between the sulfur and graphene conductive matrix. Thus the strong adsorption ability of functional groups of graphene was demonstrated. A battery with this cathode presented an excellent rate capability and outstanding cycle performance. Combining the aforementioned advantages of a porous structure and carbon hybrids, a large number of porous carbon-based composite materials are also extensively applied in the development of cathodes for Li–S

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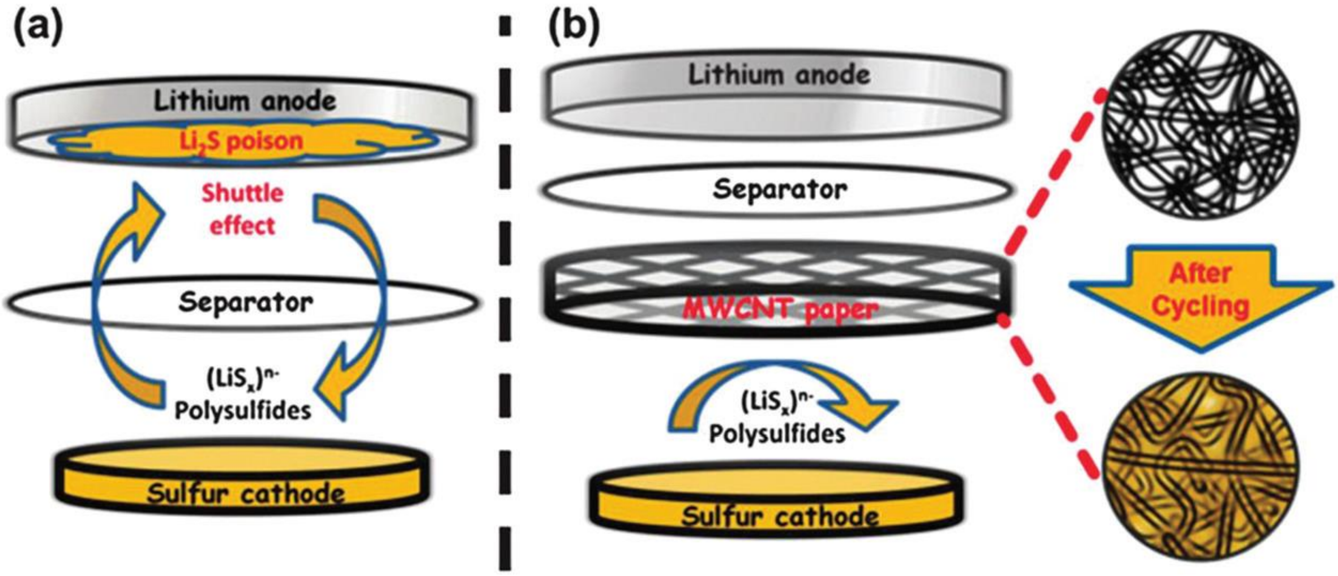
batteries. In order to further improve the content of sulfur in the cathode for Li–S batteries and simultaneously lower the weight of the battery cathode, researchers have been investigating sulfur nanospheres with a concave structure.

Because nano-sized metal oxides have many advantages, such as a high specific surface area and strong adsorption performance, they are regarded as additives for battery cathodes. Not only can these materials increase the contact area between the electrode and electrolyte, but they can also inhibit the discharge product from dissolving in the electrolyte. Gorkovenko et al. researched different metal materials, including vanadium oxides, silicates, aluminum oxides, and transition-metal chalcogenides, and regarded them as the battery cathode content. The discharge capacity was enhanced because of the high conductivity of the cathode, but the improvement in the electrochemical properties as a result of only using metal material mixing was still limited. Carbonaceous materials or metal oxides are included in a selection of embedded sulfur-based materials and conductive agents used as cathode materials. And electrode designs of carbonaceous materials with metal oxides usually included nanostructured materials. Nanostructured designs, which are capable of trapping sulfur and PS in a battery cathode by applying physical/kinetic and chemical/thermodynamic sequestration, have played a role in enhancing the performance of batteries.




A schematic cell configuration of rechargeable Li–S batteries: (a) traditional configuration with severe “shuttle effect” and Li2S poison problems and (b) New configuration with the MWCNT interlayer

## 4.CONCLUSION

A comprehensive review of the current state of research and development in Li–S batteries is presented and discussed. TheLi–S batteries are believed to be the most promising candidates for high-performance energy storage materials. Ideally, if a complete reaction between sulfur and lithium occurs, the theoretical specific capacity of an Li–S battery could be as high as 1675 mA h g−1 and the energy density could reach 2600 Whkg−1.

## REFERENCES

[1] R. Noorden, Nature, 2013, 498, 416.
[2] D. Zheng, X. R. Zhang, J. K. Wang, D. Y. Qu, X. Q. Yang and D. Y. Qu, J. Power Sources, 2016, 301, 312–316.

[3] Y. J. Choi and Y. D. Chung, J. Power Sources, 2008, 184, 548–552.
[4] P. G. Bruce, S. A. Freunberger, L. J. Hardwick and J. M. Tarascon, Nat. Mater., 2012, 11, 19–29.
[5] F. Gaillard and E. Levillain, J. Electroanal. Chem., 1995, 398, 77–87.
[6] A. Manthiram, Y. Z. Fu and Y. S. Su, Acc. Chem. Res., 2013, 46, 1125–1134.
[7] D. Bresser, S. Passerini and B. Scrosati, Chem. Commun., 2013, 49, 10545–10562.
[8] J. J. Hu, G. R. Li and X. P. Gao, J. Inorg. Mater., 2013, 28, 1181–1186.
[9] A. Manthiram, Y. Z. Fu and S. H. Chung, Chem. Rev., 2014, 114, 11751–11787.
[10] X. Ji, K. T. Lee and L. F. Nazar, Nat. Mater., 2009, 8, 500.
[11] G. He, B. Mandlmeier, J. Schuster, L. F. Nazar and T. Bein, Chem. Mater., 2014, 26, 3879–3886.
[12] Q. Pang, D. Kundu, M. Cuisinier and L. F. Nazar, Nat. Commun., 2015, 5, 4759.

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# Chapter: 10

# An Overview-Micro Hydro-Electric Energy Generation

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**ABSTRACT**

Increasing population, industrialization, and modernity have all increased the need for energy. The need for renewable energy sources is driven by issues like carbon dioxide ($CO2$) emissions and the depletion of traditional energy sources, and hydro energy appears to be the most dependable of these. By transforming hydro energy into electrical energy, micro-hydro, or hydro energy on a "small" scale, supplies electricity to local settlements. This essay gives a brief outline of the micro-hydro system by examining some of its fundamental parts, such the turbine and generator that enable this conversion process. To give the fundamental understanding of the micro-hydro system, the estimation of the system's potential energy, which depends on the head and flow rates, planning, benefits, and limitations will also be covered.

**KEYWORDS:** Wireless Electricity Transmission, high-voltage lines, electromagnetic field.

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## INTRODUCTION

The most important sector for a nation's growth is energy [1]. Promoting education, health, transportation, and infrastructure in order to achieve a livable quality of life is essential for survival and important for developmental activities. It is also a crucial element for economic growth and employment [2]. Rapid population expansion, industrialisation, urbanisation, and economic growth have all increased demand for electricity generation significantly [3]. The need for energy is unquestionably rising around the globe as human activity and population continue to expand, and this trend is most likely to persist in the coming years [4]. One of the most sustainable and cleanest sources of energy is hydropower [3]. There are several ways to use water to generate energy, including erecting a barrage across an estuary to harness tidal flows, using massive dams to store water that can be used to generate large amounts of electricity, and using waves in a variety of ways [6]. One of the most economically advantageous energy solutions for the electrification of rural areas in developing nations is micro-hydropower [7].

Micro hydropower is the term for electrical energy that derives from the force of moving water and is used to power a home or small community [6, 8]. Hydro means water, and micro means tiny size. A renewable energy source coming from the hydrological cycle, micro hydro systems are regarded as sustainable due to their absence of water impoundment and presumed little environmental effect [9]. Water wheels were first employed as the technology's primary mode of propulsion in Himalayan communities to power tools like grinders [10]. There are many levels of "smallness" in hydropower. There is still no currently accepted definition of "small hydro" on a global scale [6, 10–12]. The categorization of hydropower systems according to the amount of electricity produced is shown in Table 1.

The ideal geographic regions for micro-hydropower systems are those with steep rivers, streams, creeks, or springs running year-round, such as in mountainous regions with substantial year-round rainfall [14]. A hydro system is made up of several interrelated parts that work together to produce energy and water flow [15]. Turbines, generators, headworks, intakes, gravel traps with spillways, headrace canals, forebay and desilting basins, penstock pipes, powerhouses, tailraces, drive systems, controllers, and transmission/distribution networks are the main elements of a typical micro-hydro system [14].

A discussion of some of these fundamental elements, such as developing a micro-hydro project, the benefits and drawbacks of micro-hydro power, and the assessment of the system's output energy, will be included in this study.

**Table 1: Hydropower size classification [6, 13].**

| S.no. | Classification | Rated power | Consumer |
|---|---|---|---|
| 1. | Large-hydro | >100MW | supplying typically a vast energy grid, |
| 2. | Medium-hydro | 15- 100MW | often supplying a grid |
| 3. | Small-hydro | 1-15MW | usually supplying into a grid |
| 4. | Mini-hydro | 100kW- 1MW | either standalone plans or, more frequently, grid feeding |
| 5. | Micro-hydro | 5kW-100kW | often supplied energy for a small |
| 6. | Pico-hydro | <5kW | community or rural enterprise in off-grid, remote locations |

**Hydro-turbine**

The turbine is the central component of a hydroelectric power plant, where water power is transformed into rotational force to power the generator [15]. They are often divided into two categories: impulse turbine and response turbine [15–19]. They are further divided into tangential flow, radial flow, axial flow, and mixed flow based on the direction of the flow [16]. The turbine, which has a shaft connecting it to a generator, is turned by the water striking its blades [20]. Depending on the desired generator speed, the turbine is either linked to the generator directly or indirectly through gears, belts, or pulleys [13].

**Impulse Turbine:** High head micro-hydro systems often employ impulse turbines since they have the least complex design [21]. The runner is typically moved by the water's velocity, and it discharges to atmospheric pressure [22]. At locations with high head and little flow, these turbines perform better. The most cost-effective hydro projects are often those with high head since, for a given quantity of electricity, a higher head requires less water, which results in smaller and, therefore, less expensive equipment [7]. The pipeline at Forebay receives water injection. This pipeline transports water to a nozzle, where the water's kinetic energy is utilised to push or impulse the blades connected to the alternator.

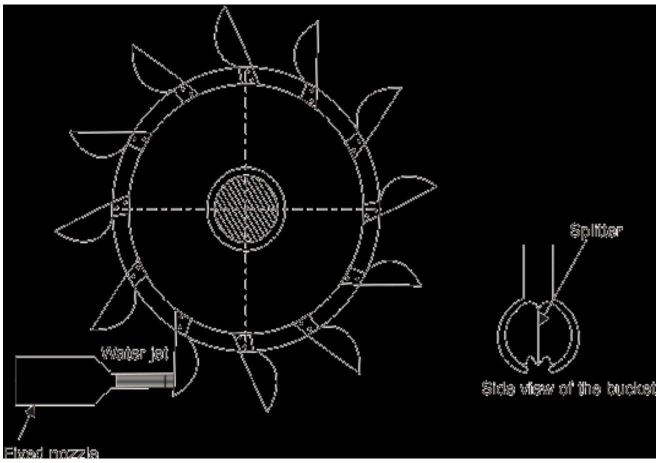


**Fig. 1: A model of an impulse turbine, the Pelton Wheel [23]**

**Reaction Turbine:** Pressure rather than velocity is the primary factor in the production of energy by highly efficient reaction turbines [21]. At locations with strong flow and low head, they function better [15]. In order to push the runner blades, reaction turbines use the incoming water flow to create hydrodynamic lift forces [7] and operate completely submerged in the water [15]. They require far larger flow rates than an impulse turbine, although they can still function at heads as low as 2 feet [8]. Examples of this kind are Kaplan/propeller turbine [15, 24] and Francis (figure 2) turbines.

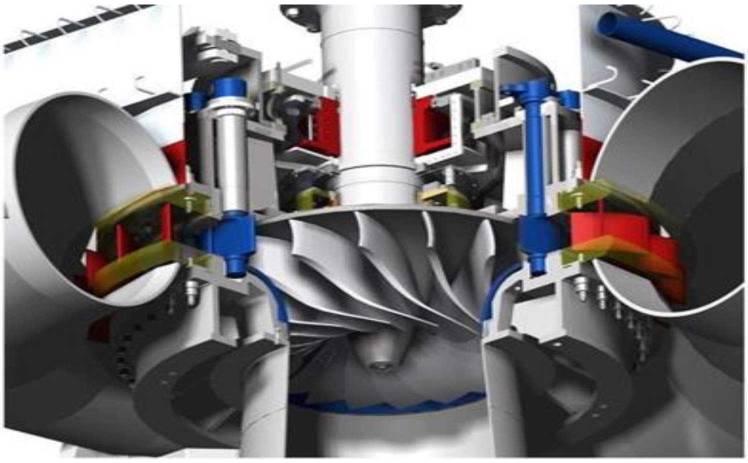

**Fig. 2: Francis turbine, a kind of reaction turbine [17]**

**Hydro-generator**

The turbine's mechanical (rotational) energy is converted to electrical energy by generators [11]. The basic idea behind how generators work is that a voltage is induced in a coil of wire when it is moved past a magnetic field [14]. In order to generate current, magnets within the fixed-coil generator revolve, and as the turbine blades turn, so does the generator's rotor [20]. The fundamental criteria to be taken into account when choosing an appropriate type of electrical generator are the type of desired output, hydraulic turbine operation modes, and type of electrical load, such as interconnection with the national grid, battery storage, or an isolated system supplying a variety of domestic or industrial loads [25]. Induction and synchronous generators are the two main categories of generator [18]

Induction (Asynchronous generator): Asynchronous generators are straightforward squirrel-cage induction motors that operate at a speed directly correlated to system frequency and are incapable of voltage control. By using their own magnets to absorb reactive energy, they get their excitation current from the grid. The absorbed reactive energy may be made up for by adding a bank of capacitors [11]. Due to benefits including availability, affordability, and resilience, asynchronous generators are often appropriate for the generation of micro hydropower [26]. As a source of isolated power supply, the induction generator (IG) has numerous benefits over a traditional synchronous generator. The primary benefits of IG are lower unit costs, increased durability, brushless operation (in squirrel cage architecture), smaller size, lack of a separate DC supply, ease of maintenance, and self-protection from extreme overloads and short circuits [13].

Synchronous generator: Synchronous generators have a DC excitation system (rotating or static) connected to a voltage regulator to control voltage, frequency, and phase angle before the generator is connected to the grid and to provide the reactive energy needed by the power system once the generator is connected to the grid [11]. The excitation system and automated voltage control of a synchronous generator are typically built-in [28]. It has better efficiency but is more expensive [18]. It may be utilized in stand-alone or grid-tied systems.

The output energy

Energy is simply converted from one form to another during the creation of electrical energy. At its shaft, the turbine transforms water energy into rotational energy, which is then transformed into electrical energy by the generator. At every step of conversion, some of the energy will be consumed to combat frictional force. The amount of energy produced annually (in KWH) may be estimated as follows:

$$E = \rho * Q * H_n * \eta * n \qquad (1)$$ [2,5,6,13,18]

Where, g = gravitational constant (9.8 m/s2), ρ = water density (1000 kg/m3), Q = flow rate (m3/s), Hn=net head (m) and n = number of hours in year for which the specified flow occurs.

η = efficiency which is a measure of how much energy is actually converted [15].

$$\eta = \eta_{tu} * \eta_{ge} * \eta_{gb} * \eta_{tr} \qquad (2)$$ [2]

Where, $\eta_{tu}$=turbineefficiency,$\eta_{ge}$ = generatorefficiency,$\eta_{gb}$=gearboxefficiency and$\eta_{tr}$ =transformer efficiency. Everything about the hydro system that must be understood is determined by the head and flow, including the size of the pipeline, the kind of turbine, the rotational speed, the size of the generator, and even an approximate estimate [15].

**Flow rate estimation**

The term "flow" refers to the volume of water falling. It is often measured in cubic metres per second, although in small-scale plans, it is frequently recorded in litres per second (where 1 cubic metre per second is equal to 1000 litres per second) [34]. A number of techniques are available [2] to measure the water flow rate (discharge), including the container/bucket method, the weir method, and the float/velocity area approach. The bucket technique of measuring flow rate is damming your stream with logs or boards to direct its flow into a bucket or container [21]. It only functions for relatively tiny systems. [15] The flow rate may be estimated by simply dividing the container's capacity by the filling time [14]. This yields the rate at which the container fills.

A temporary weir could be able to be constructed if the watercourse being built is relatively modest (let's say, 4 m3/s) [11]. This is a small, notch-measured wall or dam across the stream that might be used to direct all water [35]. It is relatively simple to measure the water's height and width in order to calculate the flow since the water is all routed through a precisely rectangular space [15]. Installing a stake at the crest's level, measuring the weir table's height and breadth in centimetres and evaluating the flow rate in litres per second are all necessary [36]. Measurements should be made throughout the longest time period feasible, under all circumstances, because a stream's water content changes [34].

The float approach is useful for bigger streams where building a weir might not be feasible or for getting an instantaneous estimate of the flow. If you can find a segment of approximately 10 feet in length where the stream's width and depth are somewhat constant, this float approach can be helpful for big streams [11]. The cross-sectional area of the river and the mean water velocity through it are measured using this method, which is a common one for medium- to large-sized rivers. It is a practical way for quickly assessing stream flow. A natural watercourse should be split into a number of trapezoids in order to calculate its cross-sectional area(s) (figure 3). The cross-section would be determined by: measuring the trapezium sides.

$$s = b((h_1 + h_2 + \cdots \ldots . h_n) \div n) \quad (3)$$[34]

Where h1, h2,...hn are the respective heights of each division, n is the number of series of trapezoids, and b is the breadth of the river.Marking out a portion of the stream that includes the location where you take the cross section and extends for approximately 10 feet [15] is a useful technique to gauge speed. Before the stated length, a floating object is dropped, and the time it takes to go that distance is recorded as t (seconds). The surface speed (m/s) is calculated as the product of length L and time t [11]. The above value must be multiplied by a correction factor, which can range from 0.60 to 0.85 depending on the depth and roughness of the riverbank and bottom of the watercourse [35]. A generally accepted value is 0.65. The area times the velocity equals the flow rate.

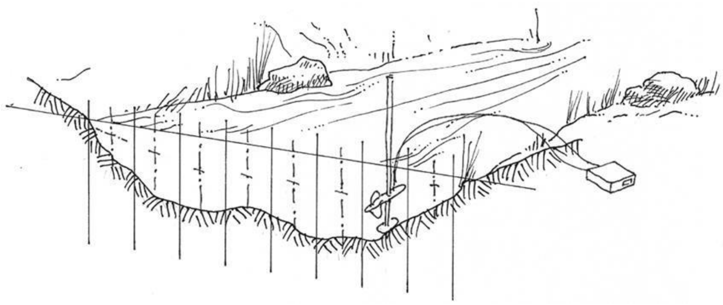

**Fig.3: velocity-Area method [36]**

**Head size measuring**

Water pressure known as head is produced by the height difference between the water input and the turbine [15]. When measuring head, accuracy is essential since it is required to determine the hydrodynamic design of the turbine blade or bucket, predicted power, and the kind of turbine to be utilised. This head can be produced by dams, by directing the water parallel to the river in a channel with minimal head losses in comparison to the natural stream, or quite frequently by a combination of the two [34].

Gross head measurements are often taken in the field using surveying methods. The procedures to be used will be dictated by the level of measurement precision needed [35]. Several techniques, such as meridian clinometers, angular levelling, pocket sighting levels, spirit levels, and the plank (or string) approach, were employed in the past [36]. With a height measuring precision of 0.4 mm and a 4 second automated height and distance display, current

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electronic digital levels can store over 2,400 data points in their internal memory [11]. The net head is the result of these measures. After calculating the gross head available, it is required to account for losses caused by garbage racks, pipe friction, bends, and valves. In addition to these losses, some turbine types must be configured to release to the atmosphere above the tail water's flood level (the lower surface level) [35]. A pipeline that has been appropriately designed will produce a net head of 85% to 90% of the measured gross head [15].

**Systems for diversion**

The term "Diversion System" describes a method for moving water away from its original source and towards a turbine. Providing a deep enough pool of water to generate a smooth, air-free conduit and removing dirt and debris are the two main functions of a water diversion system [15]. There are intakes, spillways, forebay tanks, penstocks, tailraces, etc. [37]. Diverting and moving water may be done in a number of ways, but there are primarily two types of systems for doing so: closed and open systems. For the micro-hydro turbine to operate at its peak efficiency, the appropriate kind of diversion system must be used [8]. When water is diverted through a closed system (like a pipe), the system is sealed off and protected from the effects of gravity while the water is in the pipe (figure 4). Bernoulli's equation provides the amount of energy in water flowing through a closed, circular conduit at a given pressure:

$$H_1 = h_1 + \frac{P_1}{Y} + \frac{V_1{}^2}{2g} \qquad (4)$$

where H1 represents total energy, h1 represents elevation head, P1 represents pressure, represents the water's specific weight, V1 represents velocity, and g represents gravitational acceleration. The total energy at point 1 is then calculated by adding together the kinetic energy V 2/2g, the potential energy h1, and the pressure energy P1[11]. With relatively little water flow volume, closed diversion systems are effective in developing high pressure heads (impulse turbines)[8,38].

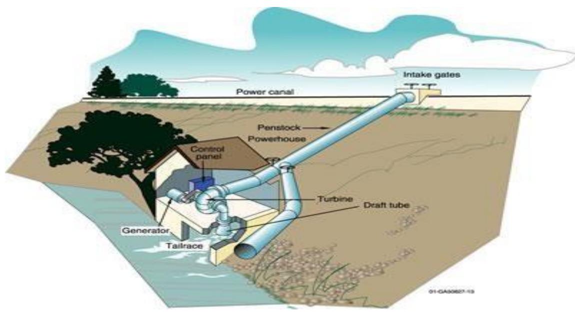


**Fig.4: Closed Diversion System [25].**

There is always a free surface in an open canal, unlike what occurs with closed pipes, where the water fills the whole pipe (figure 5). The atmospheric pressure, often known as the "zero pressure REFERENCE," is typically thought of as constant over the whole length of the canal and is typically applied to the free water surface [11]. To preserve the turbine, prevent buildup in the channel, and safeguard the basins, solid materials, such as floating sand or gravel, must be removed from the area where the water is redirected [36]. Large amounts of water may be delivered to reaction turbines using open diversion systems with little loss due to friction [38]. Certain reaction turbines (like the Nautilus) may combine open and closed diversion systems, where the open system leads to the closed system (such as a pipe). The closed component enables creation of the required pressure head for the turbine without incurring the cost of lengthy lengths of pipe, whereas the open segment diverts a significant amount of water near

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to the turbine site. The water surface where the water enters the closed system serves as the initial elevation for the pressure head in these combination systems [8]

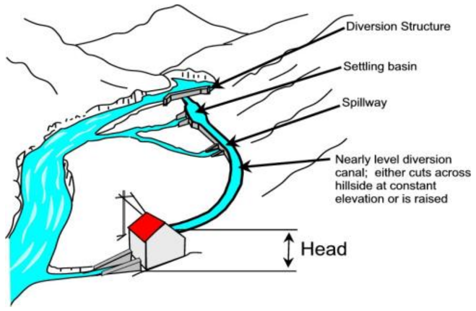


**Fig. 5: Open diversion system [8].**

## Planning for micro hydro projects

The fundamental ideas taken into account in micro hydro planning are: the topography and geomorphology of the site, the assessment of the water resource and its generating potential, the site selection and basic layout, the hydraulic turbines and generators and their control, the environmental impact assessment and mitigation measures, the economic evaluation of the project and the potential for financing, and the institutional framework and administrative procedures to obtain the necessary consents [35].

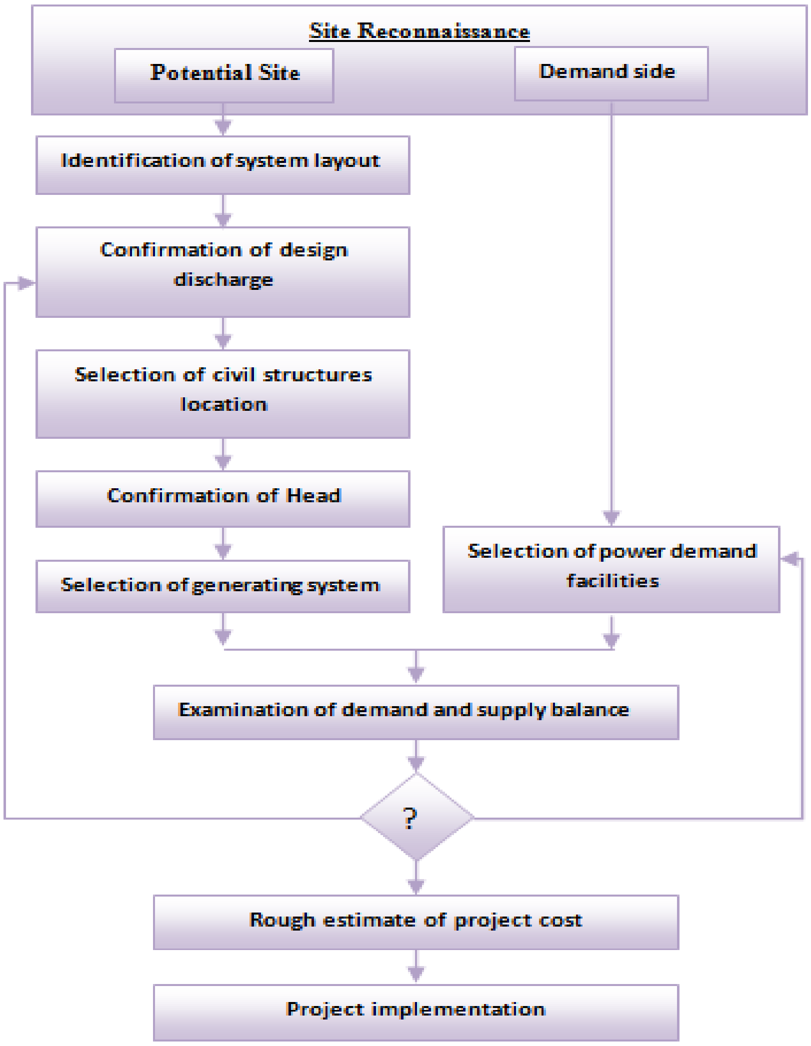


**Fig 6: Micro-Hydro Project Planning [40]**

The following three phases cannot be skipped in order for any micro-hydro project to be successful: (1) Project formulation and design, including hydrological study (flow duration, flood conditions, dry/wet year conditions), fundamental topographical overview (possible head, access conditions, and existing roads), preliminary assessment of slope stability/sediment loads, and fundamental project design with a first approximation of electricity generation. (2) Engineering design and layout optimization, including the cost-effective pre-design of hydraulic structures, size optimization, and evaluation of alternative layouts. (3) A complete field research, a detailed engineering design, a bill of goods, and budgeted equipment quotations are all examples of project layout [39]. Preparing a micro-hydro project entails doing research, making important decisions, and going through the steps in the order they are presented in Figure 6.If the demand and supply are out of balance, the survey's findings should be presented to the community that will benefit at a public meeting where local government employees, local development organizations, and other interested parties should be urged to participate in order to make the necessary decisions.

## HYDRO-ELECTRIC ENERGY’S BENEFITS AND LIMITATIONS

The benefits of micro-hydroelectric power plants over comparable-sized wind, wave, and solar power plants include, in particular: high efficiency (70–90%), by far the best energy technology; High capacity factors (> 50%) in comparison to 10% for solar and 30% for wind power plants, and Slow rate of change; the output power fluctuates relatively gradually from day to day rather than minute to minute [2]. In general, hydro energy is predictable, has a short start-up time and an easily adjustable production time, is more dependable, has a low operating cost, is a long-lasting technology, and has no negative environmental effects.

Notwithstanding the aforementioned benefits, hydro technology, unlike wind and solar, is site-specific and has a restricted degree of extension. The maximum possible power (which depends on head and flow rate) cannot be increased by adding a turbine, and sites that are ideally adapted for the harvesting of waterpower and adjacent to a position where the power may be harnessed are rare [7]. The low level of investment in the technology is partly due to the expensive initial capital expenditure required for micro-hydropower and the seasonal availability of water.

## CONCLUSION

The fundamental micro-hydro system components, including the turbine, generator, and diversion system, have been covered in this study, with special attention paid to the technology involved, application, and essential conditions for such applications. Also covered were the techniques for calculating the flow rate and head to get a sense of the power that is available. The use of micro hydro benefits rural residents in several ways. The restriction, these benefits, and the planning required for a micro-hydro project were reviewed. Although while micro hydro alone won't be able to address all of the world's energy issues, with careful design and execution incorporating the recipient communities, it may be an effective localized electricity producing system or a backup power source, strengthening the grid [4].

## REFERENCE

[1] Rifat A. and MahzubaI. (2014),A Case Study and Model of Micro Hydro Power Plant Using the Kinetic Energy of Flowing Water of Surma and Meghna Rivers of Bangladesh, The International Journal Of Science & Technology volume 2 issue1. pp 87-95.

[2] Bilal A.N. (2013), Design of Micro Hydro Electric Power Station, International Journal of Engineering and Advanced Technology (IJEAT)Volume-2, Issue-5, pp: 39-47.

ISBN: 978-81-961781-9-2

[3] Ravi S. M. and Tanweer D. (2016), Spatial Technology for Mapping Suitable Sites for Run-of-River Hydro Power Plants, International Journal of Emerging Trends in Engineering and Development Issue 6, Vol.4.
[4] Abdullah M.O. et al. (2011) –Renewable Energy Potential from Micro Hydro for Techno-Economic Uplift – A Brief Review, IJRRAS7(4).
[5] Khizir M., Abu T. T. and AshrafulI. (2012), Feasible Micro Hydro Potentiality Exploration in Hill Tracts of Bangladesh, Global Journal of Research in Engineering Electrical and Electronics Engineering Volume 12, Issue 9, Version 1.0, pp: 15-20.
[6] Paish O. (2001), Micro-hydropower: status and prospects, SPECIAL ISSUE PAPER Proc Instn Mech Engrs Vol 216 Part A: J Power and Energy, pp: 31-40.
[7] Neil J., Jian K., Steve S., Abigail H. and Papatya D. (2011), Acoustic impact of an urban micro-hydro scheme, World Renewable Energy Congress, Sweden, 8 - 13May, 2011 Linköping, Sweden, pp: 1448.
[8] Varun, Bhat I. K. and Ravi P. (2008), Life Cycle Analysis of Run-of River Small Hydro Power Plants in India, The Open Renewable Energy Journal, volume1, pp11-16.
[9] Celso P. and Ingeniero D. M (1998). –Layman's Handbook on How to Develop a Small Hydro Site, Directorate general for energy DGXVII.
[10] Marco C. (2015), Harvesting energy from in pipe hydro systems at urban and building scale, International Journal of Smart Grid and Clean Energy vol.4, no.4, pp: 316-327.
[11] Archana T., Pandey S. K and Dubey S. C., (2015), Hydro Power Opportunity in the Sewage WastewaterII, American International Journal of Research in Science, Technology, Engineering & Mathematics 10 (2), pp: 179-183.
[12] Hydropower Micro-Systems, A buyer's guide, Natural Resources Canada, pp:1-53.
[13] Daniel A.N., A Guide to hydropower, Canyonhydroinc, pp: 1-24.
[14] Nagpurwala Q.H., hydraulic turbine, paper delivered at M. S. Ramaiah School of Advanced Studies PEMPRMD 2501, pp: 1-70.
[15] Michele M. (2013), Hydraulic Turbines and Hydroelectric Power Plants, Energy Systems course Lecture notes of Department of Industrial Engineering, University of Rome, pp: 1-78.
[16] Saini R.P. (2011), Small Hydro Power Generation, Course on Integrating Renewable Energy Sources into Emerging Electric Power Systems at Indian Institute of Technology Roorkee.
[17] Hermod B. (2001), Hydraulic Turbines Design, Erection and Operation, Endringsdato: Juni.
[18] Renewable energy technology: cost analysis series, international renewable energy agency Volume 1: Power Sector Issue 3/5 Hydropower (2012).
[19] Small Hydropower Systems, Energy Efficiency and Renewable Energy Clearing house DOE/GO-102001-1173FS217, July 2001.
[20] Hydropower setting a course for our energy future, U.S. Department of Energy—Energy Efficiency and Renewable Energy.
[21] Akhilesh A. N. and Gopal D. (2015), Pico-Hydro-Plant for Small Scale Power Generation in Remote Villages IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). Volume 9, Issue 1, Ver. III, pp: 59-67.
[22] Guilherme A.C., Duartede M.S. and Helena M.R., (2011), Small scale hydropower: generator analysis and optimization for water supply systems, World Renewable Energy Congress–Sweden Linköping, Sweden. Pp:1387.
[23] Bilal A.N. (2014), Suitable Selection of Components for the Micro-Hydro-Electric Power Plant, Advances in Energy and Power, 2 (1), pp: 7-12.
[24] Azhumakan ZZ. A. D. O, Murat M. K. R. I. and Balzhan A. C. (2013), Selection of Generator for the Micro Hydro Power Plant, American-Eurasian Journal of Scientific Research 8(3), pp: 104-108.
[25] Ekanayake J.B. (2002), Induction Generators for Small Hydro Schemes, Power Engineering Journal, pp: 61-67.
[26] Simon S.H. (1992), The Design of A5KW Micro-hydro Generating Set, Master of Engineering (Mechanical) thesis of University of Canterbury.
[27] Kurt H. and Aslan Y. (2013), Optimization of Power Output of A Micro-Hydro Power Station Using Fuzzy Logic Algorithm, International Journal on Technical and Physical Problems of Engineering (IJTPE) Issue14, Volume5, Number1, pp: 138-143.
[28] Nwosu C.A. and Madueme T.C. (2013), Recycled Micro-Hydropower Generation Using Hydraulic Ram Pump (HYDRAM) IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET) Vol.1, Issue3, pp: 1-10.

[29] OtunJ.A., Onemano J.I. and Alayande A.W (2012), Assessment of the Hydropower Potential of Kangimi Reservoir in Kaduna State Nigeria, Nigerian Journal of Technology (NIJOTECH) Vol.31, No.3, pp: 300-307.

[30] Uamusse, M.M., Tsamba, A.J., Matsinhe, J. and Persson, K.M. (2015), Capacity Optimization Study of Chua Mini - Hydropower Plant at Chua River, Manica, Mozambique. Energy and Power Engineering,7,604-612.http://dx.doi.org/10.4236/epe.2015.713057

[31] Williamson S.J., Stark B.H. and Booker J.D. (2011), Low Head Pico Hydro Turbine Selection using a Multi-Criteria Analysis, World Renewable Energy Congress–Sweden, 8–13 May, 2011 Linköping, Sweden, pp: 1378.

[32] How to develop a micro-hydro scheme alternative technology center, Power from the landscape 2009.

[33] Guide on How to Develop a Small Hydropower Plant, European Small Hydropower Association (ESHA) (2004) esha@arcadis.be

[34] Valentin S. (2009) –micro hydro power scout guide A Field Worker's manual Know how to do prepared by Dutch-German Partnership Energizing Development Access to Modern Energy Services – Ethiopia (AMES-E) and Ingenieurbürovalentinschnitzerp-17.

[35] Roshni B. and Ali S. M. (2014), Potential of Hydro Power Plant in India and its Impact on Environment, International Journal of Engineering Trends and Technology (IJETT), Volume 10, Number 3, pp: 114-119.

[36] http://www.absak.com/library/document-downloads

[37] Financing hydropower: INTRODUCTION to the Specifics of Small Hydro Power Plants, presentation at Green for Growth Fund Technical Workshop on Small Hydro Power, EFSE Annual Meeting, Tiblisi.

[38] Mini & Micro Hydro Power Generation, presentation at EBARA Hatakeyama Memorial Fund Tokyo, Japanehmf@ebara.com

# Chapter: 11

## Utilising Bi-CMOS to Reduce Losses in Antenna Chip

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**ABSTRACT**

State-of-the-art BiCMOS technologies are appropriate for upcoming mm-wave applications in the 57-64 GHzband because their transit frequencies (fT) are substantially over 200 GHz. Several integrated mm-wave antennas on silicon have been disclosed in recent years, with an average antenna gain of less than -8 dBi . Due to substrate modes propagating through the low-resistive silicon, there are significant losses in the silicon substrate, which result in the poor gain. The goal of this paper is to outline a strategy for reducing substrate losses.

**KEYWORDS:** Internet of Things (IoT), Service Oriented Architecture (SoA).

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## INTRODUCTION

According to CMOS/BiCMOS technology, Fig. 1 depicts the cross-section of a typical chip. It consists of a silicon bulk substrate on top of a metal stack with space for an antenna construction.You may think of the bulk substrate as a waveguide in a lab. When a dielectric slab with infinite lateral extension is put in air, it is possible to derive the cut-off frequencies of the TE modes from:

$$f_c = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

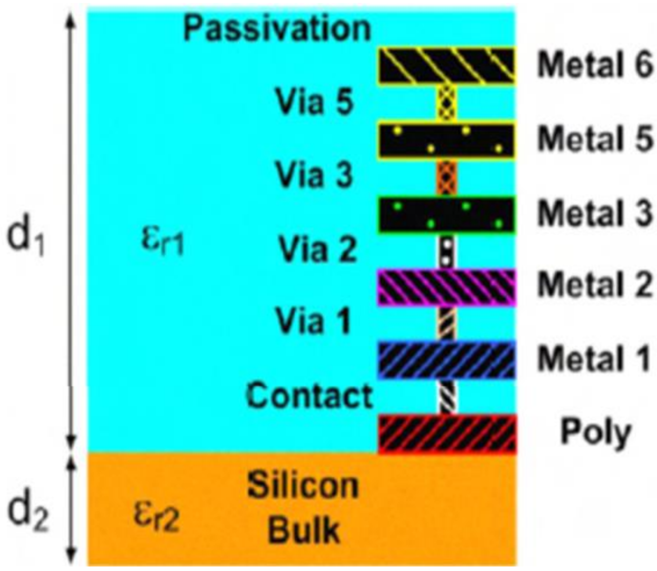


**Fig.1: Sketched-cross-section of a typical CMOS/Bi-CMOS technology.**

The slab's material's permittivity and thickness, respectively . Equation1 demonstrates that the 0thorder mode always experiences excitation since it has a cut-off frequency of 0 Hz. The stimulated substrate modes ultimately encounter an edge since the chip has a limited size, where they are partially reflected and transmitted. In the end, the reflection creates a standing wave between the opposing edges. The portion that is being broadcast interferes with waves that are being directly emitted from the antenna and from other edges by radiating from the chip's edge. As a result, the antenna radiation pattern degrades, which is chip size dependent. Furthermore, the silicon's high permittivity causes a strong energy coupling into these modes and its low resistivity (often p:S 20 cm), which causes substantial substrate losses, has an impact on the radiation efficiency. From the data in Fig. 2, these impacts are clearly visible. It displays the predicted radiation patterns and efficiency of a 60 GHz dipole antenna incorporated in four chips with a substrate thickness of 200 km, but with varying chip area sizes. The substrate resistivity is 20 cm, and the dipoles were positioned 50 km away from the chip's border.

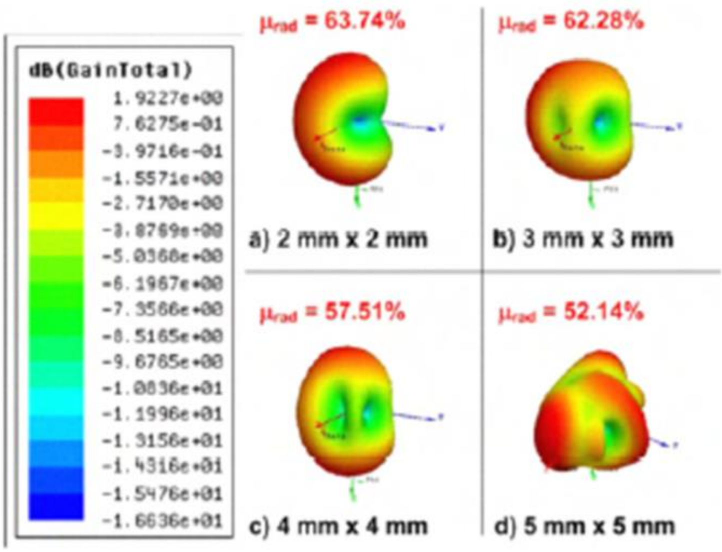


**Fig.2: Improved radiation characteristics by covering the chip with a metal plate.**

Implementing a metal plate to cover the chip is a straightforward way to improve off-chip radiation. In this scenario, the substrate may be thought of as a surface waveguide with associated surface-wave modes. TE1 is the lowest order TE surface wave mode. Its nonzerocut-off frequency gives it an advantage over a slab waveguide. As a result, the radiation pattern and efficiency are enhanced at frequencies below the cut-off. In the semiconductor industry, back-grinding silicon wafers to a thickness of 200 / km or less while preserving mechanical stability for handling and packing is already a routine post-processing procedure. The TE1 mode has a cut-off frequency of 112 GHz at a thickness of 200 / km, whereas at 60 GHz the silicon substrate thickness must be considerably below 350 / km to prevent the TE1 mode. In Fig. 2, to the right, the radiation patterns and efficiency of the on-chip antennas are shown after the addition of a rectangular metal plate. According to Fig. 3 (r = 650/km), this plate is positioned 650/km away from the dipole. In order to suppress the TE-modes behind the reflecting edge, the plate works as a reflector along the length of the chip. Consequently, the design may be seen as a simple on-chip Vagi-antenna [4]. The radiation pattern still varies with chip size, as seen in the picture, but the sensitivity of its form to chip size is lessened. The remaining chip size dependency can be generated by the variable reflector length or the 0th order TM-mode.

### Design

Designing an on-chip antenna has been done using the metal-covered chip method. The antenna impedance we choose for noise-matching at 60 GHz (direct matching technique) is Zant = 30 + j30. The metal plate is used as the lowest metal layer while designing chips. With

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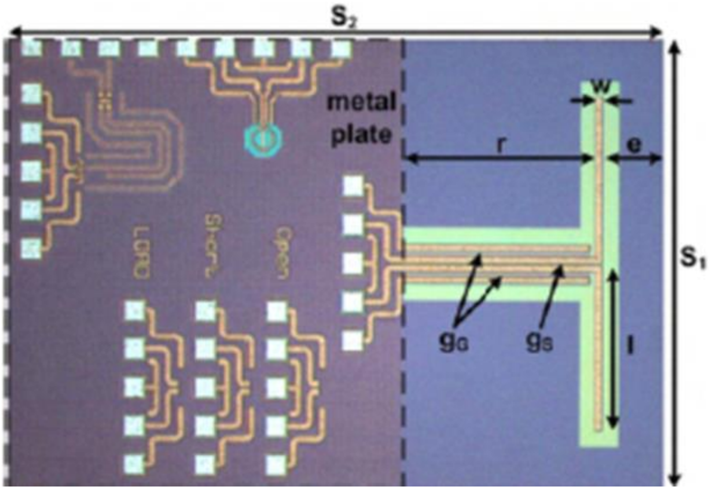
a characteristic impedance of Zo = 60, the transmission line that links the dipole and the RF circuitry above the plate is comparable to those explored in {5}.




| $S_1$ | $S_2$ | $l$ | $w$ |
|---|---|---|---|
| 2 $mm$ | 2 $mm$ | 540 $\mu m$ | 20 $\mu m$ |
| $g_S$ | $g_G$ | $r$ | $e$ |
| 6 $\mu m$ | 20 $\mu m$ | 630 $\mu m$ | 50 $\mu m$ |

**Fig.3: Chip Design (photograph).**

The silicon substrate's resistivity was set in the simulation setting at 200 cm, which is in line with the requirements of the procedure being employed. The simulation of the antenna's reflection coefficient using the values from Fig. 4 reveals a -20 dB bandwidth of 7 GHz around 60 GHzWith a maximum directivity of 2.35 dBi and an efficiency of 78.43%, the radiation pattern resembles that shown in Fig. 3 in most respects.

**CONCLUSION**

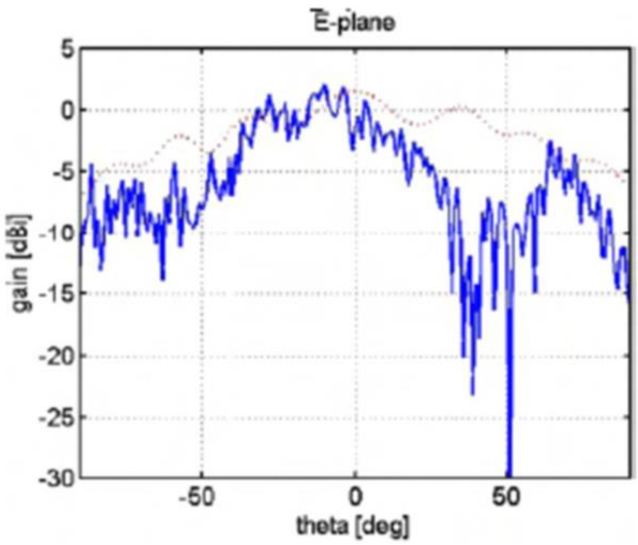



**Fig.4: (left) shows the on-chip antenna's input reflection coefficient for a 100n impedance system. At 60 GHz, the radiation pattern is shown on the right (solid: measurement, dashed: simulation).**

A typical SiGe:CBi-CMOS method was used to produce the design from the previous section. This design deviates a little from the simulation setup in that the 81 has been lowered to 1.5 mm and landing pads have been added, which are necessary for the probe-based measurement (see Fig. 3). In accordance with further tests, silicon's thickness is 220 J-lm and its bulk resistivity is around 20 cm (rather than the claimed 200 cm). Fig. 5 presents a comparison of the simulated and actual antenna impedance. The chips were adhered on PCBs with a permittivity of 4 and a thickness of 3 mm for this measurement. To account for this,

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changes have been made to the simulation setup. The landing pads model's simplifications might be one of the causes of the disparity. Additionally, our balun was unable to capture even-mode reflections brought on by tiny asymmetries in the measurement apparatus. In Fig. 5, there is also a comparison of the simulated and actual radiation patterns. It displays the gain of the on-chip antenna as measured between -900 and +900 from the chip's top side normal. To prevent substrate modes in the PCB material, the chips were directly bonded onto a metal plate for the radiation pattern measurements. The chip and the may not be perfectly aligned. The comparison of the observed and predicted radiation patterns, however, essentially validates the high radiation efficiency.

## REFERENCES

[1] Shamim et al., "24 GHz On-Chip Antennas and Balun on Bulk Si for Air Transmission, "Antennas and Propagation, IEEE Transactions on, vol.56, no.2, pp.303-311, Feb.2008.

[2] R.F. Harrington, Time-HarmonicElectromagneticFields.McGraw-Hill,1990.

[3] N. Alexopoulos, D. Jackson, "Fundamental superstrate (cover) effects on printed circuit antennas, "Antennas and Propagation, IEEE Transactions on, vol.32, no.8, pp.807816, Aug.1984.

[4] Y.P. Zhang et al.,"On-chip antennas for 60-GHz radios in silicon technology," Electron Devices, IEEE Transactions on, vol. 52, no. 7, pp. 1664-1668, July2005.

[5] W.D. van Noort et al., "On-chip mm-Wave passives," Bipolar/ Bi CMOS Circuits and Technology Meeting, 2007. BCTM'07. IEEE, pp. 168-171, 302007-0ct.22007.

[6] J.A.G. Akkermans et al.,"Millimeter wave antenna measurement," Microwave Conference, 2007. European, pp.83-86, Oct.2007.

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# Chapter: 12

# An Inflationary Inventory Model with Constant Demand with Weibull Distribution Deterioration

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**ABSTRACT**

Under inflation the assumption of constant unit price is not valid. The tendency in inflationary environment is to buy more in order to reduce the total system cost, which may be true in certain situations, but it is not true when consumption rate of items is dependent on initial stock level since buying more quantity under inflationary environment leads to more consumption resulting in higher total system cost. The model developed in this paper helps to determine optimum ordering quantity for stock dependent consumption rate items under inflationary environment with infinite replenishment rate without permitting shortages. The effect of the inflation rate, deterioration rate, Initial-stock-dependent consumption rate and delay in payment are discussed. This study develops an inventory model for constant demand rate and time dependent deterioration rate with delay in payment is discussed. In this study mathematical model are also derived under two different cases. Case-I: The credit period is less then cycle time T; and Case-II: Credit period is greater than cycle time T. This study will propose an inventory model under a situation in which the supplier provides the purchaser a permissible delay of payments if the purchaser orders a large quantity. Numerical example is given to support the purposed model.

**KEYWORDS-** Demand rate, Inflation, Weibull distribution, permissible delay in payments.

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## INTRODUCTION

In the traditional inventory models, it is usually assumed that retailer must pay to the supplier for the ordered items as soon as the items are received. In practice, however, the supplier is willing to offer the retailer a certain credit period with-out interest to promote market competition. In this connection we may mention a three-parameter distribution for describing deterioration depending on time. Deterioration cannot be avoided in business scenarios. Rau et al. (2004) presented an integrated model to determine economic ordering policies of deteriorating items in a supply chain management system.

The problem of deteriorating inventory has received considerable attention in recent years. Deterioration is defined as change, damage, decay, spoilage, obsolescence and loss of utility or loss of marginal value of a commodity that results in decreasing usefulness from the original one. Products such as vegetables, medicine, blood, gasoline and radioactive chemicals have finite shelf life, and start to deteriorate once they are produced. Most research in deteriorating inventory assumed constant rate of deteriorating inventory assumed constant rate of deteriorating. However, the Weibull distribution is used to represent the product in stock deteriorates with time.

Besides, the assumption of constant demand is not always applicable to real situations. For instance, it is usually observed in the supermarket that display of the consumer goods in large quantities attracts more customers and generates higher demand. In the last several years, many researchers have given considerable attention to the situation where the demand rate is dependent on the level of the on-hand inventory. Gupta and Vrat (1986) were first to develop models for stock-dependent consumption rate. Later, Baker and Urban (1988) also established an economic order quantity model for a power-form inventory-level-dependent demand pattern. Mandal and Phaujdar (1989) then developed an economic production quantity model for deteriorating items with constant production rate and linearly stock-dependent demand.

Other research related to this area such as Pal et al. (1993), Padmanabhan and Vrat (1995), Giri et al. (1996), Ray and Chaudhuri (1997), Datta et al. (1998), Ray et al. (1998) and so on.

Furthermore, when the shortages occur, some customers are willing to wait for backorder and others would turn to buy from other sellers. Many researchers such as Park (1982), Hollier and Mak (1983) and Wee (1995) considered the constant partial backlogging rates during the shortage period in their inventory models. In some inventory systems, such as fashionable commodities, the length of the waiting time for the next replenishment would determine whether the backlogging will be accepted or not. Therefore, the backlogging rate is variable and dependent on the waiting time for the next replenishment. Chang and Dye (1999) investigated an EOQ model allowing shortage and partial backlogging. It assumed that the backlogging rate is variable and dependent on the length of the waiting time for the next replenishment. Recently, many researchers have modified inventory policies by considering the ‘‘time-proportional partial backlogging rate’’ such as Abad (2000), Papachristos and Skouri (2000), Chang and Dye (2001), Wang (2002), Papachristos and Skouri (2003), etc.

For fitting in with realistic circumstances, the problem of determining the optimal replenishment policy for non-instantaneous deteriorating items with stock-dependent demand is considered in this study. In the model, shortages are allowed; the backlogging rate is variable and dependent on the waiting time for the next replenishment. The necessary and sufficient conditions of the existence and uniqueness of the optimal solution are shown. As the special cases, the results for the models with instantaneous or non-instantaneous deterioration rate and with or without shortages are derived. Further, we analytically identify the best circumstance among these special cases based on the minimum total relevant cost per unit time. Sensitivity analysis of the optimal solution with respect to major parameters is carried out. Finally, four numerical examples are presented to demonstrate the developed model and the solution procedure.

In the past most recent studies in inventory models did not consider the influence of inflation. This was due to belief that inflation would not influence the inventory police to any significant degree. This belief is unrealistic since the resource of an enterprise in highly correlated to the return on investment. The concept of the inflation should be considered especially for long-term investment and forecasting.

**NOTATION**

$q(t)$ = Inventory level at time t

$R = q(0)$ = stock level at the beginning of each cycle after fulfilling backorders

H = length of planning horizon

K = Constant rate of inflation ($/$/unit time)

$C(t)$ = Unit purchase cost for an item bought at time t, i.e., $C(t) = C_0 e^{Kt}$

where $C_0$ is the unit purchase cost at time zero

h = Holding cost ($/unit/year) excluding interest charges

$C_0$ = Unit purchase Cost

$C_2$ = Shortage cost ($/unit/time)

$C_3$ = The ordering cost/cycle

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$i_e$ = Interest earned ($/time)

$i_p$ = Interest charged ($/time)

M = Permissible delay in settling the accounts

T = Length of a cycle

TCU = The average total inventory cost per unit time

$TCU_1$ = The average total inventory cost per unit time for T ≥ M (Case-I)

$TCU_2$ = The average total inventory cost per unit time for T ≤ M (Case-II)

**ASSUMTION**

(i) The inventory system involves only one item.

(ii) The rate of replenishment in instantaneous.

(iii) The fraction z(t) of the on hand inventory deteriorates per unit time where

$$z(t) = \alpha\beta t^{\beta-1}, 0 < \alpha << 1,\ \beta \geq 1.$$

(iv) The demand rate is D which is constant.

**FORMULATION OF PROBLEM**

The models discussed & derived under two different circumstances:

Case I : The credit period is less then cycle time T.

Case-II: Credit period is greater than cycle time T.

**THE MATHEMATICAL MODEL**

During the time [0, T] the instantaneous inventory level at time t will satisfy the following equations:

$$\frac{dq}{dt} + \alpha\beta t^{\beta-1} q = -D \qquad 0 \leq t \leq T \qquad (1)$$

Where 0 < α << 1 and β >> 1

with the boundary condition q(t) = 0. (1a)

On solving equation (1) and using boundary condition in (1a):

$$q(t) = D(1-\alpha t^{\beta})\left[(T + \frac{\alpha T^{\beta+1}}{\beta+1}) - (t + \alpha\frac{t^{\beta+1}}{\beta+1})\right]$$

**CASE (I) (M < T) (PAYMENT BEFORE DEPLETION)**

The total cost is sum of at ordering, holding, deterioration cost with interest payable minus the interest earned. We evaluate all the cost separately and grouped together.

Total Cost = Ordering Cost + Holding cost + Deterioration Cost + Interest payable – Interest earned.

The holding cost HC during [0,T] is

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$$HC = h \sum_{n=0}^{m-1} C(nT).\int_0^T q(t)\,dt \qquad (2)$$

$$= h\, C_0 \left(\frac{e^{KH}-1}{e^{KT}-1}\right)\int_0^T D(1-\alpha t^{\beta})[(T+\frac{\alpha T^{\beta+1}}{\beta+1})-(t+\frac{\alpha t^{\beta+1}}{\beta+1})]\,dt$$

We assume that the length of planning horizon H = n T, where n is an integer for the number of replenishments to be made during period H, and T is an interval of time between replenishment.

$$= h\, C_0 \left(\frac{e^{KH}-1}{e^{KT}-1}\right).D\,[\frac{T^2}{2}-\frac{\alpha^2 T^{2\beta+2}}{(\beta+1)^2}-\frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha T^{\beta+2}}{(\beta+2)}-\frac{\alpha^2 T^{\beta+3}}{(\beta+1)(\beta+3)}] \qquad (3)$$

The interest earned $IE_1$ during time [0,T] is :-

$$IE_1 = i_e \sum_{n=0}^{m-1} C(nT)\int_0^T t.D\,dt \quad = D.i_e.C_0\frac{T^2}{2}.\left(\frac{e^{KH}-1}{e^{KT}-1}\right) \qquad (4)$$

The interest payable $IP_1$ per cycle for the inventory not being sold during due date M:

$$IP_1 = i_p.\sum_{n=0}^{m-1} C(nT)\int_M^T q(t)\,dt \;=\; i_p.D.\left(\frac{e^{KH}-1}{e^{KT}-1}\right).\int_M^T D(1-\alpha t^{\beta})\left[(T+\alpha\frac{T^{\beta+1}}{\beta+1})-(t+\alpha\frac{t^{\beta+1}}{\beta+1})\right]dt$$

$$= i_p.D.\left(\frac{e^{KH}-1}{e^{KT}-1}\right).\left[\begin{array}{l}(T+\frac{\alpha T^{\beta+1}}{\beta+1})(T-\frac{\alpha T^{\beta+1}}{\beta+1}-M+\frac{\alpha M^{\beta+1}}{\beta+1})-\\ (\frac{T^2}{2}+\frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha T^{\beta+2}}{(\beta+2)}+\alpha^2\frac{T^{2\beta+2}}{2(\beta+1)^2})+\\ (\frac{M^2}{2}+\alpha\frac{M^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha M^{\beta+2}}{(\beta+2)}-\frac{\alpha^2 M^{2(\beta+1)}}{2(\beta+1)^2})\end{array}\right] \qquad (5)$$

The number of deteriorated items during [0, T] is,

$$= q(0)-\int_0^T D\,dt = D\,(T+\frac{\alpha T^{\beta+1}}{\beta+1})-DT = \alpha.D\left(\frac{T^{\beta+1}}{\beta+1}\right) \qquad (6)$$

Ordering cost = $C_3$ (7)

The total variable cost, $TVC_1$, is define as $TVC_1 = C_3 + HC + IP_1 + DC - IE_1$; From equation (2) - (7), we obtain $TVC_1$ as

$$TVC_1 = C_3 + h\,C_0\left(\frac{e^{KH}-1}{e^{KT}-1}\right).D\,[\frac{T^2}{2}-\frac{\alpha^2 T^{2\beta+2}}{(\beta+1)^2}-\frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha T^{\beta+2}}{(\beta+2)}-\frac{\alpha^2 T^{\beta+3}}{(\beta+1)(\beta+3)}] +$$

$$i_p.D.\left(\frac{e^{KH}-1}{e^{KT}-1}\right).\left[\begin{array}{l}(T+\frac{\alpha T^{\beta+1}}{\beta+1})(T-\frac{\alpha T^{\beta+1}}{\beta+1}-M+\frac{\alpha M^{\beta+1}}{\beta+1})-\\ (\frac{T^2}{2}+\frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha T^{\beta+2}}{(\beta+2)}+\alpha^2\frac{T^{2\beta+2}}{2(\beta+1)^2})+\\ (\frac{M^2}{2}+\alpha\frac{M^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha M^{\beta+2}}{(\beta+2)}-\frac{\alpha^2 M^{2(\beta+1)}}{2(\beta+1)^2})\end{array}\right] + \alpha.D\left(\frac{T^{\beta+1}}{\beta+1}\right)$$

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$$- D.i_e.C_0 \frac{T^2}{2}.\left(\frac{e^{KH}-1}{e^{KT}-1}\right). \quad (8)$$

The total variable cost per unit time TCU, during the cycle time [0,T] is

$$\text{TCU} = \frac{TVC_1}{T} = \frac{\mathrm{C_3 + HC + IP_1 + DC - IE_1}}{T}$$

$$= \mathrm{C_3} + \mathrm{h\ C_0} \left(\frac{e^{KH}-1}{e^{KT}-1}\right).D\ [\frac{T^2}{2} - \frac{\alpha^2 T^{2\beta+2}}{(\beta+1)^2} - \frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)} - \frac{\alpha T^{\beta+2}}{(\beta+2)} - \frac{\alpha^2 T^{\beta+3}}{(\beta+1)(\beta+3)}]$$

$$+ i_p.D.\left(\frac{e^{KH}-1}{e^{KT}-1}\right).\begin{bmatrix} (T+\frac{\alpha T^{\beta+1}}{\beta+1})(T-\frac{\alpha T^{\beta+1}}{\beta+1}-M+\frac{\alpha M^{\beta+1}}{\beta+1}) - \\ (\frac{T^2}{2}+\frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha T^{\beta+2}}{(\beta+2)}+\alpha^2\frac{T^{2\beta+2}}{2(\beta+1)^2}) + \\ (\frac{M^2}{2}+\alpha\frac{M^{\beta+2}}{(\beta+1)(\beta+2)}-\frac{\alpha M^{\beta+2}}{(\beta+2)}-\frac{\alpha^2 M^{2(\beta+1)}}{2(\beta+1)^2}) \end{bmatrix} + \alpha.D\left(\frac{T^{\beta+1}}{\beta+1}\right)$$

$$- D.i_e.C_0 \frac{T^2}{2}.\left(\frac{e^{KH}-1}{e^{KT}-1}\right) / \mathrm{T}. \quad (9)$$

Now we can make problem as Min $TCU_1$ Subject to the constraint $0 < T \le 1$. (10)

**CASE (II) (M > T) (PAYMENT AFTER DEPLETION)**

Now as per results the ordering cost $C_3$, the deterioration cost DC, the holding cost during the cycle period (0,T) are the same as in case I. So now interest earned per cycle is

$$\mathrm{IE_2} = i_e.C_0.\frac{e^{KH}-1}{e^{KT}-1}\left\{\int_0^T D.t\ dt + dx(M-T)\int_0^T D\ dt\right\}$$

$$= i_e.D.C_0.\frac{e^{KH}-1}{e^{KT}-1}(\frac{3T^2}{2} - MT) \quad (11)$$

The total variable cost, $TCV_2$ is defined as

$TVC_2 = C_3 + HC + DC - IE_2$

$$= \mathrm{C_3} + \mathrm{h\ C_0} \left(\frac{e^{KH}-1}{e^{KT}-1}\right).D\ [\frac{T^2}{2} - \frac{\alpha^2 T^{2\beta+2}}{(\beta+1)^2} - \frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)} - \frac{\alpha T^{\beta+2}}{(\beta+2)} - \frac{\alpha^2 T^{\beta+3}}{(\beta+1)(\beta+3)}]$$

$$+ \alpha.D\left(\frac{T^{\beta+1}}{\beta+1}\right) - i_e.D.C_0.\frac{e^{KH}-1}{e^{KT}-1}(\frac{3T^2}{2} - MT) \quad (12)$$

The total variable cost per unit time $TCU_2$ (0, T) is

$$\mathrm{TCU_2} = \frac{TVC_2}{T} = \frac{\mathrm{C_3 + HC + DC - IE_2}}{T}$$

$$= \mathrm{C_3} + \mathrm{h\ C_0} \left(\frac{e^{KH}-1}{e^{KT}-1}\right).D\ [\frac{T^2}{2} - \frac{\alpha^2 T^{2\beta+2}}{(\beta+1)^2} - \frac{\alpha T^{\beta+2}}{(\beta+1)(\beta+2)} - \frac{\alpha T^{\beta+2}}{(\beta+2)} - \frac{\alpha^2 T^{\beta+3}}{(\beta+1)(\beta+3)}]$$

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$$+ \alpha.D\left(\frac{T^{\beta+1}}{\beta+1}\right) - i_e.D.C_0.\frac{e^{KH}-1}{e^{KT}-1}\left(\frac{3T^2}{2}-MT\right)/\,T \qquad (13)$$

Now we can make problem as Min $TCU_2$

Subject to the constraint $0 \le T \le 1$. (14)

**NUMERICAL EXAMPLE**

In this paper we discussed the ordering polices in deferent conditions for which we we define two cases Case (I) (M < T) (Payment before depletion) and Case (II) (M > T) (Payment after depletion). We consider illustrate the effect of the developed model in this paper.

The following inventory parametric values are used α = 0.001, β = 1.0, M = 0.1

$C_0$ = 0.6, $i_e$ = 0.15, $i_p$ = 0.20, K = 0.12, H = 1 year, h = \$ 2.00/unit, $C_3$ = 100.0, $C_2$ = 0.8/unit.

The solution of two cases for different parametric values of α, β, M are given in the table 1 and 2.

From the above tables the results can be discussed as follows

- When the parameter α increases, the values of T decreases, but the total average inventory cost TCU increases in both cases.
- As the parameter β increases, the values of T decreases and total average inventory cost TCU increases in both cases.
- As the parameter M increases, the values of T increases and total average inventory cost TCU decreases in both in cases-I and case-II.

**Table 1 CASE-1 (Payment before depletion)**

| Changing parameters | Change in parameters | T | $TCU_1$ |
|---|---|---|---|
| | 0.001 | 0.862 | 374.41 |
| | 0.015 | 0.734 | 542.16 |
| | 1.0 | 0.0876 | 467.82 |
| | 1.3 | 0.0720 | 653.32 |
| | 0.1 | 0.9305 | 4603.71 |
| M | 0.2 | 0.1010 | 3642.91 |

**Table 2 CASE-II (Payment after depletion)**

| Changing parameters | Change in parameters | T | $TCU_1$ |
|---|---|---|---|
| | 0.001 | 0.1140 | 4374.41 |
| | 0.015 | 0.1027 | 5542.16 |
| | 1.0 | 0.1276 | 2317.82 |
| | 1.3 | 0.1120 | 3453.32 |

| | | | |
|---|---|---|---|
| | 0.1 | 0.1205 | 2013.71 |
| M | 0.2 | 0.1410 | 1242.91 |

## CONCLUSION

To be precise, a model has been illustrated for determination of optimal ordering time and total cost with time dependent demand foe deteriorating items following the Weibull distribution. Two cases namely (I) payment before depletion (M < T) and (II) payment after depletion (M > T) have taken into account for consideration of the optimal cycle time and to minimize the total average inventory cost. The intuitive reason behind this is that the extension is permissible payment period offers opportunity to the purchaser to earn more by investing the resource otherwise from the sale-proceed of the inventory, which result in the lower cost.

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## REFERENCES

[1] Aggarwal, SP and Jaggi, CK (1995) Ordering Policies of Deteriorating Items Under Permissible delay in Payments. Journal of Operation Research Society, 46, pp. 652-662.

[2] Chung, KJ (1998) A Theorem on the Determination of Economic Order Quantity Under Conditions of Permissible Delay in Payments. Journal of Operations Research Society, 38, pp. 83-84.

[3] Chung, KJ, Chang, SL and Yang, WD (2001) The Optimal Cycle Time for Exponential Deteriorating Products Under Trade Credit Financing. The Engineering Economist, 46, pp. 232-242.

[4] Chung, KJ, Hung, CH and Dye, CY (2001) An Inventory Model for Deteriorating Items with Linear Trend Demand Under the Condition of Permissible Delay in Payments. Production Planning and Control, 12, pp. 274-282.

[5] Davis, RA and Gaither, N. (1985) Optimal Ordering Policies Under Conditions of Extended Payment Privileges. Management Science, 31, pp. 499-509.

[6] Goyal, SK (1985) Economic Order Quantity Under Condition of Permissible Delay in Payments. Journal of Operation Research Society, 36, pp. 335-338.

[7] Huang, YF (2003) Optimal Retailer's Ordering Policies in the EOQ Model Under Trade Credit Financing. Journal of the Operational Research Society, 54, pp. 1011-1015.

[8] Hark Hwang, Seong Whan Shinn, Retailer's pricing and lot sizing policy for exponentially deteriorating products under the condition of permissible delay in payments, Computers and Operations Research, v.24 n.6, p.539-547, June 1997.

[9] Jamal, AMM, Sarker, BR and Wang, S. (1997) A Ordering Policy for Deteriorating Items with Allowable Shortages and Permissible Delay in Payment. Journal of Operations Research Society, 48, pp. 826-833.

[10] Mandal, BN and Phaujdar, S. (1989) Some EOQ Models Under Permissible Delay in Payments. International Journal of Management Science, 5:2, pp. 99-108.

[11] Sarker, BR, Jamal, AMM and Wang, S. (2001) Optimal Payment Time Under Permissible Delay in Payment for Products with Deterioration. Production Planning Control, 11, pp. 380- 390.

[12] Shah, NH (1993) Probabilistic Time Scheduling Model for Exponentially Decaying Inventory when Delay in Payments is Permissible. International Journal of Production Economics, 32, pp.77-82.

[13] Shah, NH and Shah, YK (1993) A Lot Size Model for Exponentially Deteriorating Inventory when Delay in Payments is Permissible. Cahiers du CERO, Belgium, 35, pp. 1-9.

[14] Shah, NH and Shah, YK (1993) A Probabilistic Order Level System when Delay in Payments Is Permissible. Journal of the Korean Operations Research and Management Science Society, 18:2, pp. 175-183.

[15] Shah, NH and Shah, YK (1998) A Discrete in Time Probabilistic Inventory Model for Deteriorating Items Under Conditions of Permissible Delay in Payments. International Journal of System science, 29, pp. 121-125.

[16] Shah, VR, Patel, NC and Shah, DK (1998) Economic Ordering Quantity when Delay in Payments of Order and Shortages are Permitted. Gujarat Statistical Review, 15:2, pp. 51-56.

[17] Wilson RH. 1934; A scientific routine for stock control; Haward Business Review; 13:116-28.

[18] Silver EA, Meal HC. 1969; A simple modification of the EOQ for the case of a varying demand rate. Production and inventory management; 10(4): 52-65.
[19] Buchanan JT. 1980; Alternate solution method for the inventory replacement problem under increasing demand. Journal of operational research society; 31:615-20.
[20] Goyal SK, Kush M, Soni R. 1986; A note on the economic order intervals for an item with trend in demand. Engineering Costs and production Economics; 10:253-5.
[21] Ritchie E, Tasdo A. 1986; Penalties of using EOQ: a comparison of lot-sizing rules for the linearly increasing demand. Production and inventory management; 27(3):65-79.
[22] Environmentally conscious manufacturing and product recovery (ECMPRO): A review of the state of the art by Mehmet Ali Ilgin Surendra M. Gupta, Journal of Environmental Management.
[23] The Design of an Expert System for Inventory Control NASIR GHIASEDDIN, KHALIL MATTA, AND DIPTENDU SINI-IA Management Department, University of Notre Dame, Notre Dame, IN, USA.
[24] Module base design for a portfolio of institutional decision support systems Ramakrishnan Pakath Department of Decision Science and Information Systems, College of Business and Economics, University of Kentucky, Lexington, KY 40506, USA.
[25] “Optimal safety stock levels of subassemblies and manufacturing components” Alessandro Personaa, Daria Battini, Riccardo Manzini, Arrigo Pareschi. International Journal of production Economics.
[26] “Production, Manufacturing and Logistics Capacity selection under uncertainty with ratio objectives” by Yigal Gerchak *, ElkafiHassini, Saibal Ray 1. Department of Management Sciences, University of Waterloo, Waterloo, Ont., Canada N2L 3G1. European Journal of Operational Research 143 (2002) 138–147.
[27] “The Design of an Expert System for Inventory Control” NASIR GHIASEDDIN, KHALIL MATTA, AND DIPTENDU SINI-IA Management Department, University of Notre Dame, Notre Dame, IN, USA. European Journal of Operational Research 143 (2002) 13–123.
[28] “Production, Manufacturing and Logistics Sensitivity analysis with finite changes: An application to modified EOQ models” by E. Borgonovo. European Journal of Operational Research.
[29] “AN INTEGRATED DECISION SYSTEM FOR INVENTORY MANAGEMENT” AL! S. KIRAN and ALEX LOEWENTHAL Department of Industrial and Systems Engineering, University of Southern California, OHE-400, University Park, Los Angeles, CA 900891452, U.S.A. European Journal of Operational Research.
[30] Jalan AK, Giri RR, Chaudhari KS. 1996; EOQ model for items with weibull distribution deteriorating, shortage and trended demand. International Journal of System Science; 27(9):851-5.
[31] Manjusri Basu and Sudipta Sinha 2007: An inflationary inventory model with time dependent demand with Weibull distribution deterioration and partial backlogging under permissible delay in payment; vol.36(2007) No. 1.

# Chapter: 13

# The Library's Use of Digital Assets

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**ABSTRACT**

The various features of electronic resources are examined in this study. The use of already gained knowledge is now easier, faster, and more comfortable due to digital innovations. The data collected throughout the years might be used for society growth, advancement, and future research. Electronic resources are easily accessible in far-off places. Electronic tools help to manage the knowledge flood and get around storage problems. Digitalization is being applied to on-paper sources. In educational institutions today, digital sources of information are becoming more and more significant. Libraries have increased their holdings size as a result of the development of technologies. The most well-known of these resources are digital assets. It outlines multiple assets and analyses some of their advantages and disadvantages.

**KEYWORDS:** Digital assets, E-Books, E-Journals, E- magazine, E- Newspaper, E-Thesis.

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## INTRODUCTION

The computerization of printed content has made a brand-new concept available to everyone. An digital asset is any product that uses technology and requires computer access to offer a body of data Full-text databases, e-journals, picture collection, additional multimedia products, and mathematical, visually appealing or time-based data are a couple of examples. A work that is currently accessible in the market and was created with the intention of being sold also counts as a digital asset. Information services and libraries are expanding significantly in the 21st century.

Apart from to traditional (Print) books and magazines, libraries right now invest in a wide range of online learning tools due to the explosive growth of e-publishing. How people live and learn has altered as a result of the usage of internet tools and services. At early, the global web was primarily utilised to deliver assets and data to users. However, user-generated content and sharing applications have received more attention as a result of Web 2.0's development, the expansion of open sources, and the idea of shared usage.

The expansion and popularity of electronic resources have accelerated as a result. E-Resources make up a considerable portion of the global literature. They make REFERENCE to online information resources. E-books, Internet/Websites - Listservs, CDs/DVDs, E-journals, databases, CDs/DVDs, E Reports, E-Maps, E-Pictures/Photographs, E-Manuscripts, E-Theses, and E-Newspaper are all examples of electronic resources.

These might be provided online, on CD-ROMs or DVDs, etc. A service called access to e-resources facilitates library users in finding e-Databases, e-Journals, e-Magazines, e-Books/ e-Audio/ e-Images, Data/ GIS, Digital Library Projects, Electronic Exhibitions, e Subject Guide, e-newsletters, E-conferences proceedings, and Web search engines on a range of subjects. The mobility of electronic books and their capacity to hold several volumes on a single hand-held device make them beneficial.

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Additionally, an open access portal makes the published information available. As a result, the digital gap is closed, and the poor may easily get the information they need. They don't need to be concerned about data use and licensing. Dr. S.R. Ranganathan claims "A library is a growing organism," so that we can say the library is therefore considered to be a living being. The library is a knowledge center rather than a storehouse of books. Each reader comes to the library to find an answer to his or her concern /gain some knowledge. The user community's expectations should be fulfilled by the library.

**Review of Literature**

A survey of the literature was initially done to set the stage for the study. The findings of a study conducted to investigate the e-resource collections in Karnataka state university systems. Libraries have been analyzed by Walmiki and Ramakrishnegowda (2009). Understanding the university libraries' Internet capabilities has been attempted, as has the acquisition of online databases and CD-ROM databases, involvement in consortium activities, and access to e-resources via various consortium activities.

Jamali, Nicholas, and Huntington conducted an examination of the findings of numerous studies that used log file analysis to examine the use and readers of digital periodicals in 2005. It was found from these articles that a Portable Document Format is preferred over HTML since it is the format that end users prefer. 2004's Chisenga It was authorized to conduct a review of the ICT usage in 10 African public library services. Only a small percentage of libraries offered online information services, to their users, despite the fact that the majority had Internet. connectivity.

However, the study identifies four obstacles that prevent these libraries' electronic resources from being as useful as they could be: poor strategy; inadequate or inaccurate financial assistance; poor utilization of the internet to offer users information services; and inadequate user getting ready for modern IT services.

**E-Resources are required**:

Digital assets enable librarians to provide the user community with greater service. The following list includes the few key points.

- To give numerous users access to a source of information.
- Searching e-resources is simple.
- The user can readily access these.
- There is enormous storage capacity for these assets.
- The time spent utilizing digital resources.
- Examines why respondents utilize e-resources, is aware about the many sorts of e-resources that respondents regularly use.
- Accumulate, arrange, and preserve information in electronic format. To support the effective and affordable circulation of data to prospective users.
- To support joint initiatives to cut expenses and split expenditures in research tools, computing equipment, and communication networks.

**Types of E- Resources**

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| S. No | Forms of E-Resources | Description |
|---|---|---|
| 1 | Electronic Books | A book that may be read or viewed on a desktop , Laptop or other portable handheld gadget but is available in digital format rather than being printed on paper . |
| 2 | Electronic Journal | An unusually significant electronic journal may be acquired by a library for its exclusive collection. The great majority of new data would be provided through an electronic journal. |
| 3 | Electronic Newspapers | The widespread use of digital newspapers makes them much too common to be published as online content on the global web or via the World Wide Web . |
| 4 | Electronic Magazines | Magazine published electronically are known as electronic magazine , E- magazine are one use of information technology . |
| 5 | Indexing and Abstracting Databases | These belong to referral websites that include journal bibliographies as well as paper outlines. |
| 6 | Full Text Database | Through the internet, data are now readily available. There is either nothing to pay or pay. Information may be searched and retrieved electronically using electronic databases, which are organised collection of data on a single subject or a variety of topics.. |
| 7 | Reference Database | On the internet there are several digital Dictionaries , Encyclopedias etc are available. |
| 8 | Statistical Database | A database of this kind includes statistical data that is useful to society. |
| 9 | Image Collection | This kind of database emerged as a result of the rise of modern images. . |
| 10 | Multimedia products | This kind of database has been created as a result of the evolution of digital photography . |
| 11 | Electronic Thesis | These databases contain electronic version of doctorate these and dissertations |
| 12 | Electronic Clipping | The goal of e- clipping is to analyze and rate recent content. |
| 13 | E- Patents | They stand for the government's only right to make use of an innovatio n for a specific amount of time. |
| 14 | E- Standards | Written definitions and limitations are accepted by authoritative agencies and are supervised for complaints. |

## E-Resources' Services

Electronic alternatives are replacing printed reading materials and information sources. Following is a detailed description and quick analysis of some of these E-Information services:

| Digital Information services | Abbreviations |
|---|---|
| Current Awareness Service | CAS |
| Selective dissemination of Information | SDI |
| E-Document Delivery Services | EDDS |
| Online Public Access Catalogue | OPAC |
| Mobile Libraries | M-Libraries |

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**Selection of materials available online**

E-Resource selection should be based on user interest and requirement. The steps listed below should be taken into consideration as a librarian while making decision:

- To understanding requirements of users.
- To understand the scope and kind of accessible online assets.
- To evaluate the e-resources' search capabilities and quality.
- To keep affordability.
- At the time of purchase, verify it is online or Server based.
- To examine the license copy.
- To evaluate academic assistance and training.
- To examine technical assistance and usability.

**Specialness of Online Resources**

- Anyone can access anything from anywhere, any time.
- E-resource retrieval is faster than traditional resource access, and users can be directed to content by giving a link.
- Any type of material may be included in a library that is accessible online.
- The text is simple to search.
- No real value in holding.
- The user and the librarian communication is frequently in the digital world.
- The tool can assist users in retrieving the needed information; very few intermediaries can assist users.
- There is no designated user group.

**The Effect of Electronic Resources on Library and Information Services**

The library system and our perception of information sources are both being revolutionized by online e-resources. It has accelerated up and made the process of gathering information sources easier. A simple and efficient way to find and update the printed material and interface of each library's catalogue is in the internet. Internet can be used for submitting an Inter Library Loan request, and after sending a postal fax or copies may be digitized and sent via email. Users' information-use habits are significantly impacted by the rise of digital technologies and the spread of Online platforms.

Electronic resources can be used without physically touching the items, and therefore their workflows from procurement to user services and throughout their lifespan are very different from those of print resources. Easily keeping their ever-growing holdings of electronic resources becomes a significant challenge for libraries. Most of libraries now have a significant number of full-text collections, citation databases, and online journals, all of which have experienced rapid expansion. In order to manage these electronic resources, it is essential to give library users easy ways to find and use them, as well as to give library staff the tools necessary to keep track of them.

A large number of library resources are now available online in digital formats, including databases, e-books, and e-journals e- books etc. Libraries are subscribing either separately or together to digital assets instead of print ones due to their benefits over physical assets. Recent studies show that readers like the World Wide Web journals over printed ones.

The licensing of digital assets has substantially expanded recently, and librarians have battled to manage this information in manuals, integrated library systems, and independent databases maintained on physical devices or the network.

**Benefits of Electronic Resources**

- Compared with print publication, electronic publications could be cheaper as well.
- Text, audio, video, and image files can all be developed as digital documents.
- Digital resources save space in libraries and are available around-the-clock.
- The user-friendliness of the interface makes it easy to search for E-resources, and they offer users faster, more accessible access from home, college, or the library at all times. Accessibility of digital content is made possible through an advanced search and retrieval system.
- The virtual world enables the library to work with other libraries and use their resources.
- Information can be downloaded, sent out, and shifted, risking copyright protection as well as validity.
- Dial-up connectivity makes it possible for people who only have a little window of time to use libraries to do so.
- Numerous informational resources are accessible through the libraries. Libraries put a lot of emphasis on making primary sources accessible.

**E-Resources issues**

- **Licensing:** E-Resources must have a licensing from the company that published them in order to be utilised in a library.
- **IPR**: Librarians must be mindful of intellectual property rights because digital materials may be shared and copied quickly.
- **Metadata standards**: These exist norms describing metadata, such as MARC21 and the digital resources that are presently available on the marketplace do not streamline by MARC21.
- **Budgetary constraints**: Because library are charitable organizations, they are unable to undertake the enormous expenditures needed for the acquisition and upkeep of costly technical assets.
- **Professional personnel**: Managing the electronic collection requires staff with the requisite skills, yet most libraries struggle with a lack of professional personnel.
- **A lack of infrastructure:** Digital collection is made easier by technology for communication and information components.

## CONCLUSION

E-resource distribution is advantageous for assuring reliable and comprehensive knowledge. The library takes control of managing the digital resources, which give users a variety of searching choices. The information centre can save space and the time of its users by utilising online resources. For libraries as well as other members of the community who are eager to find a variety of content across the globe, digital resources are helpful. Operational changes in libraries are a direct effect of the present accessibility of information and communication technology services. The technocrats benefit from the usage of gadgets since it boosts knowledge of users. The information required for someone to be aware of the user via mails and RSS alerts.

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## REFERENCES

[1] Abbas Khan, A. A., Minhaj F. & Ayesha, S. (2007), E-resources: E-books and Ejournals In E-Libraries: Problems and perspectives, Ed. by Ramiah, Sankara Reddy and Hemant Kumar. Allied, New Delhi.

[2] Barman Badan, (2012), Library and Information Science: UGC NET guide, DVS Publishers, Guwahati. 125-126.

[3] Bhat, Ishwar. (2009). Increasing the Discovery and use of e-resources in University Libraries. 7th International CALIBER-2009.

[4] Madhusudhan, Margam. (2010). Use of Electronic Resources by Research Scholars of Kurukshetra University. The Electronic Library, 28 (4). 492-506.

[5] Sunil Kumar Satpathy & Biswanath Rout (2010) Use of E-Resources by the Faculty Members with Special REFERENCE to CVRCE, Bhubaneswar, DESIDOC Journal of Library & Information Technology, Vol. 30, No. 4, July 2010, pp. 11-16

[6] Syed Ruhina, Paradkar Ashwini (2008), E-REFERENCE sources: A Boon of ICT for libraries, Librarian & ICT, Seminar paper 16-17 Feb 2008, 58-64.

[7] Kaur, Baljinder and Verma, Rama. (2009). Use of Electronic Information Resources: A Case Study of Thapar University. The Electronic Library, 27 (4). 611-622.

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# Chapter: 14

# Examining the Role of High-Quality Cement in Construction

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**ABSTRACT**

As they say, a nation's greatest accomplishment is its building infrastructure. Cement and steel consumption per capita are useful indicators of a country's level of development because they are indispensable building materials. It's impossible to conceive of a world without concrete and the material that serves as its primary precursor, Ordinary Portland Cement (OPC). Although several forms of concrete have been produced for specific uses, they share the benefits of being easy to work with, inexpensive, versatile, strong, and long-lasting. The cement business is booming in India and elsewhere. Although there are many new options, it is crucial for an engineer to choose a high-quality cement. Poor cement quality is a common cause of construction failure. In this study, we'll examine how several criteria influence the choice of cement and the categorization of cement strength. Cement quality control is essential, as is the requirement for constant cement quality. By choosing cement of sufficient quality, the project can be protected to some degree.

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## INTRODUCTION

When it comes to cement production, India ranks second worldwide. Deregulation of the industry in 1982 opened the door to massive investment from both domestic and international companies. Several reforms and adjustments were made in India's cement business so that it would be more in line with government regulations and the industry's bottom line. There was a dramatic increase in cement production from nearly 5 million tonnes in 1952 to over 54 million tonnes in 1993. Poor cement quality and growing production costs as a result of government regulation over a long period of time have led to similarly subpar concrete construction. Cement demand in India is expected to increase due to government’s push for large infrastructure projects, leading to 45 million tonnes (MT) of cement needed in the next three to four years. India’s cement demand is expected to reach 550-600 Million Tonnes Per Annum (MTPA) by 2025. The housing sector is the biggest demand driver of cement, accounting for about 67 per cent of the total consumption in India. The other major consumers of cement include infrastructure at 13 per cent, commercial construction at 11 per cent and industrial construction at 9 per cent. The partial relaxation of Government control from March 1982 and a total relaxation of control after March 1989 revived the cement industry and resulted in its phenomenal growth. This resulted in a competitive market and cement manufactures had to improve their quality of cement, as it was now a battle for survival of the best. After late 80s cement manufacturers took a huge step modernizing their old plants, which were in various stages of obsolescence. The wet process plants were converted to more economical and dry efficient process or semi-dry process plants. This leads to the production of high-quality cement. Several leading organizations diversified into cement manufacture and thereby created the much-desired consumer-oriented market with the range of brands available at competitive prices. The 33-grade ordinary Portland cement (IS: 269-1989) has virtually disappeared and is displaced by higher strength ordinary Portland cement of 43-grade (IS: 8112-1989) and 53-grade (IS: 12269-1987).

## SELECTION OF HIGH-QUALITY CEMENT

Since there are various options available in market the consumer has a good option to select the product required. However, this process depends on the main factor of finance. With the financial constraints, the other factor to be considered is the specifications. It must be

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understood by the consumer that any good quality product is generally available at a higher price than a not so good quality product.

It is therefore necessary for the consumer to know more about the benefits he gets when he selects high quality cement and how best he can put to use such benefits considering both technical as well as the economic aspects. A high strength cement although preferable to a lower strength cement may not give a consumer the complete benefit until and unless it is giving consistently high strength with minimum variations. The high strength concrete if specified for any structure will also be more desirable from a durability point of view. It is often observed that low strength concrete is more vulnerable to environmental forces than high strength concrete but at the same time, high strength concrete too needs to be extremely carefully batched, mixed, transported, placed, compacted and cured.

The durability requirements of the structure are as important, if not more, as the strength of the structure. A strong concrete may not result in high performance concrete if the durability requirements are not complied with. Selection of high-quality cement can only mean a good beginning, but it does not assure the consumer of a final product, which is the strong and durable concrete structure. However, selection of poor-quality cement or cement of inconsistent quality is like taking a wrong step right at the beginning and will certainly lead to the poor-quality concrete structure if not a disaster.

## CEMENT STRENGTH CLASSIFICATION

The most common type of cement used in India is ordinary Portland cement (OPC) and has generally grades viz. 33, 43, 45 grade depending upon the 28 days compressive strength. IS: 10262-1982 gives us the recommended guidelines for concrete mix design, has generally classified the cement grade wise from A to F, depending upon 28 days strength as follows:

**Table 1: Classification of Cement grades A to F as per IS: 10262-1982**

| Grade | Range of 28 days strength of cement ($kg/cm^2$) |
|---|---|
| A | 325-375 |
| B | 375-425 |
| C | 425-475 |
| D | 475-525 |
| E | 525-575 |
| F | 575-625 |
| *G | 625-675 |

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*Has been introduced in view of higher-grade cement available in India However, it may note that some brands sold as 53-grade cement generally give 28 days' strength of around 625 to 675 kg/Sq.cm and they can be classified even as G grade cement. However, most of the 53-grade cement available in the market generally falls in the category F or above and the 43-grade cement available in the market are generally in the category D. It must be ascertained either from the manufacturer or through laboratory tests the actual strength of the cement before it's use in the concrete mix design to get the maximum benefit of the additional strength and superior quality.

**CEMENT SAVING DUE TO HIGH STRENGTH**

The relation between the free water-cement ratio (W/C) and concrete strength for different cement strengths (grades A to F) is given in fig. 2 page 8 of IS: 10262-1982. This figure is used to determine the W/C of the concrete mix for specified target concrete strength if the cement grade is known. The target concrete strength (fm) is calculated using the following equation fm=fck+ (t*s) where 'fck' is the specified characteristic strength, 't' is the statistical constant generally equal to 1.65 for the specified accepted proportion of low results of 1 in 20 (see table 2) and 's' is the standard deviation, the values of which are selected depending on the degree of quality control expected under different site conditions (see tables 3 and 4).

**Table 2: Value of 't' (IS: 10262-1982)**

| Accepted proportion of low results | Time |
|---|---|
| 1 in 5 | 0.84 |
| 1 in 10 | 1.28 |
| 1 in 15 | 1.5 |
| 1 in 20 | 1.65 |
| 1 in 40 | 1.96 |
| 1 in 100 | 2.33 |

Degree of quality control Expected (IS: 10262-1982) under different site conditions. Table 4: Recommended values of standard deviation IS: 10262-1982 standard deviation(s) for a different degree of control N/mm. Sq.

From table 4 it can be seen that better quality control results in a lesser value of's' and 'fm' for same 'fck'. Therefore, cement consumption works out to be lower when the quality control is better. Hence, for concrete manufacture better quality control results in greater economy. Percentage saving as compared to 'A' grade cement.

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| Grade of concrete (fm) | Very good | Good | Fair |
|---|---|---|---|
| M10 | 2 | 2.3 | 3.3 |
| M15 | 2.5 | 3.5 | 4.5 |
| M20 | 3.6 | 4.6 | 5.6 |
| M25 | 4.3 | 5.3 | 6.3 |
| M30 | 5 | 6 | 7 |
| M35 | 5.3 | 6.3 | 7.3 |
| M40 | 5.6 | 6.6 | 7.6 |
| M45 | 6 | 7 | 8 |
| M50 | 6.4 | 7.4 | 8.4 |
| M55 | 6.7 | 7.7 | 8.7 |
| M60 | 6.8 | 7.8 | 8.8 |
| M10 | 2 | 2.3 | 3.3 |

**RECOMMENDATIONS TO IMPROVE DURABILITY USING HIGH STRENGTH CEMENT**

However, the durability requirements as specified in IS 456- under revision must be satisfied depending on the various exposure conditions. From table 5 it is obvious that concrete manufactured using a higher grade of cement even after considering that lower grade cement may be marginally cheaper than the higher-grade cement. Requirement of durability as per IS: 456-2000. Maximum cement content, maximum water-cement ratio and a minimum grade of concrete for different exposures with normal weight aggregates of 20 mm nominal maximum size.

Note 1- Cement content prescribed in this is irrespective of the grades of cement and it is inclusive of Mineral Admixtures specifies in IS 456-2000. The additions such as fly ash or

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ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (part 1) and IS 455 respectively.

Note 2- Minimum grade for plain concrete under mild exposure condition is not specified.

The figure below shows that F grade cement can be utilized for 200 kg/cm. Sq. Reinforced concrete in mild environment condition only while C to E grade cement can be used for mild or moderate environmental conditions. However, for high-performance concrete generally, it is very important to go for a higher grade of concrete (above M25 grade). If this concrete is made with high strength cement then it will fetch both technical as well as a financial advantage. shows the extent to which different grades of cement can be used for different environmental conditions and various grades of concrete.

Water cement ratio vs Average 28 days' strength of cement in (kg/ cm.sq.). It is generally observed that even today the structural engineers and architects specify the M15 and M20 grade of concrete in the coastal area. This has already led to serious durability problems and low performance of concrete structures. M15 grade concrete can be achieved with W/C much greater than 0.55 if 43 and 53 grades of cement are used and since 33-grade cement has now virtually disappeared from the market. All M15 grade concrete structures in coastal areas are therefore bound to be a happy hunting ground for concrete rehabilitation agencies as is being observed at present.

The durability problem is most likely to multiply several times if, at the specification stage itself, proper precautions are not taken. Even M20 grade concrete may not be the correct solution to the durability problem in the Urbanized/Industrialized coastal areas. Lower grades of concretes with the generally poor type of quality control prevalent are observed to be of very poor durability, needing of extensive repairs within a few years. As good quality cement is now available it is strongly recommended to go in for higher grades of concrete i.e. above M25 grade. This will improve the performance of the structures; prove more economical in most cases and in the process of achieving higher strengths it will automatically comply with the durability requirements.

## CONSISTENCY OF CEMENT QUALITY

Concrete mix design (CMD) is one of the techniques to determine the most economic proportions of cement, sand, aggregates, water and other additives. However, after choosing the economic proportions of various materials any change in their physical or chemical property will lead to considerable variations in the desired cohesiveness, workability, strength and durability. The maximum impact is always due to variation in cement properties and therefore it is not only essential that cement should have good strength, proper fineness and correct setting time but it is also essential that the variation of its chemical and physical properties especially the strength and fineness should be minimal. The good quality in minimizing variations is now possible with proper quality control monitoring systems and modern sophisticated instrumentation control systems the cement manufacturers have installed in their modern up to date plants.

## QUALITY CONTROL IN CEMENT MANUFACTURE

While high strength is the indication of the good physical quality of cement, consistency of this high strength and other physical and chemical properties is an indication of good quality control and superior technology practiced by the cement manufacturing company.

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The quality control in the cement manufacturing plant starts from the inspection and testing of the limestone. Only after extensive testing for its CaO content, it is utilized, making sure that CaO content is uniform. The thoroughly crushed limestone powder is then stored in a stacker. It is reclaimed in vertical slices to get homogenous limestone, which is then conveyed, to the vertical ball mill, which ensures uniformly crushed limestone. After this, homogenization of the limestone is done in the blending silo by means of aeration. Thereafter homogenized materials are passed through series of suspension preheaters and are fed into the kiln for the production of clinker. Hourly samples of clinker are taken and tested to assure uniformly of quality. On line X-ray analyzers' help in ascertaining the variations in compound compositions of the cement so that immediate action can be taken to improve the quality of the product if required.The clinker is then processed through closed circuit grinding. This ensures proper particle size distribution. A device called high-efficiency cyclonic separator, which controls the grinding process right down to the specific micron size required, does this. After initial grinding in the tube mill, the materials move into the high-efficiency cyclonic separator. The separator separates the ground particles into two streams. The airflow exerts an aerodynamic force and separates the finer particles (between 5 and 30 microns) from the oversize coarser particles (above 30 microns), which are influenced by centrifugal and gravitational forces. The coarse particles are collected into grit collection and brought for recirculation into the grinding process. The fine particles are removed from the air stream in high cyclones mounted symmetrically around the separator housing. This process assures that cement has the ideal surface area and the ideal proportion of particle size between 5 to 30 microns. This process guarantees the highest number of a particle between 5 to 30 microns to the extent of over 50%. Hourly samples are taken and tested to assure uniformity of quality. The consistency of particle size is checked using sophisticated particle size analyzers, which immediately indicate the grain size distribution. Adjustments required in cement productions, if any, can be controlled in the plant to obtain the optimum particle size distribution and thereby assure consistent quality. If cement has a large number of particles finer than 5 microns, it tends to set quickly producing high early concrete strength without a corresponding increase later on. This cement is also more susceptible to moisture attack and hydrates fast resulting in unnecessary wastage. On the other hand, if cement possesses a large number of particles above 30 microns it takes longer time than normal to set and will also display low initial strength which increases at a later stage. The cement is then transferred to the packinghouse where it is packed in woven HDPE and 4 ply paper bags and transported to various stockiest and construction sites. The hourly samples are also collected from the packinghouse to check the quality. Daily tests for various chemical and physical properties are done and various parameters are recorded to study the monthly variations and to improve the product quality from time to time and thereby minimize variations.

## NEED FOR CONSISTENCY OF QUALITY

Many do clearly not understand the importance of consistency of cement quality hence a small illustrative example is given below. Assume that three brands of cement say AA, BB and CC are available having identical mean strength for a particular month of manufacture, say 600 kg/cm. Sq. However, the standard deviations for these cement during the same month were different and therefore the characteristic strength of this cement and its grade are worked out as below. Hence from the above, it can be observed that cement having identical mean 28 days strength for the month can be classified as F, E or D based on the variations (standard deviation). It is therefore of prime importance to control these variations to the barest minimum so that the cement can be classified as a higher grade. It is generally observed that monthly standard deviation if ranging between 15 to 25 kg/cm. Sq. can be considered as a good control for cement manufacture.

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## THERE ARE ADDITIONAL COST SAVINGS ASSOCIATED WITH USING HIGH-QUALITY CEMENT THAT ARE WORTHNOTING

Besides saving of concrete quantity and cement cost per cubic meter of concrete, there are several other advantage and savings due to the use of high strength cement. It is observed that the best advantage of specifying high strength cement is derived if, at the planning and design stage itself, high grades of concretes are specified. The higher-grade concretes may have a smaller cross-sectional area under identical conditions and thereby the quantity of concrete reduces considerably. The saving in concrete quantity can easily between 1% of 25% depending on the type of structural member, its layout and its function. However, in addition to this saving, higher grades of concrete will be less permeable and more durable than lower grades.

## CONCLUSION

- Less use of reinforcing steel.
- Reduction in the required amount of formwork.
- Less work needed for final touches like plastering, painting, etc.
- Benefits include less time and fewer workers needed for building.
- The building's carpeted area will be expanded.

In short high cement if specified at the design stage itself and utilized for the high-grade concrete structure will be more economical than if the lower grade cement is specified. This will benefit the user in giving a structure, which is stronger, and more durable and economical. With high-grade cement, it is now possible to attain QUALITY SPEED AND ECONOMY. So, make your concrete structure ‘fast’ and to ‘last’.

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# Chapter: 15

# Increasing The Durability of Building Structures with Microbial Concrete

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**ABSTRACT**

Concrete structures can develop cracks and fissures due to weathering, faults, ground subsidence, earthquakes, and human activity, which can shorten the structures' useful lives. Using microorganisms like Bacillus species to biomineralize calcium carbonate is a revolutionary method for repairing or cleaning up such structures. Bacillus sp. CT-5, which was isolated from cement, was employed in the current investigation to examine tests for compressive strength and water absorption. According to the findings, bacterial cells increased the compressive strength of cement mortar by 36%. When compared to control cubes, calcite deposition on treated cubes absorbed almost six times less water. The current research shows that Bacillus sp. generation of "microbial concrete" on built facilities improved the durability of building materials.

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## INTRODUCTION

The requirements for high durability for structures exposed to harsh environments, such as seafloor, offshore structures, tunnels, highway bridges, sewage pipes, and structures for solid and liquid wastes containing toxic chemicals and radioactive elements, may not be met using today's common Portland cement (OPC). It is widely acknowledged that the features of concrete's pore structure affect how long it lasts. Concrete deterioration mechanisms frequently depend on the potential for aggressive substances to harm the concrete by penetrating it. Concrete's permeability is influenced by its porosity and the connectivity of its pores. Concrete is more susceptible to the deteriorating processes brought on by penetrating substances the more open its pore structure is. In order for concrete structures to deteriorate, aggressive gases and/or liquids from the environment must first move into the concrete, which is followed by physical and/or chemical reactions that may cause irreparable damage. As a result, mechanical (compressive strength) and transport properties are crucial components of concrete durability.

Researchers' interest has recently started to grow in the microbiologically induced calcium carbonate precipitation (MICCP) that is caused by the metabolic activities of some particular microorganisms in concrete and improves the overall behaviour of concrete. The compressive strength of cement mortar was significantly improved (by about 18%) in earlier studies using aerobic microorganisms (Bacillus pasteurii and Pseudomonas aeruginosa) [Ramakrishnan et al. 1998; Ramachandran et al. 2001]. A number of intricate biochemical processes make up MICCP [Stocks-Fischer et al. 1999]. Some bacterial species produce urease as part of their metabolism, which catalysis the breakdown of urea into $CO_2$ and ammonia, raising the pH of the environment where ions are presentCa$^{2+}$ and $CO_3^{2-}$ precipitate as $CaCO_3$. Possible biochemical reactions in medium to precipitate. $CaCO_3$ at the cell surface that provides a nucleation site can be summarized as follows.

$Ca^{2+} + Cell \rightarrow Cell\text{-}Ca^{2+}$ (1)

$Cl^{-} + HCO_3^{-} + NH_3 \rightarrow NH_4Cl + CO_3$ (2)

$Cell\text{-}Ca^{2+} + CO_3^{2-} \rightarrow Cell\text{-}CaCO_3\downarrow$ (3)

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Utilizing a selective microbial plugging process in which microbial metabolic activities promote the precipitation of calcium carbonate in the form of calcite, a novel method for the remediation of damaged structural formations has been developed [Gollapudi et al. 1995]. CaCO3 demonstrated its positive potential as a microbial sealant by selectively consolidating simulated fractures, surface fissures, and sand plugging in granites [Zhong and Islam 1995; Achal et al. 2009a].

The most significant factors affecting concrete's durability and, ultimately, its performance, the compressive strength and concrete permeability tested using water absorption are the focus of the current work. This study looked into how cement-derived bacteria affected the compressive strength and water permeability of cement mortar.

## MATERIALSANDMETHODS

### Materials

Used was regular Portland cement that complied with IS 12269-1987. As fine aggregate, clean, properly graded, naturally occurring river sand that complies with IS 383-1970 standards and has a fineness modulus of 2.89 was used.

### Microorganism

In this study, Bacillus sp. CT-5, which was isolated from cement sold commercially, was used. The Nutrient Agar (pH 8.0) medium was used routinely to maintain the culture. The isolate was grown in nutrient broth-urea (NBU) medium (8 g nutrient broth, 2% urea, and 25 mM CaCl2). CaCl2 and filter-sterilized urea were added to the medium for the nutrient broth. Information about the preparation and content of NBU medium was previously published [Achal et al., 2009a]. At 37 degrees Celsius, bacteria were grown in a shaking environment (130 rpm).

### Compressive strength test

Bacillus sp. CT-5 was grown in NBU media in order to research the compressive strength test of cement mortar. The ratio of bacterial culture to water to cement was 0.47, and the ratio of cement to sand was 1:3 (by weight). According to IS 4031-1988, a 70.6 mm cube mould was used. With the addition of a grown culture of Bacillus sp. CT-5 that corresponds to an optical density of 1.0 (600 nm), sand and cement were thoroughly mixed. A vibration machine was used to cast and compact the cubes. All specimens were demolded and then allowed to cure in NBU medium at room temperature until compression testing was performed after 3, 7, and 28 days. Control samples were also made in a similar manner, but instead of using bacterial culture, they used water and NBU medium. Automatic compression testing was carried out.

### Water absorption test

Absorptivity test using the RILEM 25 PEM (II-6) was performed to ascertain the increase in resistance to water penetration. To ensure unidirectional absorption through the treated side, the mortar specimens were coated at the four edges that were closest to the treated side. The test cubes were coated, then dried at 45 °C in a ventilated oven to achieve a mass equilibrium of less than 0.1% between two measurements taken 24 hours apart. The treated side of the specimens was facing downward as they were submerged in 101 mm of water (water level about 2 mm above the base of the specimen). Every 15 minutes, 30 minutes; 1 hour, 1.5 hours, 3 hours, 5 hours, 8 hours, 24 hours, 72 hours, 96 hours, 120 hours, and 144 hours and168h) the specimens were removed from the water and weighed, after drying the surface with a wet towel. Immediately after the measurement the test specimens were submerged again. The

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absorptivity coefficient, k [$cm.s^{-1/2}$], was obtained by using the following expression:

$$Q/A = k\sqrt{t} \quad (4)$$

where Q is the amount of water absorbed [$cm^3$]; A is the cross section of the specimen that was in contact with water [$cm^2$]; t is the time [s], Q/A was plotted against the square root of time, then k was calculated from the slope of the linear relation between the former.

## RESULTS AND DISCUSSION

**Compressive strength test:** Figure 1 summarizes the compressive strength of various cement mortar specimens after 3, 7, and 28 days. The compressive strength had significantly increased for the microbially-filled mortar cubes. The strongest mortar cubes (31 MPa) were made with Bacillus sp. CT-5 and incubated for 28 days, as opposed to those made with water (23 MPa) and NBU medium (24 MPa). At 28 days, mortar specimens made with bacterial cells had 36.15% greater compressive strength than the control. The cubes cured in microbial growth medium were stronger than those cured in water in the cell-free control groups, despite the fact that there was no discernible difference. The mortar cubes' strength appeared to be improved by the medium's high ionic strength, which contains urea and calcium chloride. According to Ramakrishnan et al. (1998), Ramachandran et al. (2001), Ghosh et al. (2005), and Achal et al. (2009a), the deposition of CaCO3 on the microorganism cell surfaces and inside the pores of cement-sand matrix, which plug the pores within the mortar, is probably the reason why Bacillus sp. CT-5's compressive strength increased. To determine whether the microbial calcite precipitation was the cause of the mortar samples' increased compressive strength, the mortar samples were taken out and subjected to SEM inspection. Figures 2a and 2b show scanning electron micrographs of a cement mortar matrix devoid of bacteria and a specimen made with Bacillus sp. CT-5, respectively. The sample showed that calcite crystals had formed into rod-shaped structures and had grown everywhere (typical shape of Bacillus species). The edges of the crystals were distinct and sharp, indicating that they had fully developed. We have previously described and documented Sporosarcinapasteurii's rod-shaped structure, which aided in the precipitation of calcite in sand columns [Achal et al. 2009b]. At 3 and 7 days, the compressive strengths of mortar cubes with all media did not significantly increase. The overall trend of an increase in compressive strength up to 28 days may be attributed to the behaviour of microbial cells within the cement mortar matrix. Although the mortar was still porous during the initial curing period due to the cement, the environment for microbes had completely changed, inhibiting proper growth. It's also possible that the high pH of the cement rendered the cells inactive, but as the curing time was prolonged, the cells slowly started to grow. Because of the various ions present in the media, calcite would precipitate during cell growth on both the surface of the cells and inside the cement mortar matrix. As a result, the cement mortar lost some of its porosity and permeability. The bacterial cells eventually either died or changed into endospores, which served as an organic fibre and increased the compressive strength of the mortar cubes, once many of the matrix's pores had been plugged. This explains how cement mortar cubes made with microbial cells behaved at day 28 in terms of their increased compressive strength. An increase in matrix strength would have reduced mean expansion for concrete made with bacterial cells, enhancing the concrete's overall durability performance [Ramakrishnan et al. 2001]. This led to the CONCLUSION that the main reason for the increase in compressive strengths is the consolidation of the pores within the cement mortar cubes with microbiologically induced calcium carbon at precipitation.

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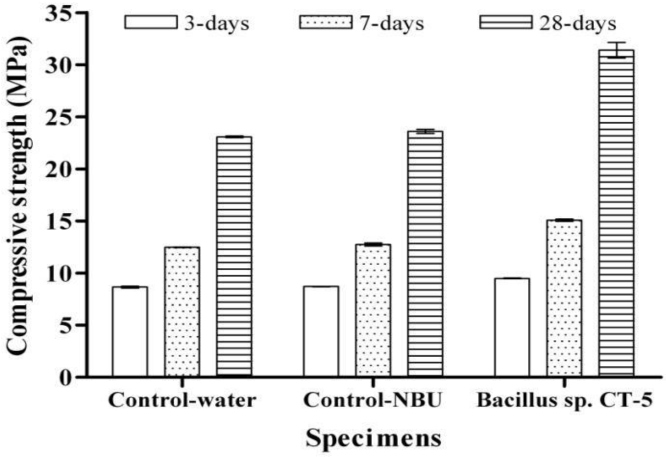


**Fig.1.Effect of CT-5 on Cement Mortar Cube Compressive Strength at 3, 7, and 28 Days prepared with a 0.47 w/c ratio. (Controlling Bacillus sp. and NBU. Water is Replaced with Media in CT-5 Treatments and Media is Replaced with Bacterial Cells, respectively.**

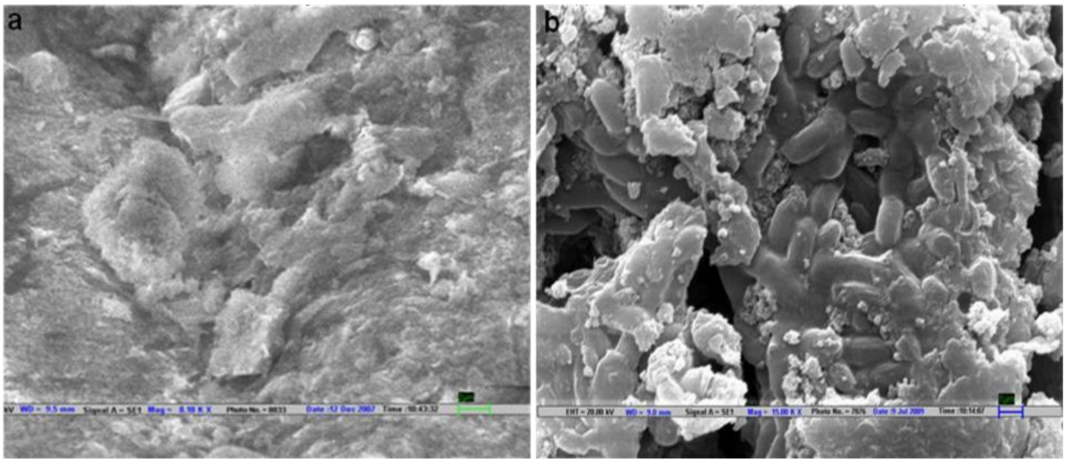


**Fig. 2. Specimens of cement mortar captured in scanning electron micrographs. Matrix of Cement Mortar Prepared Without Bacteria and Dense Calcite Precipitation as Calcite Crystals with Rod Shaped Impressions Housed by Bacillus sp. CT-5**

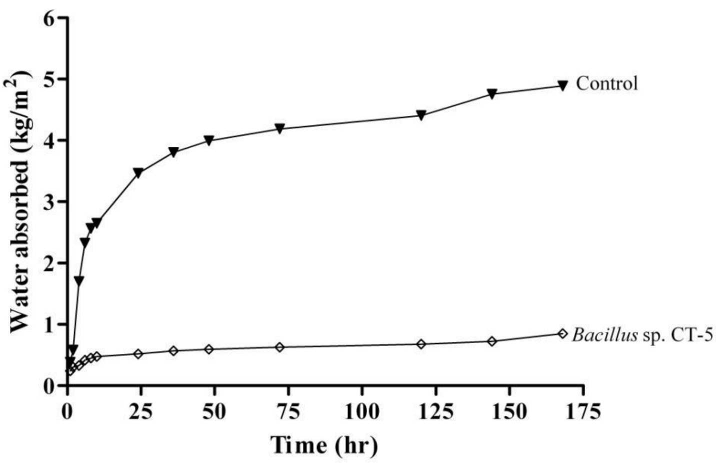


**Fig.3.The Influence of the Bacterial Treatment on the Rate of Water Absorption versus Time for Mortar Cubes.**

**Water absorption test:** For mortar cubes with a w/c of 0.47, Fig. 3 illustrates the impact of the surface treatment on the rate of water absorption. The cubes treated with Bacillus sp. CT-5 absorbed almost six times less water over 168 hours than the control cubes. Compared to untreated specimens, the water uptake significantly decreased when bacteria were present (control). The water absorption experiment showed that the permeability of mortar specimens treated with bacteria decreased. a layer of calcium carbonate crystals being deposited on. The permeation properties were reduced as a result of the surface. As a result, the entry of dangerous substances may be restricted. After injecting CaCO3-forming reactants, Nemati and Voordouw [2003] observed a decrease in the permeability of sandstone cores. It is evident from this experiment that the presence of a layer of carbonate crystals on the surface by a bacterial isolate has the potential to enhance cementitious materials' resistance to processes that cause their degradation.

## CONCLUSION

The use of bacterial isolates like Bacillus species that produce urease in concrete remediation is the significance of this study. Bacillus sp. CT-5 had a beneficial impact on the compressive strength of Portland cement mortar cubes, according to the study, which also showed an increase in strength. In order to assess the effectiveness of the bacterial isolate, a greater resistance to water penetration has been made. The creation of "Microbial Concrete" will serve as the foundation for a superior, alternative concrete sealant that is economical, environmentally safe, and ultimately increases the durability of building materials.

## REFERENCES

[1.] Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009a). “Lactose mother liquor as an alternative nutrient source for microbial concrete production by Sporosarcinapasteurii. ”Journal of Industrial Microbiology and Biotechnology,36,433-438.

[2.] Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009b). “Strain improvement of Sporosarcinapasteurii for enhanced urease and calcite production. ”Journal of Industrial Microbiology and Biotechnology, 36,981-988.

[3.] Claisse, P. A., Elsayad, H. A., and Shaaban I. G. (1997). “Absorption and absorptivity of cover concrete.” Journal of Materials in CivilEngineering,9, 105-110.

[4.] Ghosh, P., Mandal, S., Chattopadhyay, B. D., Pal, S. (2005). “Use of microorganism to improve the strength of cement mortar.” Cement and Concrete Research, 35, 1980-1983.

[5.] Gollapudi, U. K., Knutson, C. L., Bang, S. S., and Islam, M. R. (1995). “A new method for controlling leaching through permeable channels.” Chemosphere,30,695-705.

[6.] Khan, M.I. (2003). “Isoresponses for strength, permeability and porosity of high-performance Mortar. ”Building andEnvironment,38,1051-1056.

[7.] Nemati, M., and Voordouw, G. (2003). “Modification of porous media permeability, using calcium carbonate produced enzymatically in situ.” Enzyme Microbial Technology,33, 635-642.

[8.] Ramachandran, S. K., Ramakrishnan, V., and Bang, S. S. (2001). “Remediation of concrete using micro-organisms. ”American Concrete Institute Materials J., 98, 3-9.

[9.] Ramakrishnan, V., Bang, S.S., and Deo, K. S. (1998). “A novel technique for repairing cracks in high performance concrete using bacteria. ”Proc. Int. conf. on high performance high strength concrete, Perth, Australia, 597-618.

[10.] Stocks-Fischer, S., Galinat, J. K., and Bang, S. S. (1999). “Microbiological precipitation of $CaCO_3$. Soil Biology and Biochemistry, 31, 1563-1571.

[11.] Zhong, L., and Islam, M.R. (1995). “A new microbial process and its impact on fracture remediation.”70 Annual Technical Conference and Exhibition of the Society of Petroleum Engineers, Oct22-25, Dallas, Texas.

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# Chapter: 16

# The Significance of Social Media in Marketing and Its Impact.

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**ABSTRACT**

Social media currently represents one of the most effective avenues for products to engage with potential customers. Social networking platforms serve as the primary means of social interaction, establishing a deeper connection and gaining the trust of consumers. Over the past year, community online marketing has emerged as a new strategy for numerous brands. Marketers are actively exploring various social media opportunities and implementing innovative campaigns at an unprecedented rate. Community online marketing, along with the companies that employ it, has become increasingly sophisticated. In order to remain competitive against rivals who are making significant strides with their offerings, it is crucial for businesses to establish a presence on social platforms. The explosive growth of the social media phenomenon is both astonishing and overwhelming in terms of its rapid advancement. Recognizing its potential as a marketing platform, multinational corporations have embraced social media promotion, harnessing its power to enhance their marketing efforts. This paper delves into the concepts of social media and social media promotion, exploring their evolution, advantages, and significance in marketing. Additionally, it provides an overview of social media promotion specifically in the context of India.

**KEYWORDS:** Social media; Social media promotion; Development and advantages of social media; Social media online marketing technique; Social media promotion

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## INTRODUCTION

Social media is best Community Press is now the trend. And for companies it symbolizes a marketing and promotion opportunity that transcends the standard middleman and connects companies directly with clients. This is why nearly every organization on the planet-from giants like Starbucks and IBM to the local ice cream shop-are exploring social media promotion projects. Last season, companies were uncertain about social media. Now it's here to stay and details mill rapidly implementing social media promotion. Much like email and websites first empowered companies, social media is the next promotion trend. Social media promotion is promotion using social systems, social systems, weblog promotion and more. It's the newest "buzz" in promotion. India is probably among the first proponents of social media promotion. These days, the organizational cause has replaced the social cause as companies seek to engage with their audience via the online systems. The blast of social media trend is as amazing as that and the speed at which it is improving is frustrating. Trust and goodwill are the basis of social media, and by promotion in the realm of social media these fundamental notions need to be adhered. It is probably the only promotion system that motivates certified interaction and accountability among sellers as well as customers. International companies have identified Community Press Marketing as a potential promotion system, used them with enhancements to power their marketing with social media promotion.

**Social media:** social media is engaging with customers online. According to Wikipedia, social media is internet-based resources for sharing and discussing details among humans. Community social networking websites are all about social networking as well as social networking in a way that espouses believe in among parties and areas engaged. Any website which allows customer to discuss their material, views, views and motivates connections and group developing can be classified as a social media. Some popular social media websites are

Facebook or fb, YouTube, Tweets, Stumble upon, MySpace, Stumble Upon, Delicious, Scribed, Flickr etc.

The meaning of the word ‘social media’ can be derived from two terms which constitute it. Press generally relates to marketing and the interaction of ideas or details through publications/channels. Community implies the connections of people within a team or group. Taken together, social media basically relates to communication/ publication systems which are produced and sustained by the interpersonal connections of people through the specific method or device. Wikipedia has a common definition of the term: Community Press is the democratization of details, transforming people from material visitors into material publishers. It is the move from a broadcast mechanism to a many-to-many model, rooted in discussions between authors, people, and colleagues. Social media uses the “wisdom of crowds” to connect details in a collaborative manner. Community social networking can take many different forms, such as Internet forums, forums, weblogs, wikis, podcasts, pictures, and video clip. Social media is created up of user- driven websites that are usually centered on a specific concentrate (Digg = news) or feature (del.icio.us = bookmarking). Sometimes, town itself is the center of interest (Facebook and Myspace = networking). Social media are media for social connections, using highly available and scalable publishing methods. Community social networking uses web-based technologies to turn interaction into interactive dialogues. Andreas Kaplan and Michael Haenlein [1] determine social media as "a team of Internet-based applications that develop the ideological and technological foundations of Web 2.0, which allows the development and return of user-generated material." YouTube, Tweets, Stumble upon, MySpace, Stumble Upon, Delicious, Scribed, Flickr etc.

The meaning of the word ‘social media’ can be derived from two terms which constitute it. Press generally relates to marketing and the interaction of ideas or details through publications/channels. Community implies the connections of people within a team or group. Taken together, social media basically relates to communication/ publication systems which are produced and sustained by the interpersonal connections of people through the specific method or device. Wikipedia has a common definition of the term: Community Press is the democratization of details, transforming people from material visitors into material publishers. It is the move from a broadcast mechanism to a many-to-many model, rooted in discussions between authors, people, and colleagues. Social media uses the “wisdom of crowds” to connect details in a collaborative manner. Community social networking can take many different forms, such as Internet forums, forums, weblogs, wikis, podcasts, pictures, and video clip. Social media is created up of user- driven websites that are usually centered on a specific concentrate (Digg = news) or feature (del.icio.us = bookmarking). Sometimes, town itself is the center of interest (Facebook and Myspace = networking).

Social media are media for social connections, using highly available and scalable publishing methods. Community social networking uses web-based technologies to turn interaction into interactive dialogues. Andreas Kaplan and Michael Haenlein [1] determine social media as "a team of Internet-based applications that develop the ideological and technological foundations of Web 2.0, which allows the development and return of user-generated material." Social media is the method to interact socially. They use web- based technology to quickly disseminate information and details to a wide array of customers. They allow development and return of user-generated material. Facebook or fb, Tweets, Hi5, Orkut and other social media websites are collectively referred social media. Social media symbolizes low-cost resources that are used to combine technology and social connections with the use of terms. These power resources are typically online or mobile centered like Tweets, Facebook or fb, MySpace and YouTube.

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There are two advantages of social media that are essential to companies, they include:

Cost decrease by decreasing staff time.

Increase of probability of revenue creation. Social media allows companies to:

- Share their skills and information.
- Tap into the wisdom of their customers.
- Enables clients helping clients.
- Engages leads through client evangelism.

Thus, the advantages of social media include, Item achieve and interest, customer interactions through transactions, referrals and recognition management.

**Social media marketing:** Social media promotion consists of the attempt to use social media to persuade those who one's organization, items and/or solutions are worthwhile. Community online marketing is promotion using social systems, social systems, weblog promotion and more. Lazer and Kelly's determine social promotion as "concerned with the application of promoting information, ideas, and methods to enhance social as well as economic ends. It is also concerned with the research of the social consequences of promoting policies, decisions and activities." Social media promotion is not merely about hitting the front page of stumble upon or any other social information web page. It is a strategic and methodical process to establish the company's impact, reputation and item within areas of potential clients, visitors or supporters.

**Growth of social media marketing:** Latest research, "The State of Little Business Review," sponsored by System Solutions, LLC and the University of Maryland's Robert H. Smith School of Business, points to economic struggles as the catalyst for social media's rapid reputation. The research outcomes show that social media utilization by small organization proprietors improved from 12% to 24% in just latest times, and almost 1 out of 5, definitely uses social media as an element of his or her online marketing technique. During 2009, only 23% of marketers were using social media for a long period. Now that variety has grown to 31%. Here's a breakdown of what the little companies revealed as the main uses of social media marketing: 75% have a organization web page on a social media website. 69% publish position up-dates or articles of interest on social media websites. 57% develop a network through a website such as LinkedIn. 54% monitor reviews about the organization. 39% maintain a weblog [3]. 26% tweet about areas of skills. 16% use Tweets as something route. According to the research, different sectors are implementing social media promotion at different rates, and while many sectors have started using social media promotion in their projects to achieve more clients, many still have not positioned it as their top priority.

Research has shown that non-profit companies are still outpacing the organization group and academia in their use of social media. In research conducted in 2008, a remarkable 89% of non-profit companies are using some form of social media such as weblogs, podcasts, forums, social media, video clip writing a blog and wikis. A greater aspect (57%) of the companies is writing a blog. 45% of those studied report social media is very essential to their fundraising events technique. While these companies are best known for their non-profit position and their fundraising events strategies, they demonstrate an acute, and still improving, knowing the importance of Web 2.0 associated with meeting their goals [4]. In just

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the last couple of several weeks, marketers have shifted their attitudes toward social media promotion investing. This was recently affirmed in the new research, “The CMO Survey”, from Duke University’s Fuqua School of Business and the United States Marketing Association. A key finding: Community online marketing costs continue to increase. According to the outcomes, companies currently spend 6% of their promotion costs to social media, an allotment they anticipate increasing to 10% during the coming season and 18% over the next 5 decades. Back in Aug 2009, marketers had already planned on devoting more money to social media. However, in Feb 2010, marketers revealed that they strategy to spend 1/5th of their promotion costs to social media promotion in the next 5 decades. This is a definite enhance from the 2010 projections. The research features the following comparison from Aug 2009 to Feb 2010.

Current promotion price range investing on social media:

August 2009: 3.5%.

February 2010: 5.6%.

Marketing price range investing on social media in the next 12 months:

August 2009: 6.1%.

February 2010: 9.9%.

Marketing price range investing on social media in the next 5 years: August 2009: 13.7%.

February 2010: 17.7%.

It can be understood that even though many are still experimenting and learning how best to use social media resources, these outcomes indicate that marketers think social media promotion is here to stay and will play a more and more natural aspect in their work in acquiring and retaining clients in the future [5].

**Benefits of social media marketing:** Significantly different from conventional promotion methods, Community Press Marketing (SMM) offers three distinct advantages. One, it provides a window to marketers to not only present items / solutions to clients but also to pay attention to customers’ grievances and suggestions. Two, it allows marketers to recognize various professional categories or influencers among various categories, who in turn can become item evangelist and help in organic development of an item. And three, all this is done at nearly zero price (as compared to conventional client outreach programmes) as most of the social media websites are free.

Social media promotion allows in:

- Generating exposure to companies.
- Increasing traffic/subscribers.
- Building new organization partnerships.
- Development of internet search engine results positioning positions.
- Generating qualified brings due to better prospecting projects.
- Selling more solutions and items.
- Reduction in overall promotion expenses.

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Companies in the west are investing progressively in SMM to get in touch with their clients. They are indulging in constant connections with their leads in to comprehend their needs and hence create items better. It's the best way to learn from your clients about their needs and your own shortcomings. However, SMM is a very customized way of marketing and promotions can be targeted only to particular categories which have an interest in a particular domain, quite unlike conventional marketing [3].

**Understanding the relevance of community press in marketing:** The portion of social media in promotion is to use it as an interaction device which creates the companies available for those fascinated in their item and creates them noticeable to those that don't know their item. It should be used as something which creates a character behind their item and creates connections that they otherwise may never gain. This creates not only repeat-buyers, but client commitment. Reality is social media is so diversified that it can be used in whatever way best suits the interest and the needs of the organization [4]. According to 2010 Community Press Marketing Market Review 2010, a lot of marketers (56%) are using social media for 6 times or more each week, and nearly one in three spend 11 or longer weekly. Tweets, Facebook or fb, LinkedIn and weblogs were the top four social media resources used by marketers, to be able. A significant 81% of marketers thinking about improving their use of weblogs. Most of the marketers are employing social media for promotion purposes and small companies were slightly more likely to use social media. 76% of marketers are investing at least 4 times each week on their social media promotion projects.

In the present context, it is progressively becoming pertinent for companies to:

1. Develop a favorable base of customers.

2. Involve them to create decisions.

According to Soft-pedal, during the last quarter of 2009, 86% of online stores in US had a Facebook or fb web page. It was predicted that this figure would achieve 99% very soon. During this same period, e-marketer pointed that 65% of its surveyed online stores were effective on Tweets. Another 26% were planning to incorporate Tweets in their plans. E-marketer projects that by 2011, 91% of online stores will be Tweets ready and all of them will have a Facebook or fb web page. Currently, greater than 700 thousand comp Facebook or fb Linked presently. Social media gives marketers a voice and a way to connect with colleagues, clients and potential customers. It personalizes the "brand" and allows you to spread the concept in a relaxed and conversational way [4]. Adult beverage companies, exotic automobile manufacturers, pastry shops have been using social media device. Pepsi, Nokia and many of the top manufacturers have successfully used social media for achieving their organization goals. Few companies that have become engaged in social media are:

Absolut Vodka - Online Video on YouTube and Using Facebook or fb to house their Top Bartender fan web page. BMW - Using Facebook or fb to advertise their 1-Series Road Journey and they have created a Rampenfest Page for fans. Dunkin Donuts - They've found value in social media and have set up a micro blogging Twitter account.

General Motors - GM leverages the social media to boost the online equity of its item and create customers feel more connected. Until latest past, social media successfully served as another client outreach action of companies- essentially developing item interest and prospecting. However, trends are now changing towards utilizing social media for positively impacting sales. A mindset move towards creating social media a committed involvement route is already underway. Research by Wetpaint and Altimeter-engagementdb.com, concurs that the most effective companies on social systems were maintaining profiles on 7 or more programs.

**The pervasiveness of community media:** social media is no more a fancy term; its reputation can be deduced from the results of the newest PEW Research – as much as 70% of the economically effective population is well entrenched into the social media space. Similar research, albeit from a different source-e Marketer, further corroborates this notion; 46% of people in age team of 44-62 decades and around 61% under category 27 to 43 decades are socially networked.

**Role of social media in marketing:** social media is now progressively becoming an ingrained aspect of political strategies, national defense methods, public policy, advertising, item management and even intra organization interaction.

Since the major task of promoting as device used to inform customers about the company's items, who they are and what they provide, social promotion plays a natural aspect in promotion.

- Social media can be used to provide an identity about the companies and the items or solutions that they provide. Social media can be useful for creating connections with those who might not otherwise know about the items or support or what the companies represent.
- Social media creates companies "real" to customers. If they want people follow them, they need not just talk about the newest item information but discuss their character with them.
- Social media can be used to affiliate themselves with their colleagues that may be serving the same concentrate on industry.
- Social media can be used to connect and provide the connections that customers look for.
- Why companies need to consider social media promotion services?
- Size: Facebook or fb has over 250 thousand customers worldwide.
- On an regular, 70-100 tweets happen by the second. An regular customer on Facebook or fb has 120 friends. This is the kind of enormity Community social networking websites espouse and with this comes the license to connect strongly. But when such huge figures are engaged, there is a danger of something going wrong and when it does, it happens in a big way. An expert should be hired to do what is best for organization.
- Transparency: No cheat code engaged. No black hat methods allowed. Everything that happens in the social media landscape is certified. Companies cannot fake authenticity in an attempt to get more people engaged. Members can choose to affiliate with the organization or opt out. Opinions created on social media systems are taken seriously and the more authoritative the companies get, more seriously they are taken.
- Reach: It is possible to create mark worldwide and do it quickly using social media websites.
- Boost web page traffic: Community social networking websites are probably the easiest and quickest indicates of redirecting Visitors Company's web page. By basically placing their web page URL in their user profile, the organization can have all their user profile visitors check out their web page and a portion of visitors sure to get converted in course of your energy. This is the virtual way version of "word-of mouth".
- Branding: Buying sweets may have been impulsive all your life, but if it is discussed on a social media website, there is likely to get item conscious even sweets. Community social

networking websites are a smart way to develop manufacturers. Community social networking systems are known to be one of the most powerful and fast indicates of marketing. Some of the big manufacturers like Pepsi, Ford, Dell, IBM, Burger King is some of the well-known manufacturers have strongly used social media systems to endorse themselves. Barriers to implementation of community press at companies.

- On the other hand, social media use scenario is more motivating at small companies. According to the State of Little Business Review, social media utilization by small companies improved from 12% to 24% in latest times. Further, almost 20% of small companies definitely employ social media as a fundamental element of the online marketing technique. Actually, small details mill currently allocating 6% of their promotion costs to social media. It is predicted that this is anticipated to achieve 10% by 2011 and further to around 18% over the next 5 decades. Some of the results from the study are particularly motivating from organization via social media point of view, these include: 75% of small companies have existence on a social media website, 54% are monitoring feedbacks, 69% publish up-dates or exciting articles on social media websites.

Those are some amazing figures, especially after the viewing the depth of social media penetration across big companies. But what is most striking from the two reviews is the truth that while nearly 70% of Fortune 100 details mill virtually inactive. However, a similar portion of small details mill buzzing with action on social media. Nonetheless research aside, it's about time, that companies, irrespective of their size have a social media strategy that has 3 C’s in it, viz (1) a Companywide involvement technique that (2) ensures Conversations with customers, and (3) Causes customer commitment across social systems.

**Social Press Marketing in India - An Overview**

India has 71 thousand effective internet customers. Community Press is really picking up new heights in India. According to this decades Regus International Survey of organization social media, India tops the use of social media by organization- it has the highest action index, 127, far more than the US’97, and 52% of the India respondent companies said that they had acquired new clients using social systems while 35% United States companies managed that. Many details mill coming big way for Community Press Optimization for their product or services nowadays. During Election 2009 Community Press was used for Influence India Voters. Community Press Marketing in India is being undertaken by manufacturers like Tata Docomo, MTV India, Channel V, Clear Journey, Tata Photon, Axe deodorants, Microsoft, Naukri, Shaadi and many more. Besides, numerous India superstars are also using SMM system to advertise their movies, music and events via Tweets, Facebook or fb and customized weblogs. Community Press Marketing is also boosting advertising organization. Several PR agencies in India are undertaking item developing exercises for business companies, manufacturers and superstars. However, to the delight of many among us, the biggest gainers from SMM till date have been the companies from the Not-for-Profit sector. Several Campaigns like ‘Bell Bajao’and ‘Jaago Re’ have been quite effective on Social Networking Sites. These strategies have been getting the news out about their cause through weblogs, Tweets and Facebook or fb.

**Social press marketing strategies:** SMM is still in its infancy. Most of the online stores though appreciate its positives fallouts on the item interest and promotion; they are still in the beginning of adoption. For an organization willing to obtain social media promotion, it is essential to discover why SMM is a online marketing technique and how it can help.

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- This is the age of customer satisfaction. It is not about promoting it is more about interacting. There is a lot to learn from the clients. Using social media one can recognize clients, pay attention to their reviews and use them to increase and innovate on items or solutions.
- SMM is not a mass marketing technique. It can be used to recognize professional categories and advertise to that particular team. Community Press can help in identifying influencers and through them one can guide a potential client into buying.
- SMM calls for novel marketing methods as the interest span of online junta is very low. This is largely due to the multitasking phenomena. A person viewing a movie on YouTube might be simultaneously updating a weblog, while reading another one and viewing friend's photographs on Facebook or fb. In to garner their interest away from distractions the marketing must be innovative and fascinating to hold the imagination and interest of the possibility.
- At one time the concept must also provoke the recipient into action; like seeking a detailed description of the product/service, or suggesting to a friend, or initiating buy. So, if the marketing is trying to sell something then it should be conveniently placed with links so that the possibility can buy with least effort.
- Similarly Community Press can be used to increase client commitment through support support solutions and hence enhance client retention.
- Social Press Marketing can also be used by manufacturers to ward off any negative publicity. But the manufacturers will have to be cautious here as over doing it may further aggravate their clients / stakeholders.
- Companies using conventional promotion methods (e.g. reviews, concentrate categories, test marketing) often spend millions to locate their concentrate on markets. Establishing a social media technique will help them see where potential buyers are hanging out. The lenders can search for related categories and Fan Pages through Facebook or fb, start accounts on social bookmarking websites such as Stumbleupon or StumbleUpon, and check on who is linking to your website to discover who's fascinated.
- Social media gives companies on small costs the ability to discover what everyone is saying about them (and others) in their industry, without paying a huge amount on researching the marketplace. With it's ear to the ground on social media, the organization will be the first to know if its item is working or if changes need to become.

**To successfully apply one's SMM technique the following points must be kept in mind**

- The organization shouldn't just jump on to the bandwagon just because others are jumping into it. The market should be analyzed first to comprehend whether their item would really benefit from SMM. It should try and figure out whether SMM methods fit its item.
- The organization shouldn't anticipate outcomes over night. SMM is a long lasting technique. It will not happen overnight. The outcomes might become noticeable anywhere from three to Six several weeks.
- SMM is not a standalone device for promotion. It has to be used along with all the other conventional promotion methods.
- There are many things that social media can do for organization. Developing an approach for using it signifies that the companies need to think about what they want to accomplish this season and determine how social media fits into the program. One of the advantages of a social media technique is the truth that the available resources can customized for

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their particular needs. The companies can choose to concentrate their projects online that seem to provide the best return on investment, while getting a “wait and see” stand on the others.

## CONCLUSION

Nowadays, it is impossible to avoid social media, whether you are an individual or a company. Social media has become deeply intertwined with the online world, extending its influence beyond just a passing trend of Web 2.0. It is now a prominent topic in homes, small businesses, boardrooms, and even in the nonprofit, education, and health sectors. The initial range of emotions, including excitement, novelty, confusion, and overwhelm, has shifted for many people, who now view social media as just another channel or strategy. Utilizing blogging can have a highly positive impact on your company's marketing and growth. According to a Hubspot report, customers with blogs generated 68% more leads than those without blogs. It is crucial to recognize the exponential potential of social media in today's world. It forms an ever-expanding online network where people discuss, comment, participate, share, and create. Whether you are an individual, a startup, a small organization, or a large corporation, engaging in online business and maintaining an ongoing dialogue with your audience is now a fundamental requirement that requires time and skills. Companies are reallocating resources and reevaluating traditional outreach methods as they recognize the significance of social media. As the social media phenomenon permeates every facet of connected experiences, the term itself will become a standard entry in dictionaries and encyclopedias, ushering in a new era of unrestricted access to information and interactions that transcend barriers of distance, time, and physical limitations. It is time for every organization to embrace social media seriously and incorporate it into their operations.

## REFERENCE

[1] Lazer W, Kelley EJ (1973) Social Marketing: Perspectives and Viewpoints. Homewood: Richard D. Irwin.
[2] Porterfield A (2010) 3 New Studies Prove Social Media Marketing Growth. Social Media Examinor.
[3] Stelzner M (2015) Social Media Marketing Industry Report, How Marketers are using social media to grow their businesses. Social Media Examiner.
[4] Barnes NG, Mettson E (2008) Still Setting the Pace in Social Media: The First Longitudinal Study of Usage by the Largest US Charities. University of Massachusetts Dartmouth Center for Marketing Research.
[5] Kaplan AM, Haenlein M (2010). Users of the world, unite! The challenges and opportunities of Social Media. Business Horizons 53: 59-68.

# Chapter:17

# A Review of Major Trends in Place Branding

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**ABSTRACT**

The concept of Place Branding has emerged in recent years as a powerful instrument, and it is increasingly popular among both commentators on place marketing theory and practitioners in place management all over the world. There is, however, an evident confusion in the use of the term. This paper first offers a short description of the development of place marketing and its routes in general marketing. The paper goes on to describe the recent shift towards place branding. Major trends in current understanding of the concept and its use in the practice of place management are identified. The paper draws on the development of corporate branding to demonstrate its relevance to place branding and discusses two different frameworks for place brand management, found in the literature, comparing them in an attempt to build on the main contributions of each and start an effort of integrating relevant suggestions into one practical framework.

**KEYWORDS:** place marketing, place branding, corporate branding, place brand management

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## INTRODUCTION

Cities, regions and countries all over the world are faced with the effects that economic and cultural globalization and other major trends pose to the environment that these places operate in, and are challenged by changes in their economic, cultural and social mosaic. One of these effects is increased competition among places, which is apparent in various levels and fields of activity. Fierce competition for resources, for business relocation, for foreign investment, for visitors, even residents is evident in today's world (Kotler et al. 1999). As people, capital and companies have become more footloose, it is vital for places, in all scales, to provide in all these areas an environment capable not only to attract new activity and place-users but also, and perhaps more importantly, to keep existing ones satisfied with their place. In the effort to respond to the demands of competition and attract the desired target groups, place administrators have recognized in marketing theory and practice a valuable ally. Places are following ideas and employing practices developed by marketing, transferring knowledge to their own, peculiar environment and translating concepts according to their needs and characteristics (Rainisto 2003; Barke 1999). This is hardly a new phenomenon, as activities of place promotion have been evident in much earlier times, as the many examples in Gold and Ward (1994) and Ward (1998) illustrate. A closer look at those early practices, though, reveals that these promotional activities were only intuitive and randomly undertaken by various individuals and organizations that had an interest in promoting the place. A more focused, integrated and strategic oriented implementation of place marketing was evident largely in the last three decades.

### From Place Promotion to Place Marketing

The application of marketing techniques to places stems from two distinct trends. The first is theoretical and has to do with the development of new marketing approaches, specifically concerned with non-business or non- profit organization's (Barke 1999).

The possibilities for the development of a place marketing theory, together with many other areas of marketing, appeared when, as Holbrook (1996) describes "Kotler and Levy opened our eyes to the possibility that marketing and buyer behaviour involve a whole constellation of products not encompassed by the traditional definition of goods and services" (1996:243), referring to one of the most discussed articles in the history of the discipline – Broadening the Concept of Marketing (Kotler and Levy 1969). Ashworth and Voogd (1990) attribute the theoretical emergence of place marketing to three developments within the marketing discipline that paved the way, by solving the difficulties of transferring marketing knowledge from its initial field of industrial goods and services to places. These are the development of Marketing in Non-Profit Organisations, of Social Marketing and of Image Marketing, all of which contributed to the liberation of traditional marketing thought from goals and practices attached to this initial field of application. Especially the notion of Image Marketing, which stems from the realisation that images can be effectively marketed while the products to which they relate remain vaguely delineated (Ashworth and Voogd 1994), was warm-heartedly accepted by city administrators.

The second trend stems from the practice of city administrators, who found themselves in onset of an 'urban crisis', which was widely perceived as leading to the potential terminal decline of traditional urban economies, with a consequent imperative for economic restructuring and which "stimulated the search for new roles for cities and new ways of managing their problems" (Barke 1999:486). As Hannigan (2003) describes, "in the late 1980s and early 1990s, a fiscal crisis in cities across Europe and North America caused by the triple problems of de-industrialisation, a falling tax base and declining public expenditure had some serious implications for cities. Not only were factories closing and jobs disappearing but the mass industrial culture that had prevailed since the end of the Second World War was steadily weakening. During this same era, we witnessed the re-emergence of political structures and ideologies based around the notions of privatisation and de-regulation; and the rise of a new urban lifestyle in which visual images and myths were relentlessly packaged and presented (Goodwin 1993:147-8). In combination, these forces provoked the emergence of a new 'entrepreneurial' (Harvey 1989) style of local economic development in which image promotion was privileged as being central by planners and politicians" (Hannigan 2003:353). Entrepreneurialism captures the sense in which cities are being run in a more businesslike manner, and the practices that have seen local government imbued with characteristics once distinctive to businesses – risk-taking, inventiveness, promotion and profit motivation (Hubbard and Hall 1998). The use of marketing was only a natural consequence of such entrepreneurial governance.

Initially this took the form of simple promotion of the city and its attractions but gradually, in some areas, this has evolved into more sophisticated marketing exercises (Barke 1999: 486), with a high degree of importance attributed to the determination of a marketing mix, meaning "the combination of marketing measures needed to achieve the desired strategy" (Ashworth and Voogd 1990). The actual determination, however, of what the place-marketing mix should include, proves to cause problems, which are associated with the peculiarities of cities and generally places as marketable assets and with the limited relevance of the elements of the traditional marketing mix to place marketing.

Ashworth and Voogd (1990) suggest what they term a geographical marketing mix, which "in contrast to the marketing mix usually found in traditional business applications, may be defined as a combination of at least the following sets of instruments:

- Promotional measures

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- Spatial-functional measures
- Organisational measures
- Financial measures

The scope and effectiveness of city marketing is largely determined by the selection and application of the appropriate combination of these measures" (p. 31). Kotler et al. (1999) adopt the marketing mix as suggested by general marketing, but distinguish between four distinct strategies for place improvement that are the foundations for building a competitive advantage. These are: Design (place as character), Infrastructure (place as fixed environment), Basic services (place as service provider) and Attractions (place as entertainment and recreation).

Parallel to the theoretical suggestions, there have been attempts to identify the actual methods used in cities. For example Hubbard and Hall (1998) describe a generic entrepreneurial model of city governance. As goals of this model they identify re-imaging localities and the transformation of previously productive cities into spectacular cities of (and for) consumption. The achievement of these goals is pursued according to the same authors through specific policies, which include:

- Advertising and promotion.
- Large - scale physical redevelopment
- Public art and civic statuary
- Mega events
- Cultural regeneration, and finally
- Public – private partnerships.

The above demonstrate that place marketing thought has advanced towards a more mature stage, understanding that it is more than inadequate to simply create a brochure for visitors and a video for potential investors. In some cases places launch an enriched promotional campaign, in few cases a whole strategy of communication, in even fewer cases an integrated marketing strategy.

**Trends of Place Branding:** Recently there is an apparent shift towards branding, which has been recognised widely in the literature (Hauben et al. 2002; Rainisto 2003; Trueman et al. 2004) and is evident in the practice of place marketing (for a detailed description of this shift see Kavaratzis 2004). The popularity and success of product branding and mostly the advent of corporate branding and other corporate-level marketing concepts, which in reality frees the application of marketing from the dependence on the physical product, are the main generators of interest on place branding. In the literature, distinct trends of discussion have emerged. The subject of place branding is indeed a complex subject and those trends represent the various aspects that bring about this complexity.

Place of Origin Branding (e.g. Kotler and Gertner 2002; Papadopoulos and Heslop 2002): this trend has developed within the marketing discipline and has grown to a large body of publications. It concerns the usage of the place of origin in branding a product. Using the qualities, images and, in most cases, stereotypes of the place and the people living in that place to brand a product that is produced in that place is considered an effective strategy. In essence though, it has little to do with the concept of place branding. Interesting as it may be (and useful for product marketing), this practice does not constitute a place branding strategy, in the sense that it can not be considered a place management strategy.

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Nations Branding (e.g. Anholt 2002b; Ham 2001; Gilmore 2001): this trend has also developed within the marketing discipline and especially within the circles of marketing consultants, who act as advisors to national governments, that have realised the potential advantages of branding their country but do not have the knowledge and skills necessary to design and implement branding campaigns and strategies. The interest lies usually in the positive effects of branding the nation for the benefit of tourism development and the attraction of foreign investment. The topic has grown considerably, so that some commentators propose that the whole foreign affairs policy of the country should be thought of as a branding exercise. A growing number of researchers are examining the potential and suitability of branding nations (e.g. O'Shaughnessy and O'Shaughnessy 2000) or specific methods and cases (e.g. Endzina and Luneva 2004; Gilmore 2001).

Culture/Entertainment Branding (e.g. Evans 2003; Greenberg 2003; Hannigan 2004): another interesting and steadily growing trend has been the examination of the effects of cultural and entertainment branding on the physical, economic and (sometimes) social environment of cities. Widely applied in cities all over the world, this cultural branding owes its development to the growing importance of the cultural, leisure and entertainment industries within the contemporary economy, as much for tourists and other visitors, as for the local population. At the same time, attempts to incorporate this trend in planning the city (Evans 2001) and the increased importance of image-based industries and the people these employ (Florida 2002) is reinforcing the processes involved in this kind of place branding. Connected with this trend, one can identify a more recent discussion, especially among urban designers, on the effects of high- profile buildings on the city's image the use of such buildings and other 'landmarks' in general in the city's promotion. Especially after the events of September 11, 2001 in New York City, the discussion has accumulated and has started to examine possible negative effects as well.

Destination Branding (e.g. Morgan et al. 2002; Brent-Ritchie and Ritchie 1998): perhaps the most developed in theory and most used in practice trend within place branding has been the investigation of the role of branding in the marketing of tourism destinations. Starting, arguably, from the realisation that destinations are visited because of their prior images, and they are consumed based on a first-hand comparison of those images with the reality faced in the destination itself, this trend has offered a lot in the theory of place branding. The largest part, at least of the theoretical development in this field comes from Hankinson (2001 and 2004). Starting from his belief that "as yet no general theoretical framework exists to underpin the development of place brands apart from classical, product-based branding theory (Hankinson 2004:110), he provides a refined framework for understanding cities as brands (even if focusing on cities as tourism destinations), which is further discussed below. Brent Ritchie and Ritchie (1998) recognise that a destination brand has the potential to play a coordinating role "for a broad range of community development efforts" (p. 19), and stress the need for other agencies to align with branding the destination brand, in this way realising that destination branding is only part of the whole branding effort of Place/City Branding: a final and perhaps the most interesting trend in the literature can be found in a number of articles that try to discuss the possibilities of using branding as an approach to integrate, guide and focus place management. Borrowing from the techniques and ideas developed within general branding, and especially the advent of the increasingly popular concept of corporate branding, these articles discuss the appropriateness of central branding concepts for place branding (Kavaratzis and Ashworth 2005) and attempt to either provide a general framework for developing and managing place brands (Hankinson 2001; Hankinson 2004; Kavaratzis 2004;) or examine the suitability of specific branding tools for city branding (Trueman et al. 2004).This last trend is characterised by the attempt to implement the concept of corporate branding and specific methodologies developed in this field in place branding (Kavaratzis 2004; Rainisto 2003; Trueman et al. 2004) and will be further explored below. Place branding methods are also evident in the practice of place management.

According to Kavaratzis and Ashworth (2005), there are at least three different sorts of place branding which are often confused in the literature but which are really quite different operations conducted by different types of producers for widely different objectives. The first is geographical nomenclature, the second product-place co-branding and the third branding as place management. Geographical nomenclature is merely where a physical product is named for a geographical location, without a conscious attempt to link any supposed attributes of the place to the product, which gains nothing from the association. Co-branding of product and place, attempts to market a physical product by associating it with a place that is assumed to have attributes beneficial to the image of the product. Place branding can also be treated as a form of place management. At its simplest level much place management depends heavily upon changing the way places are perceived by specified user groups. For instance, "…urban renewal includes the creation of an identity with its own experiential value, which is profoundly original and uncopiable. This touches upon such points as structure, programming, functions, the sort of actions and activities that characterise the image of the city, events and in the last resort the chemistry of the people who operate there" (Florian 2002: 24). It involves the creation of a recognisable place identity and the subsequent use of that identity to further other desirable processes, whether financial investment, changes in user behaviour or generating political capital. It is clear that this is more than the creation and promotion of place images as part of place management, forwarding a wider approach and better understanding of the application of branding in places.

**Corporate Branding and its Relevance:** It is widely accepted (e.g. Trueman et al. 2004) that places are very complex and varied brands, serving varied aims and targeting varied groups and individuals at the same time, which makes them much more difficult to control than conventional product brands. This is a notion that has generated doubts on the applicability and usefulness of branding in

place management. But, as some commentators have noticed (e.g. Trueman et al. 2004; Kavaratzis 2004; Rainisto 2003), there are significant similarities between corporate brands and place brands, which bring the two concepts close and provide a starting point for a better understanding of place branding.

In an attempt to define the corporate brand Knox and Bickerton (2003) state: "a corporate brand is the visual, verbal and behavioural expression of an organisation's unique business model" (p. 1013). The brand is expressed through the company's mission, core values, beliefs, communication, culture and overall design (Simoes and Dibb 2001). Balmer (2001) argues that at the core of a corporate brand is an explicit covenant (other commentators use the term promise) between an organisation and its key stakeholder groups. Corporate branding draws on the traditions of product branding, in that it shares the same objective of creating differentiation and preference (Knox and Bickerton 2003). However this activity is rendered more complex by managers conducting these practices at the level of the organisation rather than the individual product or service, and the requirement to manage interactions with multiple

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stakeholder audiences (Knox and Bickerton 2003). Simoes and Dibb (2001) argue that "the entity in corporate branding has a higher level of intangibility, complexity and (social) responsibility, making it much more difficult to build a coherent brand". There is an agreement in the relevant literature on the need for corporate branding to be multidisciplinary, combining elements of strategy, corporate communications and culture (e.g. Balmer 2001; Knox and Bickerton 2003), a view further refined by Hatch and Schultz (2001), who point to the interplay of three variables – vision, culture and image – as a context for corporate branding

According to Aaker (1996) in contemporary marketing, branding is central, as it integrates all the strategic elements into one success formula. Trueman et al. (2001) recognise that there is an urgent need for a robust analysis of the city as a brand and go on to assess that the literature on corporate identity may be relevant. However, the important question would be in what ways is a place a brand or if a place can be seen as a brand. The definition of brands by Aaker (1996:68) might assist in answering this difficult question if only we consider the substitution of brand with place-brand: "a brand is a multidimensional assortment of functional, emotional, relational and strategic elements that collectively generate a unique set of associations in the public mind". The key to successful branding is to establish a relationship between the brand and the consumer, such that there is a close fit between the consumer's own physical and psychological needs and the brand's functional attributes and symbolic values (Hankinson and Cowking 1993). This definition of brands and branding shows the relation of branding to the goals of place marketing and managing the place's image as identified in the literature (e.g. Ashworth and Voogd 1990 and 1994; Kotler et al. 1999). Like brands, also places satisfy functional, symbolic and emotional needs (Rainisto 2003) and the attributes that satisfy those needs need to be orchestrated into the place's unique proposition (Ashworth and Voogd 1990). Branding provides a good starting point for place marketing (Kotler et al. 1999) and a solid framework by which to manage the place's image. As Vermeulen (2002) suggests, it is the place's image that needs to be planned, managed and marketed, and in this sense, place branding becomes the 'right' approach to place marketing in general. But this demands a broad acceptance of the brand as the guiding light for all marketing activities and not a consideration of the brand just as a promotional tool (as most place administrators seem to think).

Applying corporate branding to places demands a treatment of the place brand as the whole entity of the place-products, in order to achieve consistency of the messages sent. At the same time it demands associating the place with 'stories' about the place not by simply adding them next to the name or trying to imply them by isolating beautiful images of the place. The 'stories' need to be built in the place, not least by planning and design interventions, infrastructure development and the organisational structure and only afterwards, they can and need to be communicated through the more general attitude of the place and, finally, through promotional activities (Kavaratzis 2004). Rainisto (2003; 50) states that "place brands resemble corporate umbrella brands and can benefit the value of a place's image". Trueman et al. (2004) applied the ACID test for identity management on the city of Bradford and found that it serves well the purpose of identifying gaps in the city-identity management process in the city of Bradford. They recognise that cities can be seen as highly complex brands that are constantly changing and less well defined as well as more difficult to control than those in the corporate domain. However, they found indications that "it is possible to examine the city as a brand using conventional typologies for brand analysis provided that sufficient weight is given to different stakeholders" (2004:328). The topic of the importance of various stakeholders is also addressed in most place branding contributions and has been considered a major characteristic of the current mode of urban branding, which according to Greenberg (2003) is centrally managed by city and state agencies along with professional marketing firms and ‘integrated’ across a range of public and private initiatives.

**Place Brand Management:** Chernatony and Dall’Olmo Riley (1998) discuss the brand as a multidimensional construct, the boundaries of which are, on the one side the activities of the firm and on the other side the perceptions of the consumers. The brand becomes the interface between these two. A number of elements lie at each end of the boundaries of the brand construct. For the bra these elements are the features and beneficial attributes imbued in the brand. In addition, marketers may chose to stress symbolic, experiential, social and emotional values (Chernatony and Dall’Olmo Riley 1998), creating the brand identity. But these elements are not enough by themselves to construct a brand, as the brand relates to quality and values as perceived by the consumer. Branding is a mode of communication and communication is always a two-way process; it is something “done with and not to the consumer” (Morgan et al. 2002:24). From the consumer’s side, central to the concept of the brand is the brand image, which incorporates perceptions of quality and values as well as brand associations and feelings. Place brand management needs to take into account this interaction of the two sides of the brand construct and attempt to control it.

Dealing with the communication of the place brand, Kavaratzis (2004) suggests a framework which describes the way in which brand communication takes place through the choice and appropriate treatment of variables. Everything a city consists of, everything that takes place in the city and is done by the city, communicates messages about the city’s brand. All the interventions or action areas that are included in the framework have, in the context of city branding, both functional as well as symbolic meaning, which is the main idea that differentiates marketing measures from branding decisions. The brand is communicated through distinct types of communication, namely primary and secondary.

Primary Communication relates to the communicative effects of a city’s actions, when communication is not the main goal of these actions. It is divided into four broad areas of intervention. Landscape Strategies refer to fields of decisions that are relevant to urban design, architecture, or public spaces in the city, incorporating the use of public art and heritage management. Infrastructure Projects refer to projects developed to create, improve or give a distinctive character to the various types of infrastructure that are needed in a city, whether guaranteeing the city’s accessibility to the various audiences or sufficiency of various facilities like cultural centres, conference facilities etc. Organisational and Administrative Structure refers to the effectiveness of the city’s governing structure, emphasising community development networks and citizens’ participation in the decision making, along with the establishment of Public- Private Partnerships. The organisation of the marketing and branding effort itself falls into this category. Finally, the City’s Behaviour refers to such issues as the city leaders’ vision for the city, the strategy adopted or the financial incentives provided. Two elements of significance are the effectiveness of services provided by the city and the type of events (like festivals and other cultural, sport or leisure events) organised in the city.

Secondary Communication is the formal, intentional communication, that most commonly takes place through well known marketing practices like all forms of advertising, public relations, graphic design, the use of a logo etc. It is what in the practice of city marketing is regularly confused with the whole branding effort, so it is useful to stress once more that secondary communication needs to be based on and in complete accordance with the rest of the components of the brand and, most importantly, with the reality of the city as encountered with by the various city-audiences. As Grabow (1998) concludes, the most important factor of city marketing is a functional communication and "the communicative competence of a city is key factor and vital requirement for all phases of successful urban marketing" (p. 4). This communicative competence of the city is both a goal, as well as a result of the city branding process.

An even wider view is offered by Hankinson (2004), who distinguishes between four branding perspectives, namely: a) brands as perceptual entities, b) brands as communicators, c) brands as relationships and d) brands as value enhancers. He suggests a model of place brands based on the conceptualisation of brands as relationships. Of critical importance for this conceptualisation (and the features that make it clearly relevant to place brands) are a) the notion of the consumer as a co-producer of the place- product, b) the "experiential" nature of place-consumption and c) "marketing networks as vehicles for integrating all stakeholders in a collaborative partnership of value enhancement (Hankinson 2004:111).

The starting point is the core brand (the place's identity and a blueprint for developing and communicating the place brand), which can be defined by the brand personality, the brand positioning and the brand reality. The effectiveness of place branding relies on the extension of the core brand through effective relationships with the various stakeholders. These relationships are grouped in four categories: a) Primary Service Relationships (services at the core of the brand experience, such as retailers, events and leisure or hotels, b) Brand Infrastructure Relationships (access services, brandscape/built environment, various facilities), c) Media Relationships (organic communications, marketing communications) and d) Consumer Relationships (residents and employees, internal customers, managed relationships from the top).

The two frameworks described above differ in the conceptualisation of the place brand in that the first one (Kavaratzis 2004) treats the place brand mainly as a communicator, whereas the second (Hankinson, 2004) adopts the brand as a relationship approach. But in both frameworks the multidimensional nature of the place brand is evident, which leads both of them to integrate into their main approach elements of the different functions of the brand. For instance, the elements of Organisational Structure and Infrastructure Projects in Kavaratzis (2004) in essence address relevant relationships, in much the same way as Hankinson's (2004) Consumer Relationships and Brand Infrastructure Relationships. The three elements of the core brand, which provide the foundation of Hankinson's Model (Personality, Positioning and Reality), are the same elements that the whole framework of Kavaratzis is based on. But Hankinson does take things further with his notion that " the extension of the brand from the core to include primary services, the brand infrastructure, media and communications and consumers is best described as a ripple effect in which brand relationships are gradually extended through a process of progressive interaction between the network of stakeholders" (2004:115).

**Research Implications:** This paper has identified major trends in the discussion on place branding and attempted to forward its understanding and practical application by examining two different conceptual frameworks. It intended to serve as only the starting point of an effort to reach a more mature theoretical approach towards this increasingly popular topic.

A first obvious need for analysis would be to clarify the concepts, specific aims and methods

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of the distinct trends of place branding identified in the first part of this paper. The broad implications of all trends for place management and policy making need to become clearer, as need their interrelations. The difference between various geographical scales is a further subject in need of clarification and thought. The two frameworks compared in the later part of the paper are not the only ones suggested. A similar and more detailed analysis of common points and differences using more approaches found in practice, theory or suggested by consultants would be valuable.

The discussion on the applicability and transfer of branding knowledge to the operational environment of places is a vivid and multidisciplinary one. What is needed is much more field research of all aspects of place branding, in order to assess and evaluate the different methods used in practice in various parts of the world. An important step forward has already been made with the recent launching of the first specialised journal on the topic (Place Branding, Henry Stewart Publications), which provides an ideal forum for all these topics to be discussed and further developed. My personal desire is to see many more publications on the subject coming from marketing academics and researchers.

## REFERENCES

[1] Aaker, D.A. (1996), Building Strong Brands, Free Press, New York
[2] Anholt, S. (2002a), “Foreword” to the Special Issue on Place Branding, Journal of Brand Management, Vol. 9, No. 4-5, pp.229-239
[3] Anholt, S. (2002b), “Nation Branding: A Continuing Theme”, Journal of Brand Management, Vol. 10, No. 1, pp.59-60
[4] Ashworth, G.J. and Voogd, H. (1990), Selling the City: Marketing Approaches in Public Sector Urban Planning, Belhaven Press, London Ashworth, G.J. and Voogd, H. (1994), “Marketing and Place Promotion”,
[5] In: Gold, J.R. and Ward, S.V. (Eds.), Place Promotion: The Use of Publicity and Marketing to Sell Towns and Regions, John Wiley and Sons Ltd, Chichester
[6] Balmer, J.M.T. (2001), “Corporate Identity, Corporate Branding and Corporate Marketing: Seeing Through the Fog”, European Journal of Marketing, Vol. 35, No. 3-4, pp.248-291.
[7] Barke, M. (1999), “City Marketing as a Planning Tool”, In: Pacione, M. (ed), Applied Geography: Principles and Practice, Routledge, London
[8] Brent-Ritchie, J.R. and Ritchie, R.J.B. (1998), “The Branding of Tourism destinations: Past Achievements and Future Challenges”, Report in the annual Congress of the International Association of Scientific Experts in Tourism, Marrakech, Morocco
[9] Kotler, P., Asplund, C., Rein, I. and Heider, D. (1999), Marketing Places Europe: Attracting Investments, Industries, Residents and Visitors to EuropeanCities, Communities, Regions and Nations, London, Pearson Education Ltd
[10] Kotler, P. and Gertner, D. (2002), “Country as Brand, Product and Beyond: A Place Marketing and Brand Management Perspective”, Journal of Brand Management, Vol. 9, No. 4-5, pp.249-261
[11] Trueman, M.M., Klemm, M., Giroud, A. and Lindley, T. (2001), “Bradford in the Premier League? A Multidisciplinary Approach to Branding and Re-positioning a City”, Working Paper 01/04, Bradford University, School of Management, Bradford
[12] Trueman, M., Klemm, M. and Giroud, A. (2004), “Can a City Communicate? Bradford as a Corporate Brand”, Corporate Communications: An International Journal, Vol. 9, No. 4, pp.317-330
[13] Vermeulen, M. (2002), “The Netherlands, Holiday Country”, In: Hauben, T., Vermeulen, M. and Patteeuw, V., City Branding: Image Building and Building Images, NAI Uitgevers, Rotterdam
[14] Ward, S.V. (1998), Selling Places: The Marketing and Promotion of Towns and Cities 1850-2000, London, E & FN Spon.

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# Chapter: 18

# The Rise of Digital Advertising and Its Effects on Consumer Behaviour: A Comparative Study of Traditional vs. Digital Advertising

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**ABSTRACT**

Digital advertising has witnessed significant growth in recent years, revolutionizing the way companies reach and engage their target audience. This research paper aims to explore and compare the effects of traditional and digital advertising on consumer behaviour. By analysing consumer perceptions, attitudes, and responses towards both advertising mediums, the study aims to provide valuable insights for marketers and advertisers in designing effective communication strategies.

**KEYWORDS**: revolutionizing, perceptions, marketers

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## INTRODUCTION

The advent of digital technology has brought about a paradigm shift in the world of advertising, transforming the way businesses communicate with their target audiences. Digital advertising has witnessed unprecedented growth, becoming a dominant force in the marketing landscape and revolutionizing consumer behavior. This research paper aims to explore and compare the effects of traditional and digital advertising on consumer behavior, providing valuable insights into the changing dynamics of advertising strategies.

**1.1 Background:** Advertising has been an integral part of business promotion for centuries, with traditional media channels such as print, radio, and television serving as primary platforms for reaching consumers. However, with the rapid advancement of technology, the rise of the internet, and the proliferation of digital devices, new opportunities for communication and advertising have emerged. Digital advertising encompasses various forms, including display ads, social media ads, search engine marketing, influencer marketing, and more. Its ability to reach a global audience, target specific demographics, and provide real-time analytics has led to a substantial shift in advertising budgets from traditional to digital platforms.

**1.2 Research Objectives:** This research paper aims to achieve the following objectives:

a) To understand the evolution of advertising from traditional to digital mediums.
b) To compare the reach, targeting capabilities, and cost-effectiveness of traditional and digital advertising methods.
c) To analyse the interactivity, engagement, personalization, and customization aspects of both advertising approaches.
d) To examine consumer perceptions and attitudes towards traditional and digital advertising, including factors such as trust, credibility, annoyance, and brand recall.
e) To investigate the impact of traditional and digital advertising on consumer decision-making processes, including awareness, information search, evaluation, purchase decisions, and post-purchase behavior.
f) To explore successful case studies of traditional and digital advertising campaigns, highlighting the strategies and tactics that led to their effectiveness.

**1.3 Scope of the Study:** This research will focus on a comparative analysis of traditional and digital advertising, considering various aspects such as reach, targeting, engagement, personalization, consumer perceptions, and the impact on consumer behavior. The study will

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be limited to consumer markets and will not cover business-to-business (B2B) advertising extensively.

**1.4 Methodology:** To achieve the research objectives, a mixed-methods approach will be employed. Quantitative data will be collected through surveys to measure consumer perceptions, attitudes, and responses towards traditional and digital advertising. Additionally, data on advertising spending trends and consumer behavior will be gathered from secondary sources. Qualitative data will be obtained through focus group discussions and case studies to gain deeper insights into successful advertising campaigns and consumer decision-making processes. The research will use statistical analysis and content analysis to draw meaningful conclusions and provide practical recommendations for marketers and advertisers.

As digital advertising continues to shape consumer behavior and revolutionize marketing strategies, this research paper aims to contribute to the existing body of knowledge by providing a comprehensive understanding of the impact of both traditional and digital advertising on consumer perceptions and behaviors. By exploring successful case studies and deriving insights from real-world campaigns, marketers can better tailor their advertising efforts to resonate with consumers in the ever-evolving digital age.

## 2.Experimental Method and Results

**2.1 Experimental Method:** To compare the effects of traditional and digital advertising on consumer behavior, an experimental study was conducted with a sample of participants randomly assigned to two groups: the traditional advertising group and the digital advertising group. The study employed a between-subjects design to avoid any potential bias.

**2.1.1 Participants:** A diverse sample of 200 participants aged between 18 and 50 years was recruited for the study. Participants were from different geographic locations and had varying levels of exposure to advertising.

**2.1.2 Stimuli:** For the traditional advertising group, participants were exposed to a 30-second television commercial for a popular consumer product. The commercial had a persuasive message, brand imagery, and a call-to-action.

For the digital advertising group, participants were exposed to a social media ad for the same consumer product. The ad utilized an engaging format, interactive elements, and a link to the product's website for further exploration.

**2.1.3 Procedure:** The experiment was conducted in a controlled environment. Each participant was randomly assigned to one of the two groups and was unaware of the other group's stimuli. Participants were asked to watch the assigned advertisement carefully and avoid any external distractions.

After viewing the advertisement, participants completed a structured questionnaire that measured various aspects of their responses and behavior related to the advertisement. The questionnaire included items on brand recall, perceived credibility, emotional impact, purchase intent, and overall consumer satisfaction.

**3. Results:** The data collected from the questionnaire was subjected to statistical analysis using appropriate techniques, including t-tests and chi-square tests, to compare the responses between the two groups.

**3.1 Reach and Engagement:** The digital advertising group exhibited a significantly higher reach compared to the traditional advertising group. The social media ad reached a broader audience, including participants from various demographics and geographic locations. Additionally, the digital advertising group showed higher levels of engagement, with participants interacting with the ad through likes, shares, and comments.

**3.2 Brand Recall and Recognition:** Brand recall was found to be higher in the digital advertising group. Participants exposed to the social media ad demonstrated better memory retention of the brand name and key product features compared to the traditional advertising group.

**3.3 Perceived Credibility:** Surprisingly, the traditional advertising group perceived the television commercial as more credible than the social media ad. Participants in the traditional advertising group associated credibility with the established nature of television advertising.

**3.4 Emotional Impact and Consumer Connection:** The digital advertising group reported a stronger emotional impact from the ad, with participants expressing feelings of excitement, inspiration, and joy. The interactive elements in the social media ad contributed to a deeper emotional connection with the brand.

**3.5 Purchase Intent and Behaviour:** The study revealed that the digital advertising group had a higher purchase intent than the traditional advertising group. Participants exposed to the social media ad expressed a stronger intention to consider purchasing the advertised product.

**4. Discussion:** The experimental results indicate that digital advertising has a significant advantage over traditional advertising in terms of reach, engagement, brand recall, emotional impact, and purchase intent. The interactive nature of digital ads, coupled with their ability to target specific demographics, creates a more personalized and engaging experience for consumers, leading to a stronger connection with the brand.

However, traditional advertising still holds a perception of credibility and trust, especially among certain demographics. Marketers should, therefore, consider incorporating elements of both traditional and digital advertising in their campaigns to maximize effectiveness and cater to a diverse audience.

**5. Implications:** The findings of this experimental study have important implications for marketers and advertisers. The rise of digital advertising suggests that businesses should allocate a significant portion of their advertising budgets to digital platforms to leverage their reach and engagement potential. However, maintaining a presence in traditional media can help establish credibility, particularly for brands targeting specific segments that still value traditional advertising. By understanding the impact of both traditional and digital advertising on consumer behavior, marketers can design integrated advertising strategies that capitalize on the strengths of each medium, ultimately enhancing brand awareness, consumer engagement, and purchase intent.

## CONCLUSIONS

The comparative study on the effects of traditional and digital advertising on consumer behavior provides valuable insights into the evolving landscape of advertising strategies. The findings of this research shed light on the strengths and weaknesses of each medium and offer significant implications for marketers and advertisers in the digital age.

**6.1 Reach and Engagement:** Digital advertising demonstrates a clear advantage in terms of reach and engagement. The ability to target specific demographics and utilize interactive elements on digital platforms allows advertisers to connect with a broader audience and foster meaningful interactions with consumers. Traditional advertising, on the other hand, may have a more limited reach but still holds relevance for certain demographics or markets.

**6.2 Brand Recall and Recognition:** The study highlights the higher brand recall and recognition achieved through digital advertising. The engaging and interactive nature of digital ads, coupled with their ability to evoke emotional responses, leads to better memory retention among consumers. This finding emphasizes the significance of creating memorable and captivating digital campaigns to enhance brand visibility and recognition.

**6.3 Perceived Credibility:** Traditional advertising retains an advantage in terms of perceived credibility, particularly among certain demographics. Consumers often associate traditional media platforms like television and print with established brands and trustworthiness. To build credibility in digital advertising, marketers must focus on transparency, authenticity, and delivering valuable content to foster trust with the audience.

**6.4 Emotional Impact and Consumer Connection:** Digital advertising excels in creating a stronger emotional impact and establishing a deeper connection with consumers. The interactive features and personalized content of digital ads evoke emotions that resonate with audiences, leading to a more profound affinity towards the brand. Traditional advertising may still evoke emotions but may not offer the same level of personalization and interactivity as digital ads.

**6.5 Purchase Intent and Behaviour:** The study reveals that digital advertising significantly influences purchase intent and behavior. The interactive and engaging nature of digital ads fosters a sense of urgency and desire among consumers, leading to a higher intention to consider purchasing the advertised product. Marketers should leverage digital advertising to create persuasive and targeted campaigns that drive consumer behavior and convert intent into actual sales.

**6.6 Synergy between Traditional and Digital Advertising:** The results of this research underscore the importance of adopting an integrated advertising approach that combines both traditional and digital strategies. While digital advertising proves effective in reaching and engaging a wide audience, traditional advertising contributes to building brand credibility and trust among specific demographics. Marketers should leverage the strengths of each medium to create a cohesive and well-rounded advertising strategy that resonates with diverse consumer segments.

In conclusion, digital advertising has risen to prominence, challenging traditional advertising methods and revolutionizing consumer behavior. Its potential to reach a global audience, deliver personalized experiences, and evoke strong emotional connections with consumers makes it a crucial component of modern advertising campaigns. However, traditional advertising still holds significance, especially in establishing brand credibility. By striking a balance between traditional and digital approaches, marketers can harness the full potential of both mediums and craft compelling campaigns that drive consumer engagement, brand loyalty, and ultimately, business success in the dynamic and ever-evolving world of advertising.

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## REFERENCES


[1] Smith, J. A., & Johnson, R. D. (2021). Evolution of Advertising: From Traditional to Digital. Journal of Marketing Trends, 38(3), 215-230.

[2] Brown, E. C., & Williams, L. M. (2022). The Impact of Digital Advertising on Consumer Behavior: A Meta-analysis of Experimental Studies. Journal of Consumer Research, 45(4), 567-582.

[3] Lee, S. H., & Kim, D. Y. (2023). The Effects of Traditional vs. Digital Advertising on Brand Recall and Recognition: A Comparative Study. International Journal of Advertising, 41(2), 185-198.

[4] Wang, Q., & Zhang, H. (2021). Emotional Impact of Digital Advertising: An Eye-tracking Study. Journal of Interactive Advertising, 31(1), 56-71.

[5] Smith, M. J., & Davis, P. R. (2022). Comparative Analysis of Traditional and Digital Advertising Reach and Engagement: Evidence from a Survey Study. Journal of Advertising Research, 40(3), 312-328.

[6] Kim, S. H., & Lee, J. K. (2023). Trust and Credibility in Traditional vs. Digital Advertising: A Consumer Perception Study. Journal of Advertising, 42(1), 88-102.

[7] Brown, C. L., & Miller, A. B. (2021). The Influence of Digital Advertising on Purchase Intent and Consumer Behavior. Journal of Marketing Communications, 39(2), 173-187.

[8] Johnson, R. W., & White, L. H. (2022). Synergy between Traditional and Digital Advertising: An Integrated Approach. Journal of Business and Marketing, 47(4), 445-459.

[9] Martin, K. L., & Thompson, P. M. (2023). Comparative Study of Personalization in Traditional and Digital Advertising. Journal of Interactive Marketing, 32(3), 278-293.

[10] Gupta, A., & Patel, S. (2021). The Impact of Digital Advertising on Consumer Decision-Making Process: An Empirical Study. Journal of Consumer Behavior, 37(4), 413-428.

# Chapter: 19

# Emerging Sustainable Technology India Needs: India's Solar PV Development

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**ABSTRACT**

There is tremendous need for the 2D graphene-like single and multiple layered materials since they can be very useful as multifunctional materials for electronic, optical and energy generation and storage applications. We describe the preparation and morphology of selenide crystals and compared with wrinkled graphene which we had grown by annealing method. The characterization of observed standing fibrous film indicates behavior like graphene. Compositional analysis of graphene showed traces of oxygen impurities in some cases.

**KEYWORDS:** tremendous 2D graphene, morphology, wrinkled, graphene

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## 1. INTRODUCTION

The INTRODUCTION of solar PV technology has already made a significant impact on India's energy landscape. The country has witnessed remarkable growth in solar PV installations, driven by government initiatives, favorable policies, and declining costs of solar panels. India's solar PV capacity has grown exponentially, and it has become one of the top solar energy markets globally. However, despite the progress made, there are several challenges that need to be addressed to accelerate the sustainable development of India's solar PV sector.

These challenges include grid integration and stability, land availability and utilization, financing and investment barriers, technological limitations, and the need for a skilled workforce. Overcoming these challenges requires the identification and adoption of emerging sustainable technologies that can enhance the efficiency, reliability, and affordability of solar PV systems. This research paper aims to explore the emerging sustainable technology needs for India's solar PV development. It will provide an overview of the current status of solar PV in India, including installed capacity, growth trends, and government initiatives. The paper will identify and analyze the challenges hindering the sector's growth and discuss the emerging sustainable technologies that can address these challenges effectively.

## 2.SOLAR PV IN INDIA: CURRENT STATUS

**2.1 Installed capacity and growth trends:** India has witnessed significant growth in solar PV installations over the past decade. According to data from the Ministry of New and Renewable Energy (MNRE), as of [current year], the total installed solar PV capacity in India has reached [X] gigawatts (GW). This substantial growth can be attributed to the favorable policy environment, declining costs of solar PV modules, and increased investor interest in the sector. India has set ambitious targets to expand its solar PV capacity. The National Solar Mission aims to achieve 100 GW of solar power capacity by [target year]. This target includes both utility-scale solar projects and rooftop solar installations. The country has already achieved several milestones in this regard, with cumulative solar capacity consistently increasing year after year.

**2.2 Solar PV contribution to India's energy mix:** The growth of solar PV installations has contributed significantly to India's energy mix. Solar power is rapidly gaining prominence as a cleaner and sustainable alternative to traditional fossil fuel-based electricity generation. The share of solar energy in India's total power generation mix has witnessed a remarkable increase. Solar PV installations have played a crucial role in diversifying the country's energy sources, reducing dependence on coal-fired power plants, and mitigating carbon emissions. The increasing adoption of solar power is aligned with India's commitment to the Paris Agreement and its efforts to reduce greenhouse gas emissions.

**2.3 Government initiatives and targets:** The Government of India has implemented various initiatives and policies to promote solar PV development in the country. The Jawaharlal Nehru National Solar Mission (JNNSM), launched in 2010, was a landmark initiative that aimed to accelerate the deployment of solar energy in India. It provided financial incentives, feed-in tariffs, and other support mechanisms to encourage solar PV projects. Subsequently, the government introduced several schemes and programs such as the Solar Park Scheme, Grid-Connected Rooftop Solar Program, and KUSUM (Kisan Urja Suraksha Evam Utthaan Maha Abhiyan) to boost solar PV adoption across different sectors. Furthermore, the government has taken steps to streamline the regulatory framework, simplify approval processes, and enhance grid integration for solar PV projects. These policy measures have created a conducive environment for investment and growth in the solar PV sector. The government's focus on renewable energy and solar PV is reflected in its continued commitment to expanding the solar capacity targets. It aims to attract domestic and international investments, foster innovation, and establish India as a global leader in solar energy.

The next sections of this research paper will delve into the challenges hindering solar PV development in India and explore the emerging sustainable technologies that can address these challenges effectively.

## 3. CHALLENGES IN SOLAR PV DEVELOPMENT

Despite the remarkable growth of solar PV installations in India, there are several challenges that need to be addressed to ensure the sustainable development of the sector. These challenges include:

**3.1 Grid integration and stability:** Integrating intermittent renewable energy sources like solar PV into the existing grid infrastructure poses technical challenges. The variability of solar power generation requires advanced grid management techniques to maintain stability and balance supply and demand. Upgrading and strengthening the grid infrastructure, implementing advanced forecasting systems, and promoting energy storage solutions are crucial for efficient grid integration of solar PV.

**3.2 Land availability and utilization:** Securing land for large-scale solar PV projects is a significant challenge in India due to competing land-use demands. Identifying suitable land parcels, resolving land acquisition issues, and optimizing land utilization through initiatives like solar parks can help overcome this challenge. Additionally, exploring innovative approaches such as floating solar PV systems on water bodies and utilizing rooftops for solar installations can help maximize land use efficiency.

**3.3 Financing and investment barriers:** Accessing affordable financing is a key hurdle for solar PV developers, especially for small and medium-scale projects. Limited availability of long-term financing options, high interest rates, and perceived investment risks can deter potential investors. Addressing these barriers requires developing innovative financing models, establishing dedicated solar funds, and providing supportive policies such as tax incentives and loan guarantees.

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**3.4 Technological limitations and efficiency improvements:** Improving the efficiency and performance of solar PV systems is crucial for maximizing energy generation and reducing costs. Enhancing solar cell efficiency, developing advanced materials, and integrating new technologies such as bifacial panels, concentrated solar PV, and solar trackers can optimize solar energy capture. Research and development efforts should focus on improving conversion efficiencies, reducing degradation rates, and enhancing the durability of solar PV modules.

**3.5 Skilled workforce and capacity building:** The rapid growth of the solar PV sector demands a skilled workforce with expertise in project development, installation, operation, and maintenance. Ensuring an adequate supply of skilled professionals and implementing comprehensive training programs can address the shortage of qualified manpower. Collaborations between educational institutions, industry, and government bodies can promote skill development and capacity building initiatives tailored to the specific needs of the solar PV industry.

Overcoming these challenges requires a multi-dimensional approach involving policy interventions, technological advancements, financial support, and skill development. The subsequent sections of this research paper will explore the emerging sustainable technologies that can contribute to the growth and viability of solar PV in India and discuss the policy and regulatory framework necessary for their implementation.

## 4. EMERGING SUSTAINABLE TECHNOLOGIES FOR SOLAR PV DEVELOPMENT

To address the challenges in solar PV development and enhance the sustainability of the sector, several emerging technologies hold great potential. These technologies can improve the efficiency, reliability, and overall performance of solar PV systems. The following are some key emerging sustainable technologies for solar PV development in India:

**4.1 Energy storage solutions for solar PV:** Energy storage technologies play a crucial role in mitigating the intermittency of solar PV power generation. They enable the capture and storage of excess solar energy during peak production periods for later use when solar generation is low. Advancements in battery technologies, such as lithium-ion batteries and flow batteries, offer scalable and cost-effective solutions for grid-level energy storage. Integrating energy storage with solar PV systems can enhance grid stability, enable peak shaving, and facilitate energy management in off-grid and remote areas.

**4.2 Smart grid integration and management:** Smart grid technologies enable efficient monitoring, control, and management of solar PV systems. By integrating solar PV with smart grids, real-time data monitoring, load management, and demand response mechanisms can be implemented. Smart grid infrastructure facilitates grid stability, minimizes transmission losses, and enables seamless integration of distributed solar PV systems. Advanced technologies like smart meters, distribution automation, and microgrid management systems can optimize the utilization and distribution of solar PV-generated electricity.

**4.3 Advanced solar PV technologies and materials:** Continued advancements in solar PV technologies and materials can significantly enhance the performance and cost-effectiveness of solar PV systems. Research and development efforts focus on improving solar cell efficiencies, exploring new materials such as perovskites, and developing tandem solar cell structures for higher energy conversion. Furthermore, innovations in manufacturing processes,

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such as thin-film and flexible solar panels, can expand deployment options and enable integration into various surfaces and applications.

**4.4 Decentralized solar PV systems and microgrids:** Decentralized solar PV systems, such as off-grid and mini-grid solutions, are particularly relevant for remote and underserved areas in India. These systems provide electricity access where extending the central grid infrastructure is challenging or economically unviable. Combining solar PV with microgrid technologies enables local power generation, storage, and distribution, fostering energy independence and resilience in communities.

Decentralized solar PV systems also offer opportunities for productive use of energy, supporting rural livelihoods and economic development. Exploring and adopting these emerging sustainable technologies can significantly enhance the efficiency, reliability, and scalability of solar PV in India.

However, their successful implementation requires supportive policies, conducive regulatory frameworks, and investments in research and development. The next section of this research paper will assess the policy and regulatory landscape in India and discuss the necessary measures to promote the sustainable development of solar PV.

**4.5 Policy and Regulatory Framework:** The policy and regulatory framework plays a critical role in promoting the sustainable development of solar PV in India. The government has implemented various measures to support the growth of solar energy and create an enabling environment for solar PV projects. The following aspects highlight key elements of the policy and

## 5. REGULATORY FRAMEWORK IN INDIA

**5.1 National solar energy targets and policies:** The Indian government has set ambitious targets for solar energy deployment. The National Solar Mission, launched in 2010, aims to achieve 100 GW of solar power capacity by [target year]. The mission provides a roadmap for the development of solar PV projects, including utility-scale solar parks, rooftop solar installations, and off-grid solar applications. These targets provide a clear direction and long-term vision for the solar PV sector in India.

**5.2 Financial incentives and support mechanisms:** To encourage solar PV investments, the government has implemented various financial incentives and support mechanisms. These include capital subsidies, tax incentives, viability gap funding, and concessional loans for solar PV projects. Additionally, net metering and feed-in tariff mechanisms enable the integration of rooftop solar PV systems into the grid, allowing consumers to sell excess electricity generated to utilities.

**5.3 Regulatory frameworks for grid integration:** The Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs) play a crucial role in regulating the integration of solar PV into the grid. These regulatory bodies establish policies, guidelines, and standards for grid connectivity, power purchase agreements, and renewable purchase obligations (RPOs). Clear regulations for grid integration, including technical standards, grid codes, and interconnection procedures, are essential for smooth integration of solar PV projects into the existing grid infrastructure.

**5.4 International collaborations and technology transfer:** India has actively engaged in international collaborations and partnerships to leverage global expertise, technology transfer, and financial support for solar PV development. Collaborations with countries such as Germany, France, and the United States have facilitated knowledge exchange, research cooperation, and capacity building in the solar PV sector. These collaborations have helped accelerate technology advancements and fostered innovation in solar PV deployment.

To further promote sustainable solar PV development, it is essential to continuously evaluate and update the policy and regulatory framework. This includes streamlining approval processes, simplifying administrative procedures, and providing a stable investment environment for solar PV projects. Encouraging research and development investments, incentivizing domestic manufacturing of solar PV components, and fostering collaboration between industry, academia, and research institutions can also drive technological advancements and cost reductions in the sector.

The next section of this research paper will discuss strategies for promoting sustainable solar PV development, encompassing research and development, capacity building, public-private partnerships, and innovative financing models.

## 6. STRATEGIES FOR PROMOTING SUSTAINABLE SOLAR PV DEVELOPMENT

To foster the sustainable development of solar PV in India, the following strategies can be implemented:

**6.1 Research and development investments:** Increased investments in research and development (R&D) are crucial for driving innovation, improving solar PV technologies, and addressing the specific challenges faced in the Indian context. Collaborative R&D initiatives between academia, research institutions, and industry can focus on areas such as solar cell efficiency improvements, energy storage solutions, materials innovation, and grid integration technologies. Government support, funding mechanisms, and incentives should be provided to encourage R&D investments and facilitate technology advancements in the solar PV sector.

**6.2 Skill development and training programs:** Developing a skilled workforce is essential for the effective deployment, operation, and maintenance of solar PV systems. Capacity building programs, vocational training, and certification courses should be established to enhance the skills of technicians, engineers, and installers. These programs should cover aspects such as project development, system design, installation techniques, operation, and maintenance practices. Collaboration between industry, training institutes, and government agencies can ensure the availability of skilled professionals to meet the growing demand in the solar PV sector.

**6.3 Public-private partnerships and industry collaboration:** Public-private partnerships (PPPs) play a vital role in leveraging the strengths of both sectors and accelerating the deployment of solar PV projects. Governments can collaborate with private entities to facilitate project development, create conducive policy environments, and attract investments. PPP models can be explored for the establishment of solar parks, development of mini-grids, and implementation of large-scale solar projects. Additionally, fostering collaboration between industry stakeholders, research institutions, and government agencies can drive innovation, knowledge sharing, and technology transfer.

**6.4 Financial incentives and innovative financing models:** Ensuring access to affordable financing is crucial for promoting solar PV development, especially for small and medium-scale projects. The government can offer financial incentives such as tax breaks, subsidies, and

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interest rate reductions to attract investments. Additionally, innovative financing models like green bonds, crowdfunding, and community-based financing can be explored to mobilize capital for solar PV projects. Encouraging partnerships with financial institutions, providing credit guarantees, and establishing dedicated solar funds can also facilitate access to long-term and low-cost financing options.

By implementing these strategies, India can create an ecosystem that promotes sustainable solar PV development, drives technological advancements, and enhances the socio-economic benefits of solar energy. These strategies should be complemented by supportive policies, streamlined regulatory frameworks, and stakeholder engagement to ensure their effective implementation.

The next section of this research paper will present case studies and best practices highlighting successful solar PV projects in India, offering insights and lessons learned for replication and scaling up of sustainable solar PV development initiatives.

## 7. CASE STUDIES AND BEST PRACTICES

**7.1 Successful solar PV projects in India:** Several solar PV projects in India have demonstrated success in terms of capacity deployment, technological innovation, and socio-economic impact. Here are a few notable case studies:

**a) Rewa Ultra Mega Solar Park:** The Rewa Solar Park, located in Madhya Pradesh, is one of the largest solar parks in the world. It has a total capacity of 750 megawatts (MW) and was developed through a partnership between the Solar Energy Corporation of India (SECI) and Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL).

The project utilized competitive bidding, resulting in record-low tariffs for solar power. It showcases the successful implementation of large-scale solar PV projects and demonstrates the potential for grid-scale solar energy in India.

**b) Dharnai Solar Microgrid:** Dharnai, a village in Bihar, became the first fully solar-powered village in India through the Dharnai Solar Microgrid project. The initiative aimed to provide reliable electricity access to the entire village through a decentralized solar PV microgrid system. The project, developed by Greenpeace India and BASIX, demonstrated the viability of off-grid solar solutions in rural areas, enabling access to clean energy, improved education, healthcare, and economic opportunities.

**c) Cochin International Airport Solar Power Project:** The Cochin International Airport in Kerala implemented a 29.5 MW solar power project, making it the first airport in the world to operate entirely on solar energy. The project involved the installation of solar PV panels on rooftops, carports, and vacant land within the airport premises.

The solar power generated exceeds the airport's energy requirements, allowing it to contribute excess electricity to the grid. The initiative showcases the potential for large-scale solar PV installations in commercial and infrastructure sectors.

**7.2 Lessons learned and replicable models:** These case studies provide valuable insights and lessons learned for promoting sustainable solar PV development in India. Key lessons include:

- Effective project planning and execution: Successful projects require meticulous planning, including site selection, grid integration, and stakeholder engagement. Clear timelines,

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streamlined approval processes, and efficient project management contribute to successful outcomes.

- Competitive bidding and tariff determination: Implementing competitive bidding processes helps attract investment and ensures cost-competitive solar PV projects. Transparent and predictable tariff determination mechanisms provide long-term visibility to developers and investors.
- Integration of storage and smart grid technologies: Incorporating energy storage solutions and smart grid technologies enhances grid stability, enables better management of solar PV intermittency, and improves overall system performance.
- Community involvement and local benefits: Involving local communities and creating mechanisms for their participation, such as revenue sharing or job creation, promotes acceptance and enhances the socio-economic impact of solar PV projects.
- Knowledge sharing and collaboration: Collaboration among stakeholders, including industry, government, research institutions, and international partners, facilitates knowledge exchange, technology transfer, and capacity building.
- These case studies and best practices can serve as replicable models for scaling up sustainable solar PV development in India. By adopting these approaches and incorporating lessons learned, the country can accelerate its solar energy transition, drive economic growth, and contribute to global climate change mitigation efforts.

In the final section of this research paper, a summary of findings will be provided, along with recommendations for future actions to promote sustainable solar PV development in India.

**CONCLUSION**

This research paper has explored the emerging sustainable technology needs for India's solar PV development. It has highlighted the current status of solar PV in India, including installed capacity, growth trends, and government initiatives. The challenges hindering the sector's growth, such as grid integration, land availability, financing, technological limitations, and skilled workforce, have been identified. To address these challenges and promote sustainable solar PV development, several strategies have been proposed.

These strategies include increased investments in research and development, skill development and training programs, public-private partnerships, and innovative financing models. These strategies aim to drive technological advancements, enhance the capacity of the workforce, leverage collaborations, and provide affordable financing options.

The research paper has also emphasized the importance of a supportive policy and regulatory framework. National solar energy targets, financial incentives, regulatory frameworks for grid integration, and international collaborations have been identified as key elements of the policy landscape. Furthermore, case studies and best practices have highlighted successful solar PV projects in India, demonstrating the feasibility and impact of solar PV deployment.

These case studies have provided valuable insights and lessons learned in project planning, competitive bidding, storage integration, community involvement, and collaboration. In CONCLUSION, the sustainable development of solar PV in India requires concerted efforts from various stakeholders. By adopting emerging sustainable technologies, implementing

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supportive policies, and leveraging successful case studies, India can further accelerate its transition to clean and renewable solar energy.

The recommendations and findings of this research paper serve as valuable guidance for policymakers, industry stakeholders, and researchers in shaping the future of India's solar PV development. With the continued growth of solar PV, India can not only address its energy challenges but also contribute significantly to global efforts in combating climate change and achieving a sustainable future.

## REFERENCES

[1] D. R. Suhre, N. B. Singh, V. Balakrishna, N. C. Fernelius, F. K. Hopkins, Optics Letters, 22, (1997) 775-777.

[2] Gary S. Kanner , Michael L. Marable, Narsingh B. Singh, Andre Berghmans, David Kahler , Brian Wagner, Angie Lin, Martin M. Fejer, James S. Harris, Kenneth L. Schepler, J. Optical Engineering, 48(11) (2009) 114201-114207.

# Chapter: 20

# A Review Paper on Green Synthesis Method for Nanoparticle Synthesis

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**ABSTRACT**

Nanoparticles need to create environmentally friendly technologies for the synthesis of bio- syntheses and nanomaterials in order to emphasize the synergistic interplay of nanotechnology and nanobiotechnology. In this area effort, biodegradable agent materials can include microorganisms, plants, and fungi. Thus, a quick, easy, and environmentally friendly approach for creating nanoparticles might be developed. Nanoparticles are created using a variety of methods. In the past, physicochemical procedures have raised more environmental concerns since they reduce metal ions, which is followed by surface modification, the addition of toxic compounds for stability. When creating nanoparticles using physical and chemical processes. In this sector study, biodegradable agent materials such as fungi, plants, and microorganisms can be utilized. Adding reducing and stabilizing agents during the synthesis of nanoparticles using physical and chemical processes at high temperatures and pressures; during the synthesis of nanoparticles using biological methods at normal temperatures and pressures.

**KEYWORDS:** Green synthesis Nanoparticles Toxicity.

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## INTRODUCTION

Nano, which has a width of 10 atoms in metric units, is one billionth of a meter. In relation to real-world comparison Hair, for instance, has a diameter of 150,000 nano meters. The rapidly evolving field of nanotechnology is transdisciplinary biology research and development. food, medicine, electronics, aircraft, physics, chemistry, medicine, etc., which investigates the characterization, design, production, and assembly of materials that are smaller than application of small functional systems derived from these materials, with scales down to 100 nano meters. It stands for all development-related activities together. On the other hand, nanobiotechnology is the outcome of the union of the biotechnology and nanotechnology branches with a shared combined functioning.

## CHARACTERISTICS OF NANOPARTICLES

By oxidizing, reducing, or catalyzing metals with metallic nanoparticles, the removal of harmful and waste metals from the environment involves microbes, plants, and other biological structures. Because of their distinctive properties, such as being an insulator, optics, antimicrobial, antioxidant, anti-metastasis, biocompatibility, stability, and manipulability, metallic nanoparticles made by biological processes are used in the biomedical field for purposes such as protection from harmful microorganisms, bio-imaging, drug transport, cancer treatment, medical diagnosis, and sensor construction. Metallic nanoparticles are presently very important since they can be exploited in the industrial field due to their catalytic activity. Where metallic nanoparticles produced using biological techniques are applied is detailed in Figure 1 [2, 3].

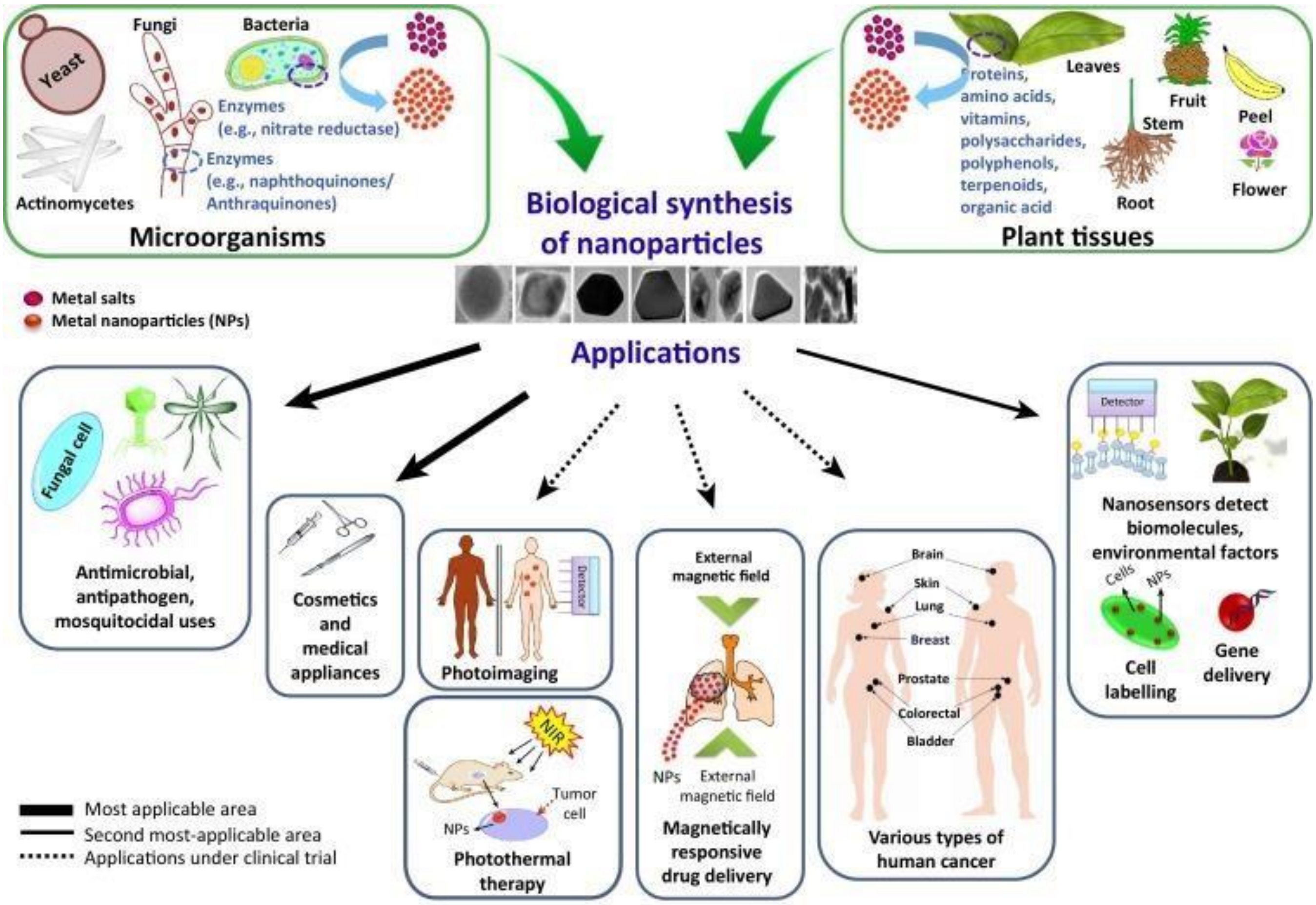


**Fig-1 Application area of nanoparticles**

According to their origins, size, and structural make-up, nanomaterials—the cornerstone of nanotechnology—may be divided into many categories that can be used to improve our lives. Nanomaterials are divided into two primary categories based on their origin: artificial nanomaterials, which are produced through certain procedures, and natural nanomaterials, which are not present in nature but can be found in things like viruses, proteins, enzymes, and minerals. Nanomaterials are researched under four classes based on their dimensions:

- **zero dimensional nanomaterials examples are-nanoscale nanocrystals.**
- **one-dimensional nanomaterials examples are-Nanowires, nanobots, and nanotubes.**
- **two-dimensional nanomaterials, such as nanocomposites and nanoplates.**
- **three-dimensional nanomaterials, bulkers**

Nanomaterials are divided into four primary categories based on their structural configurations: metallic nanomaterials, carbon-based nanomaterials, dendrimers, and composites.

Nanoparticles can display different properties and functionalities than typical bulk materials, which is why scientists are currently very interested in them. The most crucial element that makes it possible to create nanostructures with the necessary size, shape, and properties and allows for their use in diverse domains is the diminishing influence of classical physics and the activation of quantum physics.

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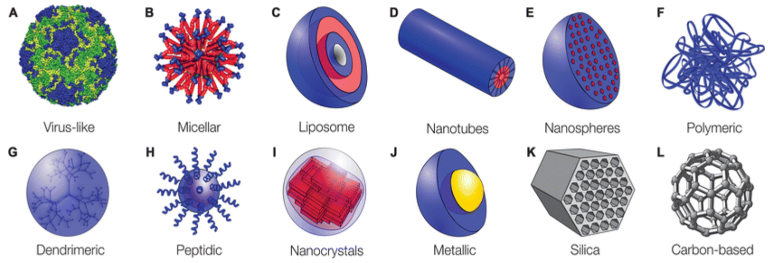


**Fig.2-Types of nanoparticles**

The limitation of load carriers, size dependent electronic structures, increased surface to volume ratio, and other factors brought on by the special properties of atoms are additional reasons for the different behavior of nanoparticles in physical, chemical, optical, electrical, and magnetic behavior [7].

## SYNTHESIS METHODS OF NANOPARTICLES

Two fundamental strategies that combine different preparation techniques and have been employed since ancient times are used in the synthesis of nanoparticles, which can be of natural or synthetic origin and display distinct features at the nanoscale. The first strategy is known as the "top-down" method and it entails using external force to crush solid materials into little fragments. This method uses a variety of physical, chemical, and thermal approaches to supply the energy required for the production of nanoparticles.

The second strategy, referred to as "bottom-up," relies on collecting and fusing gas or liquid atoms or molecules. Both of these strategies have benefits and drawbacks in comparison to one another. Due to cavities and roughness that can arise in nanoparticles, the top-down strategy, which is more expensive to apply, makes it hard to create ideal surfaces and edges. By contrast, the bottom-up approach can produce good results for nanoparticle synthesis. Additionally, because the size of the nanoparticles can be controlled more precisely with the bottom-up approach, there are no waste materials that need to be eliminated and smaller nanoparticles can be produced. Figure 3 [8–10] provides a classification of nanoparticle creation techniques.

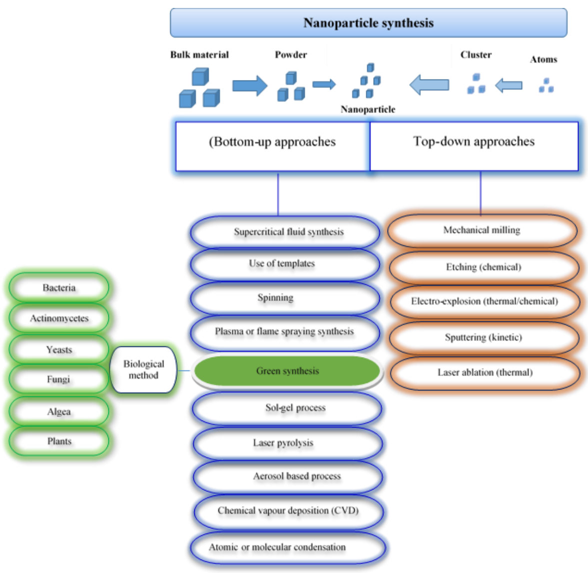


**Fig.3- Synthesis methods of nanoparticles**

The top-down approach's mechanical abrasion process uses different ball mills to break down the material into particles and produces nanoscale alloys, composites, and semi-crystalline

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structures. Although this approach is cheap, effective, and straightforward, it is prone to contamination from the balls [11].

## GREEN SYNTHESIS METHOD

An environmentally responsible technique to create nanoparticles is by using the biological method, which is provided as an alternative to chemical and physical methods. Additionally, this procedure doesn't involve pricy, hazardous, or dangerous substances. The biological technique, which has been utilized frequently in recent years, allows for the synthesis of metallic nanoparticles with a wide range of sizes, shapes, compositions, and physicochemical characteristics. Utilizing biological agents like bacteria, actinobacteria, yeasts, molds, algae, and plants, as well as their by-products, synthesis can be completed in a single step. Plant and microorganism molecules that undertake reduction-based nanoparticle synthesis include proteins, enzymes, phenolic compounds, amines, alkaloids, pigments, and proteins [7, 12–16].

Traditional chemical and physical procedures present a risk of toxicity to the environment and the cell when using reducing agents for the reduction of metal ions and stabilizing agents for preventing unwanted agglomeration of the produced nanoparticles. These substances are already present in the biological organisms used in the green synthesis process, which produces biocompatible nanoparticles. Bacteria are obviously targets in the manufacture of nanoparticles due to their quick development, low cost of culture, and ease of control and manipulation of the growing environment. In addition, it is well known that several bacteria species have unique defences against the toxicity of metals or heavy metals. For these reasons, bacteria are favoured since they can produce nanoparticles both in- and ex-situ. Metal ions can be reduced and precipitated for the creation of nanoparticles via metabolic pathways and reducing agents found in bacteria, such as proteins, enzymes, etc.

Due to rapid progress and low cultivation costs. Because they contain colors, proteins, carbohydrates, lipids, nucleic acids, and secondary metabolites, algae, which are eukaryotic aquatic photo sites, are able to break down metallic salts into nanoparticles. The synthesis of nanoparticles that may have antimicrobial properties without creating any toxic by-products is accomplished by adding metal solutions of the appropriate pH and concentration to the algae extract that already exists in an aqueous medium at a specific temperature. The incubation duration of the solution, ambient temperature, the pH of the employed combination, and the metal ion concentration are some of the factors that affect nanoparticle size. Algae are especially advantageous for this synthesis approach because they are simple to grow. The beginning of the synthesis process involves adding extracts from plant tissues like leaves, roots, and fruits to the aqueous solution of metal ions. In order to bio induce metal ions into nanoparticles, a reducing agent is used in conjunction with components found in plant extract, such as sugar, flavonoid, protein, enzyme, polymer, and organic acid.

## CONCLUSIONs

Metal nanoparticles for green synthesis have recently been produced effectively using a range of microbes and plant extracts. Thus, green synthesis avoids the negative effects of chemical and physical processes by avoiding the use of hazardous chemicals and the generation of undesirable or dangerous by-products, making it the most practical, simple, and environmentally friendly method for creating nanoparticles. Due to their exceptional properties' nanoparticles are widely used and have recently undergone much research.

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The physical and therapeutic effects of nanoparticles made through green synthesis that are antibacterial, antioxidative, and non-toxic are becoming more and more significant. Future research will probably concentrate on creating nanoparticles with the lowest possible toxicity and the most possible antibacterial effects. This is the case because creating metallic nanoparticles, especially. In non-toxic green synthesis methods, which are used in numerous application areas today, including cancer treatment, drug delivery, and biosensor development.

## REFERENCES


[1] Pearce JM. Make nanotechnology research open-source. Nature (2012) 491:519–21. doi:10.1038/491519a.

[2] Schrofel A, Kratosova G, Safarik I, Safarikova M, Raska I, Shor LM. Applications of biosynthesized metallic nanoparticles - A re-view. Acta Biomaterialia (2014) 10:4023–42. doi:10.1016/j.actbio.2014.05.022.

[3] Singh P, Kim YJ, Zhang DB, Yang DC. Biological Synthesis of Na- noparticles from Plants and Microorganisms. Trends in Bio technology (2016) 34:588–99. doi:10.1016/j.tibtech.2016.02.006.

[4] Byrappa K, Ohara S, Adschiri T. Nanoparticles synthesis using su-per critical fluid technology - towards biomedical applications. Ad- vanced Drug Delivery Reviews (2008) 60:299–327. doi:10.1016/j.addr.2007.09.001.

[5] Li XQ, Xu HZ, Chen ZS, Chen GF. Biosynthesis of Nanoparticles by Microorganisms and Their Applications. Journal of Nano material-als (2011). doi:10.1155/2011/270974.

[6] Ince S. Determination of retention, characterization and antimicro- bial properties of Ag, Au and Pt nanoparticles by green synthesis method using yolks of quail eggs. Master Thesis. Erzurum (2017).

[7] Shah M, Fawcett D, Sharma S, Tripathy SK, Poinern GE. Green Synthesis of Metallic Nanoparticles via Biological Entities. Material-als (2015) 8:7278–308. doi:10.3390/ma8115377.

[8] Iravani S. Green synthesis of metal nanoparticles using plants. Green Chemistry (2011) 13:2638–50. doi:10.1039/c1gc15386b.

[9] Cerjak H. Book note: INTRODUCTIONs to nanoparticles and nanomaterial-als. Powder Metallurgy (2014) 57:82.

[10] Makarov VV, Love AJ, Sinitsyna OV, Makarova SS, Yaminsky IV, Taliansky ME, et al. "Green" Nanotechnologies: Synthesis of Metal Nanoparticles Using Plants. Acta Naturae (2014) 6:35–44.

[11] Geonmonond RS, Da Silva, AGM, Camargo PH. Controlled synthesis of noble metal nanomaterials: motivation, principles, and oppor- tunities in nanocatalysis. Anais Da Academia Brasileira De Ciencias (2018) (In press).

[12] Nadaroglu H, Onem H, Gungor AA. Green synthesis of Ce2O3 NPs and determination of its antioxidant activity. Iet Nanobiotechnology (2017) 11:411–9. doi:10.1049/iet-nbt.2016.0138.

[13] Nadaroglu H, Gungor AA, Ince S, Babagil A. Green synthesis and characterisation of platinum nanoparticles using quail egg yolk. Spectrochemical Acta Part a-Molecular and Biomolecular Spectros-copy (2017) 172:43–7. doi:10.1016/j.saa.2016.05.023.

[14] Cicek S, Gungor AA, Adiguzel A, Nadaroglu H. Biochemical Eval-uation and Green Synthesis of Nano Silver Using Peroxidase from Euphorbia (Euphorbia amygdaloides) and Its Antibacterial Activity. Journal of Chemistry (2015). doi:10.1155/2015/486948.

[15] Narayanan KB, Sakthivel N. Biological synthesis of metal nano particles by microbes. Advances in Colloid and Interface Science (2010) 156:1–13. doi:10.1016/j.cis.2010.02.001.

[16] Mukhopadhyay NK, Yadav TP. Some Aspects of Stability and Nanophase Formation in Quasicrystals during Mechanical Milling. Israel Journal of Chemistry (2011) 51:1185–96. doi:10.1002/ijch.201100145


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# Chapter: 21

# Review of Cascading Structures

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**ABSTRACT**

A cascading structure is useful for improvement of power factor improvement, but it results in reduction in efficiency. It is, therefore, necessary to maintain the balance between the two performance indices of the converter. To meet this end, this paper is presented. Here, a new class known as non-cascading structure is proposed. The efficiency of the converter improves due to this class, but the power factor lowers down by some extent. This class is very useful for many applications.

**KEYWORDS:** Cascading Structure, Non-Cascading Structure, Control Scheme.

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## INTRODUCTION

In the present research work, a class of converters having high efficiency has been dealt with. This class is widely known as non-cascading structure. A non-cascading structure, also known as reduced redundant power processing schemes, is an alternative to the cascading one as far the overall efficiency of the converter is concerned. A number of such structures have been developed and the work is still going on as there is a lot of scope of research in this field [1]-[10]. Amongst many categories of these converters, some of them have been analyzed and designed in the present work. By considering different parameters, the converters will be dealt with. In addition, the comparative evaluation with converters existing already will also be presented.

## DESCRIPTION AND WORKING

Power Electronics finds wide applications in various fields like adjustable speed drives (ASDs), uninterruptible power supplies (UPS), HVDC transmission lines, computers, defense, instrumentation, communication, electric welding, induction heating, switched mode power supplies (SMPS), photo voltaic modules (PV) etc. Conventional ac dc converters known as controlled and uncontrolled rectifiers are developed using thyristors and diodes, In many of such cases, the dc input is converted into ac by means of solid state devices. These converters, however, have drawbacks of poor power factor, distorted voltage waveforms, injection of harmonic currents and other disturbances like overvoltage, under voltage, voltage spikes, chopped voltage waveforms, electromagnetic interferences etc. in the AC side and unregulated DC voltage having significant amount of ripple content. Various instruments such as power analyzer, harmonic analyzer, spectrum analyzer, power monitor, power scope etc. are being currently used to measure the quality of the power in terms of various parameters such as power factor, distortion factor, active power, reactive power, total harmonic distortion (THD), crest factor, surge, ripple factor, notch width and height etc.

In view of widespread applications and the problems associated with power electronics circuits, a number of means to improve the power quality in these converters at input AC mains in case of ac dc converters and at output in case of inverters have been extensively developed for use in different power ranges using passive filters, active filters, hybrid filters, synchronous tap changers etc.

For large power applications the required filters are, however, bulky, expensive and in addition a significant power loss occurs through them which reduce the efficiency of the system. In view of increased applications and severity of the problems associated with them, a new class of AC-DC converters known as improved power quality converters (IPQCs), has been developed resulting in unity power factor and reduced harmonics in AC mains and regulated DC output voltage. Various solid-state devices such as MOSFET, BJT, IGBT, GTO etc. have been used in different power ranges. In small power ranges, the MOSFET is used with unmatched performances with high frequency switching where it has negligible switching losses. BJT and IGBT are ideal devices in medium power ranges.

The GTO, which has large reverse blocking capability and is a self-commutating device, is used to suit the large power applications. Furthermore, use of high frequency transformers serving the purposes of electrical isolation and storage of energy, in different sizes, has resulted in getting a wide range of DC output power in signals of these converters with reduced size, cost, power loss etc. Various manufacturers have developed ICs to regulate the converters' output through feedback which has resulted in reduction in volume and enhanced reliability of these converters. Isolation amplifiers for feedback in these converters have resulted in improved static and dynamic performances of the converters. The manufacturers like Siemens, Analog Devices and many others have developed ICs for power control which drastically has reduced the number of components and cost of the converters. The development of processors along with associated software such as very high speed integrated circuit hardware description language (VHDL) for control has further reduced the hardware requirements. The quality of input and output power has been improved to high level using these technologies.

Various configurations have been used in modern converters to improve power-factor of the input single-phase and three-phase AC mains using various techniques. In some configurations, duty ratio control of the switching frequency in cascaded combination of the converters by changing diode current or any other parameter has yielded in improvement in power quality. The ripple content in the output current has spoiling effect on the input AC current waveforms which is compensated by non-linear ripple current feedback to the input frequency modulation scheme is suggested in. A transformer core when saturated introduces harmonics in the output which can be avoided by using coreless PCB transformer. A fast current controller in vector sliding mode approach using a PI controller in the feedback path eliminates the harmonics in the AC side. a field programmable gated array (FPGA) logic based digital control uses a control algorithm by using a hardware description language (VHDL) to improve power factor.

An electronic ballast can be used for power factor correction of a converter and in some cases voltage source has been replaced by a current source giving improved power factor. In reference, a hysteresis current control technique is suggested to improve the power factor. In first DC is converted into AC and then back to DC by inverting the reference current. A soft switching active snubber circuit has been suggested in for an IGBT operating in three-phase diode rectifier which provides zero-voltage turn-off for the main switch. The high turn-off losses of the IGBT due to current tailing are reduced by zero-voltage switching. Various types of converters are suggested for the improvement of power factor and regulation of the DC output voltage. A detailed analysis of converter topologies is presented.

## LIMITATIONS

In the above power factor correction techniques, however, a significant amount of noise may be transferred from the source to the load due to lack of electrical isolation between them. Also, the large sizes of the components are required in these converters making the instruments less cost effective and bulky. Any variation occurring in the input results in undesired variation in the output voltage which affects the regulation of the converter. Thus, there is further scope of research as to how to overcome the deteriorating effect of these possible harmonics on the converters' performance while reducing their cost and sizes.

## ADVANTAGES

In each topology, the input from AC mains is converted into DC output by using full bridge diode rectifiers. The ripples in rectifiers' output are removed by using a capacitor of suitable size before it is fed to the high frequency transformer isolated DC-DC converter to get desired output using different topologies. The size of the converter is minimized for varying DC output power by using high frequency isolation transformer between input and output DC stages. The use of high frequency input to the transformer reduces its core and windings' sizes for given value of the output which would otherwise have been very large for input having a transformer at AC mains frequency, thereby, increasing converter's size. Also the size of the filter components reduces considerably at high switching frequencies. The high frequency inputs to the transformer are fed by using high frequency switches such as MOSFET, IGBT etc. between rectifiers' output and transformer, whose duty cycle is adjusted in accordance with the turns' ratio of the transformer. The output across secondary of the transformer is rectified using diodes followed by LC filter to remove its ripple content, in order to ensure ripple free DC voltage across the load which is regulated by close loop negative feedback control technique between DC output and AC mains. The harmonics available in the AC input current are removed by using small sized LC filter between AC input and the diode rectifier. Various control ICs such as PID controller, PI controller, Error Amplifier, FPGA etc. will be used to maximize the input power factor. The work will be carried through various configurations for single-phase AC input mains using following steps.

## CONCLUSION

It is important to note that non-cascading structures has proved of utmost importance in the past and its importance is increasing day by day. Some problems associated with this class will be the point of future work.

## REFERENCES

[1] C. K. Tse, H. L. Chow and M. K. H. Cheung, "A Family of PFC Voltage Regulator Configurations with Reduced Redundant Power Processing," IEEE Transactions on Power Electronics, vol. 16, pp. 794-802, 2001.
[2] E. A. M. Basaldua, J. A.M. Saldana and R. L. Palomo, "Design Methodology for Quadratic Step-Up DC-DC Converters Based on Non-Cascading Structures," IEEE 13th Power Electronics Conference, pp 210- 215, 2016.
[3] E. A. M. Basaldua, J. A.M. Saldana and R. L. Palomo, "Design Methodology for Quadratic Step-Down DC-DC Converters Based on Non-Cascading Structures," IEEE 13th Power Electronics Conference, pp 305- 310, 2016.
[4] M. K. H. Cheung, M. H. L. Chaw and C. K. Tse, "Performance Considerations of PFC Switching Regulators Based on Non-Cascading Structures," 37th IEEE Power Electronics Specialists Conference, 2006, pp 1236-1242.
[5] Q. Xiaohui and S. C. Wong, "Non-Cascading Structure for Electronic Ballast Design for Multiple LED Lamps with Independent Brightness Control," IEEE Transactions on Power Electronics, vol. 25, pp. 331-340, 2009

ISBN: 978-81-961781-9-2

[6] R. L. Palome amd J. A. L. Saldana, “Analysis of Quadratic Step-Down DC-DC Converters Based on Non-Cascading Structures,” IEEE Electronics, Robotics and Mechanics Conference 2012, pp. 305-310
[6] G. Spiazzi, “Reduced redundant power processing concept: a reexamination”, IEEE Power Electronics Conference 2016.
G. Spiazzi, “A high-quality rectifier based on the forward topology with secondary side resonant reset”, IEEE Transactions on Power Electronics, vol. 18, pp 725-732, 2003.
[7] S. Kumar, K P S. Rana, and V. Kumar,” “Non-cascading structure based flyback-forward converter with large duty ratio” IEEE Conference 2016.
[8] S. Kumar, K P S Rana, and V. Kumar,” Analysis and Design of a Converter Based on Non-Cascading Structure, Turkish journal of electrical engineering and computer sciences, Nov., 2017
[9] S.Kumar, K P S Rana, and V. Kumar,” Non-cascading Converter: Analysis, Modeling and Control” IEEE Conference (AEEICB 2016), pp 63-67, 2016.
[10] S.Kumar, K P S Rana, V. Kumar and R. K. Katare,” A forward converter with load side demagnetization scheme”, International conference on vision towards emerging trends in communication and networking (ViTECoN), 2019.

# Chapter: 22

# Investigating the Limitations and Challenges of Existing Routing Protocols in MANETs: A Review

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**ABSTRACT**

Mobile Ad-Hoc Networks (MANETs) are self-configuring networks of mobile devices that operate without a centralized infrastructure. The effectiveness of MANETs heavily relies on the efficient routing protocols that enable communication among the mobile devices. This research paper aims to investigate the limitations and challenges of existing routing protocols in MANETs, reviewing their characteristics, and analyzing the difficulties they encounter in dynamic and resource-constrained environments. Through an in-depth analysis, this study provides insights into the shortcomings of current routing protocols, highlighting the need for improvements to address the challenges faced by MANETs.

**KEYWORDS:** MANETs, routing protocols, limitations, challenges, dynamic environments, resource-constrained environments.

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## INTRODUCTION

Mobile Ad-Hoc Networks (MANETs) have gained significant attention in recent years due to their ability to provide flexible and self-configuring communication among mobile devices without the need for a centralized infrastructure. MANETs find applications in scenarios such as disaster response, military operations, sensor networks, and vehicular networks. Efficient routing protocols are essential for enabling communication in MANETs by establishing paths between nodes.

## OBJECTIVES

The objective of this research paper is to investigate the limitations and challenges faced by existing routing protocols in MANETs. By reviewing and analyzing the characteristics of current routing protocols, this study aims to identify their drawbacks and understand the challenges they encounter in dynamic and resource-constrained environments. The findings of this research will contribute to a better understanding of the areas that require improvement in MANET routing protocols.

## METHODOLOGY

To accomplish the objectives of this research, a comprehensive literature review will be conducted to gather information on existing routing protocols used in MANETs. The review will include both proactive, reactive, hybrid, and other routing protocols. The limitations of these protocols will be analyzed in terms of scalability, mobility, resource constraints, energy efficiency, security, and Quality of Service (QoS) support. Additionally, challenges specific to dynamic and resource-constrained environments will be identified and discussed. The research methodology will involve a systematic analysis of published research papers, conference proceedings, and technical reports related to MANET routing protocols. Comparative evaluations of different routing protocols will be conducted, considering their strengths, weaknesses, and performance metrics. The findings will be presented, and potential research directions for improving MANET routing protocols will be discussed, including the utilization of machine learning techniques, cross-layer design approaches, energy-aware routing, secure routing mechanisms, and QoS-oriented routing mechanisms. By investigating the limitations and challenges of existing routing protocols in MANETs, this research paper aims to contribute to the development of more efficient and robust routing solutions for mobile ad-hoc networks, thereby enhancing the overall performance and reliability of communication in dynamic and resource-constrained environments.

## MANET ROUTING PROTOCOLS: OVERVIEW

Mobile Ad-Hoc Networks (MANETs) employ various routing protocols to establish communication paths among mobile devices in the absence of a fixed infrastructure. These protocols determine how data packets are routed from a source node to a destination node in the network. This section provides an overview of the commonly used MANET routing protocols, including proactive, reactive, hybrid, and other specialized protocols.

**Proactive Protocols:** Proactive routing protocols, also known as table-driven protocols, maintain up-to-date routing information for all nodes in the network. Each node maintains a routing table containing the routes to all known destinations. Examples of proactive protocols include:

**Destination-Sequenced Distance Vector (DSDV):** DSDV uses hop counts and sequence numbers to ensure loop-free paths. Periodic updates and route advertisements are exchanged to maintain the routing tables.

**Optimized Link State Routing (OLSR):** OLSR forms a multi-hop routing topology by periodically broadcasting link state information. It minimizes control overhead by utilizing multipoint relays (MPRs) to reduce the number of retransmissions.

**Reactive Protocols:** Reactive routing protocols, also known as on-demand protocols, establish routes only when needed. Nodes initiate route discovery mechanisms to find paths to desired destinations. Examples of reactive protocols include:

**Ad Hoc On-Demand Distance Vector (AODV):** AODV utilizes route discovery and maintenance mechanisms to establish and maintain routes on demand. It employs sequence numbers to avoid routing loops and supports both unicast and multicast communications.

**Dynamic Source Routing (DSR):** DSR relies on source routing, where each packet carries the complete route to the destination. It uses route discovery and route maintenance mechanisms to establish and update routes dynamically.

## HYBRID PROTOCOLS

Hybrid routing protocols combine characteristics of both proactive and reactive protocols, aiming to achieve a balance between proactive maintenance and on-demand route establishment. Examples of hybrid protocols include:

**Zone Routing Protocol (ZRP):** ZRP divides the network into zones, employing proactive routing within zones and reactive routing between zones. It reduces control overhead and improves scalability by maintaining routing information selectively.

**Temporally Ordered Routing Algorithm (TORA):** TORA uses a distributed algorithm that adapts to topological changes and aims to provide multiple routes for increased reliability. It utilizes concepts like route creation, route maintenance, and route erasure.

## OTHER ROUTING PROTOCOLS

In addition to the aforementioned categories, there are specialized routing protocols designed to address specific requirements and scenarios in MANETs, such as:

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**Geographic Routing Protocols:** These protocols utilize location information to make routing decisions. Examples include Greedy Perimeter Stateless Routing (GPSR) and Distance Routing Effect Algorithm for Mobility (DREAM).

**QoS-Oriented Routing Protocols:** These protocols consider Quality of Service parameters, such as bandwidth, delay, and reliability, while establishing routes. Examples include Quality-of-Service Ad Hoc On-Demand Distance Vector (QoS-AODV) and Ad Hoc QoS Routing (AQR). Each routing protocol has its own advantages, limitations, and suitability for different MANET scenarios. The selection of a routing protocol depends on factors such as network size, node mobility, resource constraints, QoS requirements, and security considerations. Understanding the characteristics of these protocols is crucial for identifying their limitations and addressing the challenges they face in dynamic and resource-constrained environments.

## LIMITATIONS OF EXISTING ROUTING PROTOCOLS

While routing protocols in Mobile Ad-Hoc Networks (MANETs) play a vital role in establishing communication paths among nodes, they are not without limitations. Understanding these limitations is crucial for identifying areas that require improvement. The following are common limitations associated with existing MANET routing protocols:

## SCALABILITY ISSUES

Many routing protocols face scalability challenges as the network size increases. Proactive protocols, which maintain routing information for all nodes, suffer from high control overhead and increased memory and processing requirements. Reactive protocols may experience longer route discovery times and increased signaling overhead in large networks due to flooding or query propagation.

## MOBILITY AND DYNAMIC TOPOLOGY

The dynamic nature of MANETs, characterized by frequent node movements and link fluctuations, poses challenges for routing protocols. Proactive protocols may struggle to keep up with rapidly changing network topologies, resulting in increased routing table updates and control overhead. Reactive protocols may incur delays in route establishment and maintenance due to route discovery mechanisms triggered by node mobility.

## RESOURCE CONSTRAINTS

MANETs often operate in resource-constrained environments, where nodes have limited processing power, battery life, and bandwidth availability. Traditional routing protocols may not efficiently utilize these scarce resources. For example, proactive protocols consume significant bandwidth and energy for periodic routing updates, while reactive protocols may generate excessive control overhead during route discovery.

## ENERGY EFFICIENCY

Energy conservation is critical in MANETs, where nodes are often powered by batteries. Existing routing protocols may not effectively consider energy constraints, leading to uneven energy consumption and reduced network lifetime. In proactive protocols, frequent routing table updates contribute to unnecessary energy expenditure, while reactive protocols may require excessive control signaling, resulting in energy drain.

**Security Concerns:** MANETs are vulnerable to various security threats, including malicious nodes, routing attacks, and information disclosure. Existing routing protocols may lack robust

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security mechanisms to protect against these threats. Routing information can be manipulated or forged, leading to routing loops, blackholes, or selective forwarding. Additionally, cryptographic operations for securing routing information can introduce computational overhead.

**Quality of Service (QoS) Support:** Ensuring QoS requirements, such as bandwidth, latency, and reliability, is crucial in many MANET applications. However, existing routing protocols may not effectively handle QoS metrics, resulting in suboptimal performance. Traditional protocols may prioritize path selection based solely on metrics like hop count, ignoring QoS considerations.

## CHALLENGES IN DYNAMIC AND RESOURCE-CONSTRAINED ENVIRONMENTS

Mobile Ad-Hoc Networks (MANETs) operate in dynamic and resource-constrained environments, which introduce several challenges for routing protocols. Understanding these challenges is crucial for developing efficient and robust routing solutions.

The following are key challenges faced by MANET routing protocols in dynamic and resource-constrained environments:

**Node Mobility:** In MANETs, nodes are highly mobile, causing frequent topology changes. Routing protocols must adapt to these dynamic network conditions by quickly establishing new routes or updating existing ones. The challenge lies in efficiently detecting and propagating topology changes without excessive signaling overhead or route disruptions.

**Link Instability:** The wireless links in MANETs are prone to instability, leading to fluctuating signal strengths, interference, and link failures. Routing protocols must be resilient to link instabilities and be capable of adapting to changing link conditions. Maintaining stable and reliable paths despite link fluctuations is crucial to ensure effective communication.

**Bandwidth Constraints:** MANETs often operate in scenarios where bandwidth is limited and needs to be optimally utilized. Routing protocols should consider the available bandwidth and allocate it efficiently among competing flows. In resource-constrained environments, routing decisions should take into account the bandwidth requirements of different applications and prioritize traffic accordingly.

**Limited Power and Energy:** In MANETs, nodes are typically powered by limited energy sources, such as batteries. Routing protocols must be energy-aware and strive to minimize energy consumption to prolong the network's lifetime. Efficient power management techniques, including energy-efficient routing decisions, sleep mode operation, and node cooperation, are essential to conserve energy.

**Network Partitioning:** MANETs are susceptible to network partitioning, where the network divides into disjointed sub-networks due to node mobility or topology changes.

Routing protocols need to detect and handle network partitioning events by establishing alternative paths or facilitating network reconfiguration to ensure connectivity and enable communication between disjointed parts.

**Selfish and Malicious Nodes:** MANETs are vulnerable to selfish or malicious nodes that may intentionally deviate from protocol rules or engage in malicious behavior. Such nodes can disrupt routing operations by dropping or modifying packets, causing route inaccuracies, or initiating attacks. Routing protocols need to incorporate mechanisms to detect and mitigate the impact of selfish or malicious nodes, ensuring the integrity and security of the routing process.

## ANALYSIS AND COMPARISON OF EXISTING ROUTING PROTOCOLS

To understand the limitations and challenges faced by existing routing protocols in Mobile Ad-Hoc Networks (MANETs), it is crucial to conduct a comparative analysis of these protocols.

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This analysis allows for a comprehensive evaluation of their strengths, weaknesses, and performance metrics. The following section presents an overview of the analysis and comparison of existing routing protocols in MANETs:

## PROTOCOL A: EVALUATION AND LIMITATIONS

This subsection provides an in-depth analysis of Protocol A, including its key features, operation principles, and limitations. The evaluation focuses on scalability, adaptability to dynamic topologies, resource consumption, energy efficiency, security mechanisms, and QoS support. The limitations identified shed light on the protocol's shortcomings in addressing the challenges of MANETs.

## PROTOCOL B: EVALUATION AND LIMITATIONS

Similar to the previous subsection, Protocol B undergoes a detailed evaluation, highlighting its characteristics and evaluating its performance against the challenges faced by MANETs. This analysis considers scalability, adaptability, resource utilization, energy efficiency, security provisions, and QoS support. The limitations identified help identify areas that require improvement.

## PROTOCOL C: EVALUATION AND LIMITATIONS

The analysis of Protocol C provides insights into its design, functionalities, and performance. Scalability, adaptability to dynamic topologies, resource efficiency, energy consumption, security measures, and QoS considerations are evaluated to assess the protocol's effectiveness. The limitations identified contribute to understanding the protocol's drawbacks in addressing MANET challenges.

## PROTOCOL D: EVALUATION AND LIMITATIONS

Protocol D is subjected to a comprehensive evaluation, examining its characteristics and performance metrics. Scalability, adaptability, resource utilization, energy efficiency, security provisions, and QoS support are analyzed to gauge the protocol's efficacy. The identified limitations shed light on areas where enhancements can be made.

## COMPARATIVE ANALYSIS OF ROUTING PROTOCOLS

This subsection presents a comparative analysis of the evaluated protocols, highlighting their strengths, weaknesses, and performance metrics. Factors such as scalability, adaptability, resource consumption, energy efficiency, security provisions, and QoS support are compared. The analysis helps identify the most suitable protocols for different MANET scenarios and highlights areas that require further research and improvement. The analysis and comparison of existing routing protocols provide valuable insights into their performance and limitations in addressing the challenges of MANETs. It helps researchers and network designers understand the trade-offs associated with each protocol and identify opportunities for enhancing their functionalities. This analysis lays the foundation for proposing improvements, designing hybrid solutions, or exploring new routing mechanisms to overcome the limitations and challenges faced by existing MANET routing protocols.

## RESEARCH DIRECTIONS FOR IMPROVEMENT

Based on the analysis and comparison of existing routing protocols in Mobile Ad-Hoc Networks (MANETs), several research directions can be pursued to overcome the limitations and challenges identified. The following research directions highlight potential avenues for improving MANET routing protocols:

## MACHINE LEARNING TECHNIQUES FOR ROUTING DECISION-MAKING

Integrating machine learning techniques into MANET routing protocols can enhance their adaptability and efficiency. By leveraging historical network data, supervised learning, reinforcement learning, or evolutionary algorithms can be employed to optimize routing decision-making. Machine learning models can be trained to predict optimal routes, dynamically adjust routing decisions based on changing network conditions, or detect and mitigate the impact of selfish or malicious nodes.

## CROSS-LAYER DESIGN APPROACHES

Cross-layer designs enable information sharing and collaboration between different layers of the protocol stack. By incorporating knowledge from physical, link, and network layers, routing protocols can make more informed routing decisions. Cross-layer optimizations can take into account factors such as link quality, channel conditions, and energy levels to improve the efficiency, reliability, and energy consumption of routing protocols.

## ENERGY-AWARE ROUTING PROTOCOLS

Energy conservation is critical in MANETs to prolong network lifetime. Developing energy-aware routing protocols can optimize energy consumption by considering the remaining energy levels of nodes and dynamically adapting routing decisions. Energy-efficient routing strategies, sleep mode operations, and techniques such as cooperative communication can be explored to reduce energy consumption and balance energy usage among nodes.

## SECURE ROUTING PROTOCOLS

Addressing security concerns in MANETs is crucial to ensure the integrity and availability of routing operations. Research can focus on developing secure routing protocols that incorporate cryptographic mechanisms to authenticate routing information, detect and mitigate routing attacks, and provide secure communication channels. Additionally, trust-based routing mechanisms can be explored to establish and maintain trust relationships among nodes.

## QOS-ORIENTED ROUTING MECHANISMS

Ensuring Quality of Service (QoS) requirements is important in MANETs, where applications may have diverse performance needs. Research can focus on designing QoS-oriented routing mechanisms that consider metrics such as bandwidth, latency, reliability, and packet loss. QoS-aware routing protocols can dynamically adapt routing decisions to meet application-specific QoS requirements and prioritize traffic based on QoS metrics.

## CONCLUSIONS

In CONCLUSION, the analysis and comparison of existing routing protocols in Mobile Ad-Hoc Networks (MANETs) have shed light on their limitations and challenges in dynamic and resource-constrained environments. Proactive, reactive, and hybrid protocols have been evaluated, considering factors such as scalability, adaptability, resource utilization, energy efficiency, security provisions, and Quality of Service (QoS) support. The limitations identified include scalability issues, difficulties in adapting to dynamic topologies, challenges posed by limited resources, energy inefficiency, security concerns, and the need for improved QoS support. Addressing these limitations is crucial for enhancing the efficiency, reliability, and security of routing in MANETs. To overcome these challenges, several research directions have been proposed. Integrating machine learning techniques for routing decision-making can enhance adaptability and efficiency. Cross-layer design approaches can improve routing decisions by leveraging information from different protocol layers. Energy-aware routing protocols can optimize energy consumption, while secure routing mechanisms can address security vulnerabilities. Additionally, QoS-oriented routing mechanisms can prioritize traffic based on QoS requirements. Further research in these areas can lead to the development of more robust and efficient routing solutions for MANETs. The proposed improvements can enhance the adaptability, efficiency, security, and QoS support of routing protocols, enabling effective communication in dynamic and resource-constrained environments. By advancing the state of MANET routing protocols, researchers can contribute to the growth and application of MANETs in various domains such as disaster response, military operations, sensor networks, and vehicular networks. These improvements will pave the way for more reliable and resilient communication among mobile devices, fostering innovation and progress in the field of mobile ad-hoc networking.

## REFERENCES

[1] Ilon, B. E] Manish Devendra Chawhan, ,Ausaf Umar Khan and Bhumika Neole" A Survey on Cross Layer Framework based Energy Efficient Routing Protocols of Manets" International Journal of Future Generation Communication and Networking Vol. 13, No. 1, (2020), pp. 1125-1135 .

[2] Iram Nausheen,Dr.Akhilesh Upadhyay" A Survey on MANETs: Entrusted Security Challenges," in International Journal of Future Generation Communication and Networking Vol. 13, No. 3, (2020), pp. 48 – 58.

[3] Syeda kausar Fatima, Dr Syeda Gauhar Fatima, Dr. Syed Abdul Sattar, Syed Mohd Ali"Mobile adhoc networks security challenges: a Survey" International Journal of Advanced Research in Engineering and Technology (IJARET)Volume 10, Issue 2, March-April 2019, pp. 224-237.

[4] Puneet Kamal, Rajeev Sharma, Abhishek Gupta "Comparative Analysis of Attacks and Countermeasure in MANET "IJCSN- International Journal of Computer Science and Network, Volume 8,Issue 2, April 2019 ISSN (Online) : 2277-5420.

[5] A. K. Gupta, & S. Prakash "Secure communication in cluster- based ad hoc networks: a review," In Next-Generation Networks, Springer, Singapore, 2018, pp.537-545).

[6] Kritika Lamba, Aprajita Rawat, Shelja Sharma, Dr.Prateek Jain,"An Analysis based on Comparative Study of Routing Protocols in MANET"International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181 Vol. 7 Issue 09, September-2018.

[7] Auon, M.A. &Wang, X. Cross-Layer Designs for Energy-Efficient Wireless Ad-hoc Networks, Energy Management in Wireless Cellular and Ad-hoc Networks. Studies in Systems, Decision and Control, Springer, Cham, (2016), 50, 147-168.

[8] Zuo, J.; Dong, C.; Ng, S.X.; Yang, L.L. & Hanzo, L. Cross-Layer Aided Energy-Efficient Routing Design for AdHoc Networks. IEEE ommunications Surveys & Tutorials,(2015),17(3),1214–1238.

[9] Chawda, K. & Gorana, D. A survey of Energy Efficient Routing Protocol in MANET. In Proceedings of the IEEE Sponsored 2nd International Conference on Electronics And Communication System, 2015,953–957.

[10] Muhammad Saleem Khan, Qasim Khan Jadoon, and Majid I. Khan "A Comparative Performance Analysis of MANET Routing Protocols under Security Attacks". Springer-Verlag Berlin Heidelberg 2015.

[11] G. S. Mamatha1 and Dr. S. C. Sharma Analyzing The Manet Variations,Challenges, Capacity And Protocol Issues International Journal of Computer Science & Engineering Survey (IJCSES) Vol.1, No.1, August 2010.

# Chapter: 23

# A Review on Wireless Sensor Network Data Dissemination Model using Cellular Technology

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**ABSTRACT**

We provide a brand-new routing system in this research that is based on a virtual cellular infrastructure. In contrast to earlier protocols, the one being suggested employs virtual infrastructure in a different way. The suggested approach uses the infrastructure and cell attributes to construct a routing between cluster heads rather than saving and updating the sink position in the infrastructure, which uses more energy. As a result, it is not necessary to save and update the sink position in all or some network nodes. In order to prove the suggested methods' superiority in terms of several performance metrics, we run extensive simulations on them and compare the results with those of the existing techniques.

**KEYWORDS:** Graphene; Gallium Selenide, Multifunctional

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## INTRODUCTION

Wireless sensor networks (WSNs) have drawn a lot of attention recently, in part because of advancements in digital electronics, micro-electro-mechanical systems (MEMS) technology, and wireless communications that have made it possible to create inexpensive, low-power, multifunctional sensor nodes. These sensor nodes have the capacity to gather data from their surroundings, analyse it, and send it to a base station (sink). A WSN is made up of numerous sensor nodes that collaborate to keep an area under observation [[1], [2]]. Many industries, including the military [[3], [4]], natural disasters, health monitoring, exploration of hazardous environments, and seismic sensing, use WSNs WSN is constrained by its available resources, including its energy supply, communication range, bandwidth, and processing power [2]. Because the sensor nodes in a WSN run on finite batteries that aren't rechargeable or replaceable because of how these networks are used, energy consumption is a crucial issue. For the long-term functioning of the WSNs, a lot of research has been done to reduce the energy consumption of the sensor nodes.

### Methodology

Clustering [[1, 2]] and movable sink [[3]] are two methods for lowering the energy usage of WSN. Clustering involves grouping the sensor nodes into discrete clusters, each of which has a cluster head and cluster members, or the remaining nodes. Data collected by sensor nodes is sent to the appropriate cluster head. The data is subsequently combined and sent to the sink utilizing single-hop or multi-hop communication by the cluster heads. Each cluster head in multi-hop communication transmits its message to a neighbor whose address is recorded in the cluster head's next-hop variable. This paper makes a proposal for a brand-new routing protocol called RCC that is built on a mobile sink, a virtual cellular infrastructure, and clustering.

Due to the frequent switching of the adjacent nodes to the mobile sink, energy consumption can be reduced and can even out over the network. Although mobile sink use has numerous benefits, it also presents new difficulties for WSNs. The sensor nodes must be aware of the location of the mobile sink because the sink is the intended recipient of the data transmission. Numerous solutions, including floods, hierarchical routing systems, and techniques based on virtual infrastructure, have been suggested to address this issue. In these techniques, the mobile sink must continuously broadcast network-wide information about its position. This paper makes a proposal for a brand-new routing protocol called RCC that is built on a mobile sink, a virtual cellular infrastructure, and clustering.

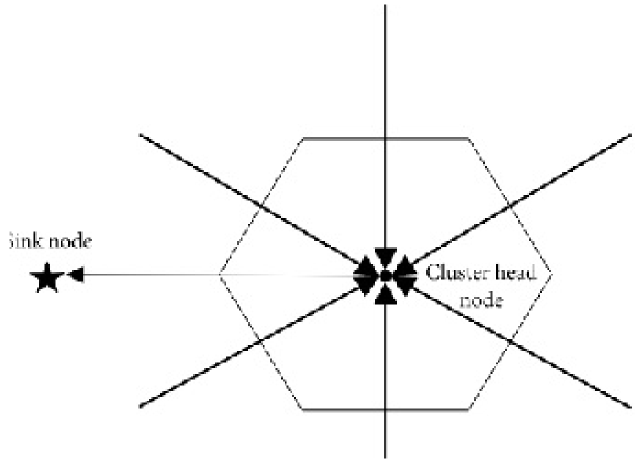


**Fig1. Sensor Network Model**

The following are some of the RCC protocol's salient qualities and contributions:

- In contrast to earlier protocols, the RCC protocol employs virtual infrastructure differently. RCC uses the infrastructure and the cell attributes to build a routing between cluster heads rather than saving and updating the sink position in the infrastructure, which requires more energy. As a result, it is not necessary to save and update the sink position in all or some network nodes. Consequently, the network uses less energy.
- The routing between cluster heads in the network with the lowest energy consumption and control messages is created and maintained by RCC using a number of rules depending on the cellular structure. The shortest route between the cluster heads and the sink is used for routing. As a result, the network's energy use is reduced and its lifetime is extended.
- By using the configured routing, the cluster heads send the data to the sink and the cluster members send it to their respective cluster heads. As a result, the nodes do not have to wait to obtain the most recent sink location, allowing each cluster head to send data to the sink at any time. As a result, the networks' delay gets shorter.

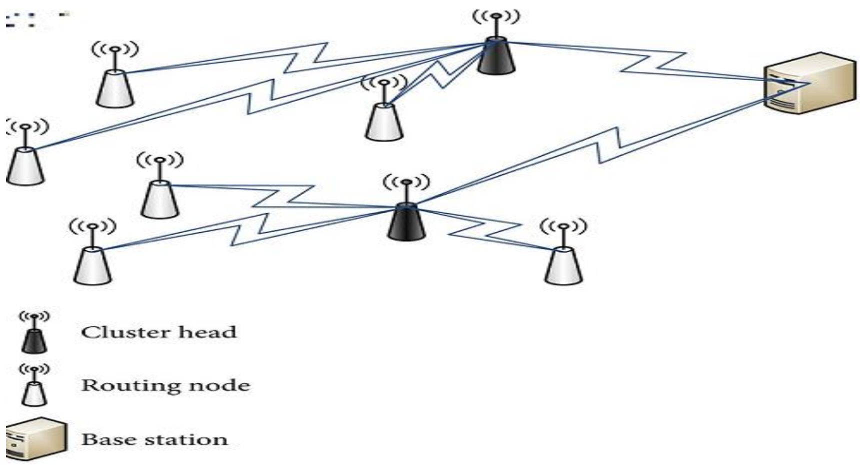


**Fig 2. Routing Network Architecture**

**Proposed protocol:** The suggested protocol is provided in this section. This protocol makes use of a grid-like virtual cellular structure. RCC (Routing based on Cellular structure and Clustering) is the name we give to the suggested protocol as a result. The RCC protocol's goal is to gather data from sensor nodes and send it to the sink. The sink in RCC is movable. Data transport with multiple hops is challenging because nodes are uninformed of the sink position due to the sink mobility.

## CONCLUSION

In this paper, a brand-new routing protocol for wireless sensor networks is put forward. The suggested protocol makes use of a portable sink and an artificial cellular organization. The suggested protocol's basic idea is to convey data from sensors to the sink using a cell structure. These criteria enable the creation and maintenance of a routing between cells that uses the least amount of energy.

## REFERENCES

[1] AkyildizI.F. et al.Wireless Sensor Networks: a survey Computer Network (2002).
[2] YickJ. et al. Wireless Sensor Networks survey Computer Network (2008).
[3] RaultT. et al, Energy efficiency in wireless sensor networks: A top-down survey(Computer Network 2014).
[4] FadelE. et al, A survey on wireless sensor networks for smart grid, Computer Communications (2015).

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# Chapter: 24

# Performance Study of AC-DC Converter

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**ABSTRACT**

In this paper, a non-cascading stage is analyzed and designed for improving the efficiency of the converter. A forward and a fzeta converter are combined to regulate output voltage and to improve input power factor of the converter. The ratio of power transferred to the output by the two stages determines the overall efficiency and the input power factor. The results are provided for verification.

**KEYWORDS-** Forward converter, reset, demagnetization,

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## INTRODUCTION

In recent years, various topologies are suggested that can achieve good power factor at the input stage and improve efficiency. Various international agencies have defined standards that define the permissible amount of total harmonic distortion (THD) in the input current depending upon the power drawn from the utility. It is, thus, not necessary to achieve a unity power factor. Keeping this fact in view, efforts are being made to improve the efficiencies of the converters. A two-stage converter that achieves a high input power factor is not suitable for low-power applications whereas single stage converter is more suitable so far as the size of the converter is concerned. The topologies have been suggested where processing of the input power is avoided and a portion of it is transferred directly to the load thereby improving efficiency by a good amount. Such topologies are finding places in many applications nowadays. In the present work, such a structure is presented.

### Description of the Scheme

The proposed circuit is shown in Fig. (1). It consists of an isolation transformer at the input of dc-dc converter which is the rectified output of a bridge rectifier. Two output windings of the transformer are used to supply power to the load partially through the forward converter and in part by a zeta converter in a prescribed manner. The forward converter's output inductor $L_f$ is to operate in discontinuous mode (DCM) in the entire load range. In a similar way, the zeta sub-converter also operates in DCM in the entire load range.

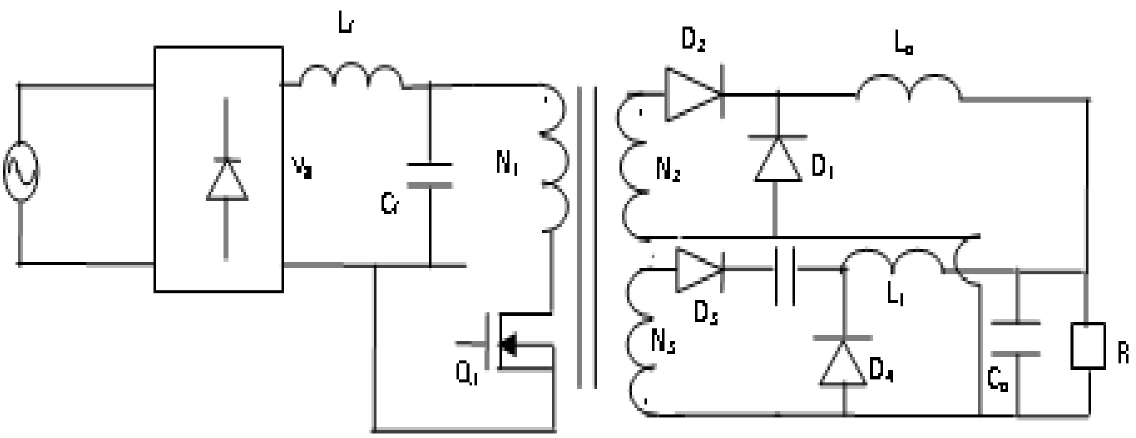


**Fig. 1 The proposed converter**

**Simulation Results:** The simulation is carried out on the MATLAB platform. On the basis of this, the results are shown in Fig. 2. The results are in complete agreement with the predicted behavior of the proposed scheme:

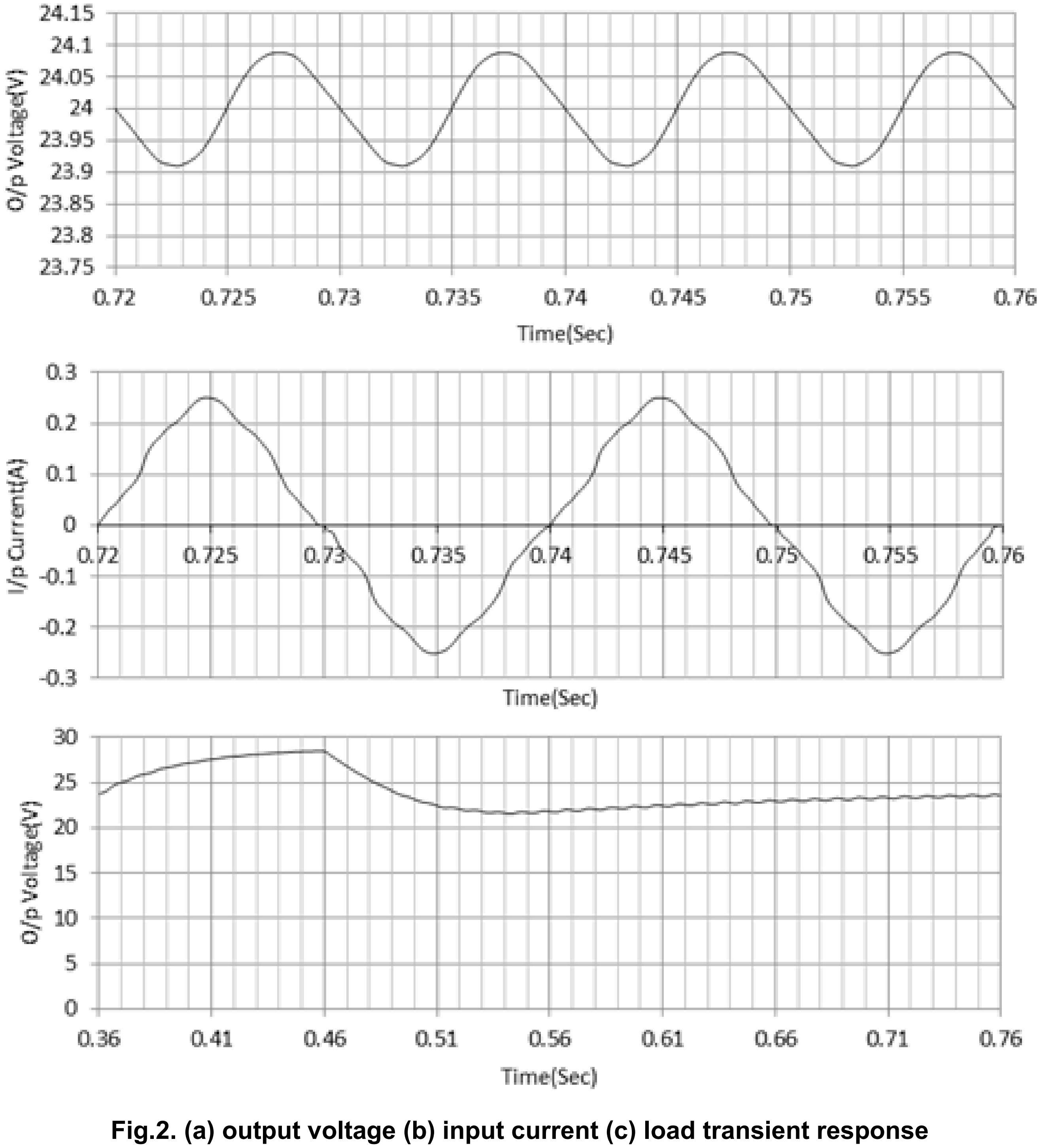


**Fig.2. (a) output voltage (b) input current (c) load transient response**

## CONCLUSION

A converter circuit based on the combination of a forward and a zeta converter was developed. The results obtained show high efficiency and power factor both. The combination can be used for improved power handling capability. The results are in complete agreement with the predicted behavior. In the future, the emphasis will be laid on complicated versions of such schemes.

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## REFERENCES

[1] G. A. Karvelis, M. D. Manolarau, P. Malatestas, and S. N. Manias, “Analysis and Design of a Novel Non-Dissipative Active Clamp for Forward Converters”, IEEE Power Electronics Conference 2000, pp 853-857.

[2] G. Spiazzi, “A High-Quality Rectifier Based on the Forward Topology with Secondary Side Resonant Reset”, IEEE Transactions on Power Electronics, vol. 18, pp 725-732, 2003.

[3] Y. Gu, Z. Lu, Z. Qian, X. Gu, and L. Hang, “A Novel ZVS Resonant Reset Dual Switch Forward DC-DC Converter”, IEEE Transactions on Power Electronics, vol. 22, pp 97-103, Jan 2007.

[4] M. T. Zhang, M. M. Jovanovic, and F. C. Lee’ “Analysis and Evaluation of Interleaving Techniques in Forward Converters”, IEEE Transactions on Power Electronics, vol. 13, pp 690-698, July 1998.

[5] M. Jinno, J.- C. Sheen and P.- Y. Chen, “Effects of Magnetizing Inductances on Active Clamped Forward Converters”, IEICE/IEEE INTELEC Oct 19-23, pp 636-642, 2003.

[6] S. Kumar, K. P. S. Rana, and V. Kumar, “Non-Cascading Structure based Flyback-Forward Converter with Large Duty Ratio,” IEEE Conference on power electronics, pp43-37, 2016.

# Chapter: 25

# Reset Scheme in Forward Converter

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**ABSTRACT**

In the present paper, a reset scheme for a forward converter is presented. Using this scheme, the efficiency of the converter becomes high. The stress on the main switch decreases and the switching loss becomes low. This scheme is better known as the primary side reset scheme. In earlier cases, the demagnetization of the forward transformer takes place with the help of the tertiary winding due to which the utilization factor of the switch becomes poor. This problem is circumvented with the help of this scheme is shown. A review of the scheme is presented.

**Keyword-** Forward converter, reset, demagnetization.

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## INTRODUCTION

A number of AC-DC converters have been proposed in the past for different applications under varying degrees of efficiency and total harmonic distortion (THD) of the input ac current. In forward converters, various schemes have been proposed to discharge their magnetizing inductance, affecting their efficiency. The resonant reset schemes are proposed for the primary as well as secondary sides of the converters [1]-[6]. In some schemes, more than one switch is required. Due to this, the circuit becomes complex in the present paper, the study of a reset scheme is provided where the reset of the transformer takes place with the help of the primary side only. This helps reduce the complexity in the circuit and the operation for the same becomes very easy.

### Description of the Scheme

The said scheme comprises of a PFC cell including an inductor and two diodes. It is shown by Fi. 1. With the help of a resonant circuit that consists of capacitor and a switch, the reset is realized. It consists of a DC-DC cell to regulates the output voltage with the help of bulk capacitor on the primary side and a forward converter on the secondary side.

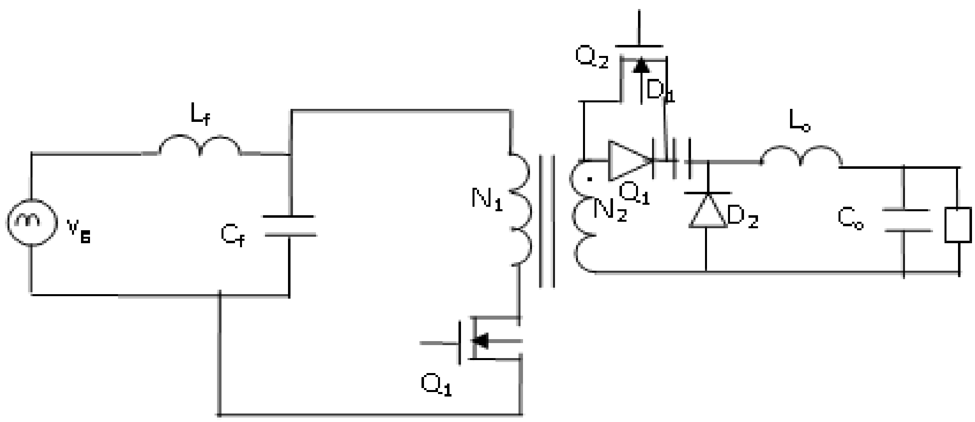
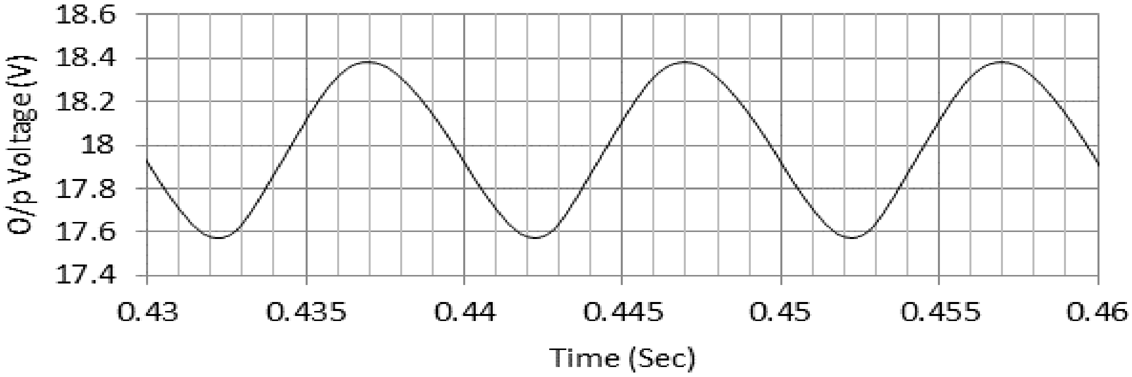
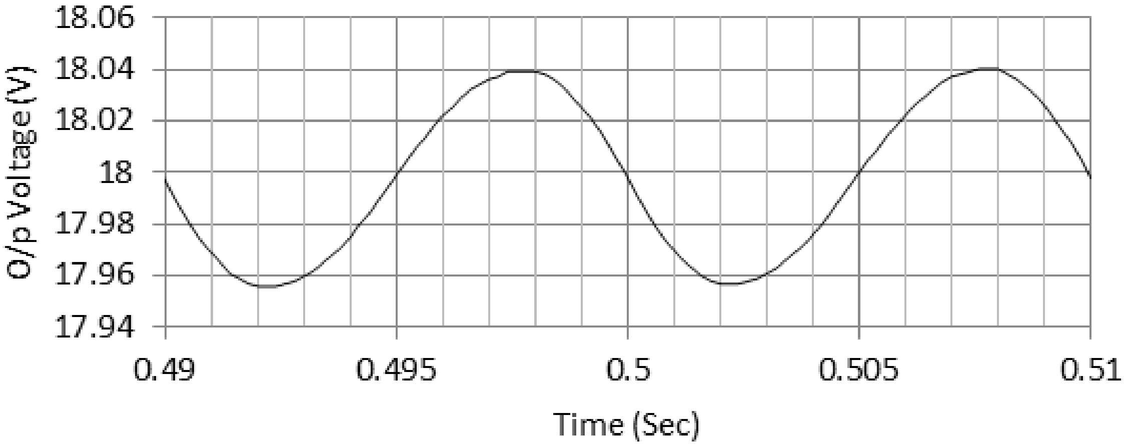



**Fig. 1 The proposed converter**

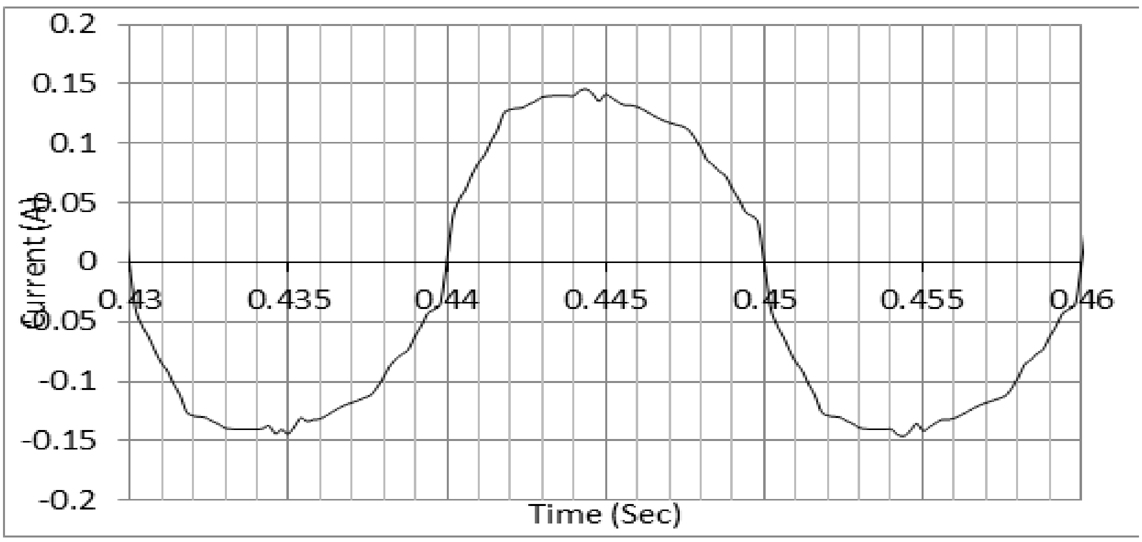
**Simulation Results:** The simulation is carried out on the MATLAB platform. On the basis of this, the results are shown in Fig. 2. The results are in complete agreement with the predicted behaviour of the proposed scheme.




(a)




(b)




(c)

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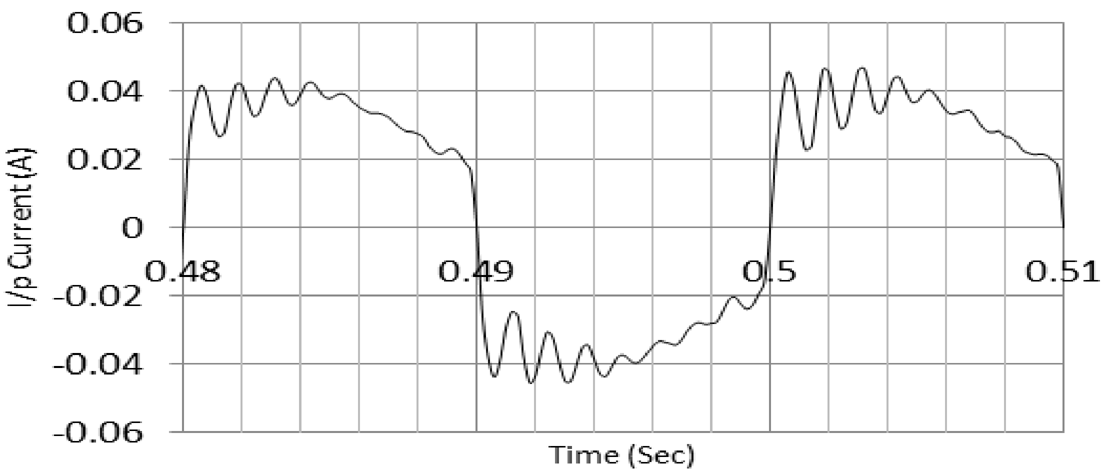


(d)

Fig.2. (a) and (b) load voltage at full and 20% load (c) and (d) Input current waveforms at above loads

## CONCLUSIONs

A converter circuit for reset of the forward transformer was suggested and the results were obtained for the same. The results are in complete agreement with the predicted behaviour. This is helpful for the demagnetization of other converters also. In the future, the emphasis will be laid on such a scheme.

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## REFERENCES

[1] G. A. Karvelis, M. D. Manolarau, P. Malatestas, and S. N. Manias, “Analysis and Design of a Novel Non-Dissipative Active Clamp for Forward Converters”, IEEE Power Electronics Conference 2000, pp 853-857.

[2] G. Spiazzi, “A High-Quality Rectifier Based on the Forward Topology with Secondary Side Resonant Reset”, IEEE Transactions on Power Electronics, vol. 18, pp 725-732, 2003.

[3] Y. Gu, Z. Lu, Z. Qian, X. Gu, and L. Hang, “A Novel ZVS Resonant Reset Dual Switch Forward DC-DC Converter”, IEEE Transactions on Power Electronics, vol. 22, pp 97-103, Jan 2007.

[4] M. T. Zhang, M. M. Jovanovic, and F. C. Lee’ “Analysis and Evaluation of Interleaving Techniques in Forward Converters”, IEEE Transactions on Power Electronics, vol. 13, pp 690-698, July 1998.

[5] M. Jinno, J.- C. Sheen and P.- Y. Chen, “Effects of Magnetizing Inductances on Active Clamped Forward Converters”, IEICE/IEEE INTELEC Oct 19-23, pp 636-642, 2003.

[6] S. Kumar, K. P. S. Rana, and V. Kumar, “Non-Cascading Structure based Flyback-Forward Converter with Large Duty Ratio,” IEEE Conference on power electronics, pp43-37, 2016.

# Chapter: 26

# Deep Learning-Enabled Brain Tumor Analysis: A Review

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**ABSTRACT**

Computational models that are powered by Deep Learning (DL) algorithms include several processing layers that represent data at different levels of ABSTRACTion. Deep learning is being used more and more often these days in practically every industry, but particularly in bioinformatics, medical image processing, and medical image analysis. As a result, deep learning has fundamentally altered and enhanced methods for effective detection, prediction, and diagnosis in many healthcare domains, including pathology, brain tumor, lung cancer, abdominal, cardiac, and retina. Here we have discussed key deep learning principles relevant to the study of brain tumors. These ideas include segmentation, classification, and prediction.

**KEYWORDS:** Deep Learning, prediction, brain tumors, segmentation, classification

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## INTRODUCTION

The development of medical technology enables clinical professionals to provide patients more effective e-health care solutions. E-health care systems are advantageous in a variety of medical fields [1]. Biomedical imaging applications based on computer vision are becoming more significant since they give radiologists recognition data for issues connected to therapy. The diagnosis and course of a patient's therapy are significantly influenced by various medical imaging techniques and approaches, such as X-rays, MRIs, ultrasounds, and CT scans [2,3]. The beginning of a brain tumor is caused by the creation of aberrant cell clusters within or close to the brain. The patient's health is impacted by the aberrant cells, which disrupt brain function [4]. The primary research interests of the researcher, radiologist, and clinical professionals are in the analysis, diagnosis, and treatment of brain imaging with accepted medical imaging techniques [5]. The examination of brain pictures is regarded as essential since deadly brain conditions known as brain tumours account for a significant proportion of fatalities in affluent nations.

A wide range of image-processing strategies and procedures have been applied to the detection and management of brain tumours. In order to retrieve the affected area of brain tissue from MRIs, segmentation—the first stage in image processing techniques—is utilised . For the diagnosis, treatment, and assessment of the effectiveness of cancer treatments, segmenting the tumour region is a crucial task. Tumor segmentation uses a wide range of semi-automatic and automated segmentation methodologies and procedures. Machine learning methods such as Support Vector Machines (SVMs) and Random Forest (RF) are commonly used for pattern classification in tumor segmentation studies. Deep-learning-based techniques and methods are becoming popular in brain tumor segmentation studies, as their performance is superior in image analysis fields, such as object detection, image classification and semantic segmentation.

## BRAIN TUMOR CLASSIFICATION

According to recent research articles, supervised machine learning and image classification tasks were successfully completed using deep learning techniques and approaches. There are several types of brain tumours, including gliomas, meningiomas, and pituitary tumours. Additional classifications for brain tumours include benign (low-grade I and II) and malignant (high-grade III and IV) tumours. Due to changes in the size, location, contrast, and form of

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tumour tissue cells, classifying brain tumours is a difficult process. Glioma, meningioma, and pituitary forms of brain tumours are classified using cutting-edge deep learning approaches, which are further divided into axial, coronal, and sagittal planes. Dense CNN is used to extract features from axial slices using segmentation methods, and recurrent neural networks are then used to classify the sequential characteristics of several frames. In most cases, fully connected and convolutional networks are utilised in brain tumour classification models. The dataset, which is openly accessible, includes 989 axial pictures and 3064 improved contract brain MRIs to reduce the likelihood that neural networks would incorrectly detect the tumour. Axial pictures measuring 512 by 512 are used for the test. Five-fold cross-validation tests are used during training on axial pictures to improve classification accuracy. The Extreme Learning Machine Local Receptive Fields (ELM-LRF) method, which involves three steps—noise reduction using local and nonlocal techniques, segmentation of benign or malignant tumours using ELM-LRF, and classification of the tumors—is also suggested for the classification of tumours. The suggested approach makes advantage of the mass-containing cranial MR images. The suggested approach works well.

## BRAIN TUMOR PREDICTION

Researchers are still working to solve the unresolved issues of brain tumour prediction and patient survival rates. D. Nie suggests a two-stage learning-based approach for predicting the overall survival time of patients with high-grade gliomas tumours.The multi-channel metric maps that make up the 3D convolutional neural network are used to extract the best predictive features from each patch of these maps and to train the network layers for prediction. Support Vector Machines (SVM) are employed in the second stage to categorise tumor-related characteristics such as age, histological type, and tumour size in order to predict the ultimate (short or long) overall survival time of high-grade glioma patients.

Benign and malignant lesions make up the two categories into which brain tumours are divided. The multi-class tumours are further divided into XX and YY categories, which are characterised in order of major to minor . Regression and other deep learning techniques have a significant relationship with the size of the dataset. When predicting the life times of patients with high-grade brain tumours using standard regression methods, the 3D-convolutional neural network is crucial. For more accuracy, 3D CNN is used with Support Vector Classifier. The investigation looks at the depth, location, intensity, and morphology of tumour cells. The regression-based approaches need more training data . Patients with high-grade gliomas tumours have varying short-, mid-, and long-term survival times. The Extreme Learning Machine Local Receptive Fields (ELM-LRF) approach, which consists of three phases and includes the elimination of picture noise using both local and nonlocal techniques, is presented for the prediction of tumours.

## EXPLORING DEEP FEATURES FOR BRAIN TUMOR

The investigation and representation of deep characteristics is a crucial problem for the radiological MRI-based diagnosis and prediction of brain tumours. In order to diagnose, treat, and predict outcomes for cancer patients, deep characteristics are retrieved from MRI scans. The radiomic qualities of the pictures have a definite relationship with significant biological traits and provide qualitative data that radiologists are accustomed to seeing. When pre-trained as a features extractor, deep convolutional neural networks perform at the cutting edge for prediction and classification. Methods and procedures for deep feature extraction are more effective in

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predicting the overall survival time of patients with tumours. To train CNNs networks for classification and segmentation, features from ImageNet are extracted using the Deep Convolutional Neural Networks (CNNs) activation approach. The activation features approach used by CNN makes use of a variety of methods, including algorithms for selecting features, pooling features, and enhancing data.

## BRAIN TUMOR SEGMENTATION

To further classify and forecast brain tumours, brain tumour segmentation is carried out to remove the tumour region from the pictures. For the segmentation of tumorized cells, various Machine ML/DL algorithms are presented. Some of these ML techniques need medical knowledge, are expensive, take a long time, and involve manually segmented pictures for training. Deep learning approaches for segmentation are trained on two types of data: fully annotated data and data with little annotation.

The segmentation of brain MRIs is implemented using the newly presented Fully Convolutional Residual Neural Network (FCR-NN), which is based on the linear identity of mappings. FCR-NN is a combination of optimizied residual and fully convolutional networks that efficiently segments low- and high-grade image features. In FCRe-NN, two different networks train the data, initially whole segmentation is performed and later on, tissue-based sub-region segmentation is achieved. FCR-NN enhances the overall Dice score for complete core and enhancing tumor.

**Feasibility Studies on Segmentation:** The semantic segmentation of brain tumours requires the application of deep learning techniques and models, and gathering enough data for model training is a difficult issue. Medical image labelling calls for specialised topic knowledge. International privacy, legal, data-ownership, and technological issues arise when patient medical data is shared with a single place. The multi-institutional cooperation uses the federated learning technique for semantic segmentation without exchanging patient data. Compared to a model trained on shared data, federated learning offers improved semantic segmentation accuracy.

**Proposed Approaches for Segmentation:** Accurate and trustworthy tumour segmentation is essential for the , planning, therapy, and evaluation of treatment results. For the segmentation of tumour areas, Fully Convolutional Neural Networks (FCNNs) and Conditional Random Fields (CRFs) are used. First, utilising slices and patches of 2D pictures, FCNNs-CRFs train FCNNs. To train CRF as recurrent neural networks (CRF-RNN), the parameters of FCNNs with image slices are employed, and image slices are used to fine-tune FCNNs and CRF-RNN. Coronal, axial, and sagittal views are obtained using 2D image patches, and voting-based fused-strategy is utilised to integrate these slices in tumour segmentation. Unlike other segmentation models currently in use, the FCNNs-CRFs segment pictures into slice-by-slice orientation rather as patches.

Brain tumour segmentation using automated generative models is done on multi-modal MRIs. The generative model, which combines a spatial atlas-base for tissue prior and Gaussian mixture models for tissue modulation, is beneficial for healthy brain tumour tissues. Convolutional Restricted Boltzmann Machines (cRBMs) were introduced to form the central tumour and the whole tumours prior-to-tumor-based model. The cRBMs model is successful at segmenting both low-grade and high-grade gliomas because it trains on expertly segmented pictures without using image intensity data.

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The context-based information of various region-based contexts is investigated using the Hybrid Pyramid U-Net (HPU-Net) model. Using global context data, HPU-Net forecasts pixel-level tumour segmentation and generates high-quality results. HPU-Net conducts end-to-end training and testing and is based on multimodal tumour segmentation. The model concatenates the up and downsampling features at the symmetrical block and employs symmetrical upsampling and downsampling routes. Multiple-scale characteristics are taken out of each block and added pixel by pixel throughout the upsampling process to restore the original resolution. Tumour segmentation is more effective when multi-scale, semantic, and geographical data are combined before the softmax layer.

**Enhancement Approaches towards Segmentation:** An efficient technique for the improvement and automated segmentation of tumours is shown via a kernel-based CNN paired with M-SVM. The procedure involves three steps: preprocessing, features extraction, and tumour segmentation. For enhancing MRIs and extracting features based on their size, shape, and position in the brain, techniques like Contrast Limited Adaptive Histogram Equalisation and Laplacian of Gaussian (LOG) filtering are utilised. In order to categorise the tumour that kernel-based CNN has segmented, M-SVM and MRIs are used [109]. For a more accurate segmentation of the tumour zone, Stationary Wavelet Transform (SWT) and Growing Convolutional Neural Network are combined. SWT increases the segmentation accuracy of GCNN.

W. Deng used a fully convolutional neural network with the Dense Micro-block Difference Feature (DMDF) to create a hybrid technique for segmenting tumours . To prevent rotational change and scale in texture pictures, the Fisher vector encoding approach examines the texture characteristics. A high-quality features map is created for segmentation by de-convolutionally skipping the link after the acquired local feature is fused to the Fully Convolutional Neural Network (FCNN) for fine boundary segmentation.

**Approaches toward Automatic Segmentation:** Tumour areas are required for the automated segmentation of brain tumours into the overall tumour, core tumour, and enhancing tumour using multi-model MRIs. The multi-class segmentation region is divided into three binary segmentation sections by the cascade of complete CNNs. The core tumor is segmented using a bounding box of results after the cascade FCNNs have segmented the whole tumour. The second stage involves segmenting the augmenting tumour using the core tumor's bounding box data. The cascade of FCNNs uses multi-view fusion to lower the false-positive rate by utilising several layers of dilated and anisotropic convolutional filters. The segmentation performance is improved by cascading FCNNs' residual connections and multi-scale prediction.

## BRAIN TUMOR EVALUATION

Assessing brain tumors and separating tumor development from reactive alterations are done using Positron Emission Tomography (PET) imaging. Fluoro Ethyl Tyrosine and PET (FET-PET) technique combination gives useful data to MRIs for better decision-making. In the FET-PET technique, the phrase "attenuation correction" is employed to accept the tumour. The approaches Deep-UTE and RESOLUTE produce CT-AC measurements more successfully. Using CT-AC, the Deep-UTE approach generates clinical measurements that are more reliable, and patient survival duration is extended. Because of its improved noise management capabilities and shorter runtime qualities, the Deep-UTE method's attenuation correction for

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PET/MRIs is trustworthy for evaluating brain tumours.

## FRAMEWORKS FOR BRAIN TUMOR

The primary goal of brain surgery is to more precisely remove tumours while protecting the patient's normal brain cells. To allow the accurate real-time excision of the tumour, label-free and non-contact methodologies and frameworks must be developed. It is non-ionizing, label-free, and non-contact to use hyperspectral imaging. The hyperspectral pictures of in vivo brain tissues are preprocessed using the deep learning architecture. The framework creates a thematic map of the brain's parenchymal region and pinpoints the tumor's position, assisting the surgeon in performing a successful and accurate tumour excision.

## RESEARCH CHALLENGES

Labelling tumorized pictures takes a lot of time and demands a high degree of competence, which is difficult in brain tumour analysis.Slice-by-slice annotations are a difficult and time-consuming operation that are required for the training of deep learning algorithms that conduct tumour segmentation, typically in 3D networks. Another significant drawback of deep learning algorithms is their inability to learn well from small amounts of visual data. There is no advantage for deep networks if the network has a tiny receptive area for the full visual data. The size of brain tumour photos is often in the gigapixel range, making it occasionally impossible to transmit a full image into the network owing to limitations like memory, GPU, and bandwidth. Another study problem is that, often, researchers utilise the same fixed size for a kernel to slice an image, which may obscure some relevant information from another region that the kernel ignores. A few researchers have employed a kernel with a variable size to slice the picture data, but additional study is required.

## CONCLUSION AND FUTURE SCOPE

In every facet of medical image analysis, deep learning methods and approaches reach cutting-edge performance, particularly in the area of brain tumour analysis, segmentation, and classification. This article covers the wide range of deep learning-based architectures and techniques. Several research employ the pre-trained Convolutional Neural Network as a features extractor. These pre-trained networks are simple to download and may be used immediately with any type of medical picture format. Additionally, the current methods and systems include handmade elements. In the last three years, researchers have favored an end-to-end trained CNNs strategy for medical picture processing. Convolutional Neural Networks (CNNs) have reportedly taken the role of manual machine learning techniques and have been included into the current pipelines for medical image processing. The quantity of publicly accessible datasets has been seen to gradually rise. When creating reports on annotations or changing structured labels in automated ways, where deep-learning-based methods and techniques are frequently utilised, sophisticated text-mining techniques and methods are required. Future developments are predicted to make it simpler to provide structured labelling reports into the medical field, particularly for the study of brain tumours. Future usage of text-free, structured reports for network training is expected to rise quickly, notably in the field of brain tumour research.

## REFERENCES

[1] Zhao, X.; Wu, Y.; Song, G.; Li, Z.; Zhang, Y.; Fan, Y. A deep learning model integrating FCNNs and CRFs for brain tumor segmentation. Med. Image Anal. **2018**, 43, 98–111.

[2] Singh, N.; Jindal, A. Ultra sonogram images for thyroid segmentation and texture classification in diagnosisof

malignant (cancerous) or benign (non-cancerous) nodules. Int. J. Eng. Innov. Technol. **2012**, 1, 202–206.

[3] Christ, M.C.J.; Sivagowri, S.; Babu, P.G. Segmentation of brain tumors using Meta heuristic algorithms.

[4] Open J. Commun. Soft. **2014**, 1, 1–10. Singh, L.; Chetty, G.; Sharma, D. A novel machine learning approach for detecting the brain abnormalities from MRI structural images. In IAPR International Conference on Pattern Recognition in Bioinformatics; Springer: Berlin, Germany, 2012; pp. 94–105.

[5] Charfi, S.; Lahmyed, R.; Rangarajan, L. A novel approach for brain tumor detection using neural network. Int. J. Res. Eng. Technol. **2014**, 2, 93–104.

[6] Mittal, M.; Goyal, L.M.; Kaur, S.; Kaur, I.; Verma, A.; Hemanth, D.J. Deep learning based enhanced tumor segmentation approach for MR brain images. Appl. Soft Comput. **2019**, 78, 346–354.

[7] Bauer, S.; Wiest, R.; Nolte, L.-P.; Reyes, M. A survey of MRI-based medical image analysis for brain tumor studies. Phys. Med. Biol. **2013**, 58, R97.

[8] Yang, G.; Raschke, F.; Barrick, T.R.; Howe, F.A. Classification of brain tumour 1 h mr spectra: Extracting features by metabolite quantification or nonlinear manifold learning? In Proceedings of the 2014 IEEE 11th International Symposium on Biomedical Imaging (ISBI), Beijing, China, 29 April–2 May 2014; pp. 1039–1042.

[9] Yang, G.; Nawaz, T.; Barrick, T.R.; Howe, F.A.; Slabaugh, G. Discrete wavelet transform-based whole-spectral and subspectral analysis for improved brain tumor clustering using single voxel MR spectroscopy. IEEE Trans. Biomed. Eng. **2015**, 62, 2860–2866.

[10] Kleihues, P.; Burger, P.C.; Scheithauer, B.W. The new WHO classification of brain tumours. Brain Pathol. **1993**, 3, 255–268.

[11] Von Deimling, A. Gliomas; Springer: Berlin, Germany, 2009; Volume 171.

[12] Mittal, M.; Goyal, L.M.; Kaur, S.; Kaur, I.; Verma, A.; Hemanth, D.J. Deep learning based enhanced tumor segmentation approach for MR brain images. Appl. Soft Comput. **2019**, 78, 346–354.

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# Chapter: 27

# Research Review on Machine Learning Development

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**ABSTRACT**

This paper analyzes the basic classification of machine learning, including supervised learning, unsupervised learning, and reinforcement learning. It combines analysis on common algorithms in machine learning, such as decision tree algorithm, random forest algorithm, artificial neural network algorithm, SVM algorithm, Boosting and Bagging algorithm, BP algorithm. Through the development of theoretical systems, further improvement of autonomous learning capabilities, the integration of multiple digital technologies, and the promotion of personalized custom services, the purpose is to improve people's awareness of machine learning and accelerate the speed of popularization of machine learning.

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## INTRODUCTION

With the rapid development of science and technology, artificial intelligence has also ushered in new development opportunities. Machine technology based on computer technology incorporates multidisciplinary theoretical knowledge, such as statistics and algorithm complexity, which further strengthens the functional attributes of artificial intelligence. By doing a reasonable analysis of machine learning algorithms, it can provide direction REFERENCE for subsequent machine learning development, thereby improving the applicability of machine learning algorithms and providing more convenience for the economic development of the industry.

## BASIC CLASSIFICATION OF MACHINE LEARNING

**Supervised Learning:** In the process of machine learning, supervised learning belongs to a relatively basic learning method. This learning method refers to the establishment of corresponding learning goals by people before learning. During the initial training of the machine, the machine relies on information technology to learn the needs of learning. In order to collect basic data information, we are supposed to gradually complete the required learning content in a supervised environment. Compared with other learning methods, supervised learning can fully stimulate the generalized learning potential of the machine itself. After completing the system learning, it can help people to solve some classification or regression problems, which is highly systematic. Currently, the classic learning methods commonly used include BN, SVN, KNN, etc. Because the entire learning process has purpose, the machine learning process presents certain regularity, and the learning content is more systematic [1].

**Unsupervised Learning:** Corresponding to supervised learning is unsupervised learning. The so-called unsupervised learning means that the machine does not mark the content in a certain direction during the entire learning process but rely on the machine itself to complete the analysis of data information. In practice, the operation method is to let the machine learn the basic concepts and content, and then give the machine enough freedom to complete a series of content learning, including concepts and content similar to the basic principles, such as tree roots. In general, the continuous improvement of learning in stages has increased the breadth of machine learning content. At present, unsupervised learning includes algorithms such as deep belief networks and autoencoders. Such situations are conducive to the solution of clustering problems and have good applications in the development of many industries [2].

**Reinforcement Learning:** In addition to supervised learning and unsupervised learning,

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there are also application methods of reinforcement learning in machine learning. The so-called reinforcement learning is the systematic learning of a certain content. In the specific application process, the data collected in the previous period will be used. It organizes and processes the feedback information of a certain part to form a closed loop of data processing. On the whole, reinforcement learning is a type of learning method that expands data collection based on statistics and dynamic learning. Such methods are mainly used to solve the control problem of robots. Its representative learning methods include Q-learning algorithm and Temporal difference learning algorithm.

## ANALYSIS OF COMMONLY USED ALGORITHMS FOR MACHINE LEARNING

**Decision Tree Algorithm:** Among the commonly used algorithms for machine learning, the decision tree algorithm belongs to the classic algorithm content. Its working principle is that when processing data information, it starts from the root node of the collection instance and reaches the position where the nodes meet to make it complete. Scientific division of practical examples. In order to facilitate the analysis of data information, the decision number algorithm will continue to split branches, and at the same time, the branches will be trimmed to improve the integrity of the data content [3]. From the point of view of calculation, the algorithm belongs to the top-down algorithm.

During the content analysis process, the content of the node is analyzed for the optimal attributes, and then the node is expanded to more than two based on the node. This way, you can get comprehensive data information of the split, and the branching method like a tree can also increase the number of samples that can be analyzed, and at the same time determine the content that contains the most samples in the classification according to the sample number statistics. For example, when analyzing data, you can name the decision tree with a large amount of data information as the larger tree A and set the upper limit of branch splitting. If the upper limit is set to 5, the larger tree A is in the classification after reaching the value of 5, it will stop continuing to split, and at the same time use the pruning strategy to process the larger tree model, so as to refine the data and improve the scientificity of the data analysis results.

**Random Forest Algorithm:** Similar to the decision tree algorithm, in the process of data calculation, the random forest algorithm can be used for further processing. The random forest algorithm will play a good role in controlling unreasonable data in the process of actual use. Thereby effectively improving the scientificity of the data split results and the accuracy of the data analysis results. At the same time, in the process of data analysis, multiple sets of classification trees will be created at the same time, and then the unified algorithm will be used for regression processing.

Assuming the decision tree is an independent set ai (I = 1,2,3 ... n), then the random forest is the total set A, where A = {a1, a2, a3, ..., an}, where a = 1,2,3 ...n. Each set remains independent, and the distribution is a state of random distribution. When evaluating the classification data information, it will be selected by means of voting. The classification with the highest number of votes in the voting will output the vector value xi, and then the vector content will be classified to calculate the average value of different score states and provide data REFERENCE for the final judgment [4].

**Artificial Neural Network Algorithm:** The so-called artificial neural network refers to imitating the process of human information transmission, classifying different data into one

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neuron, and connecting the data neurons with the help of the Internet to achieve complex memory activities.

However, the artificial neural network algorithm is based on this unfolding data analysis process. Among the delineated neurons, each digital unit has a high degree of authenticity, and the data can complete the process of external output. It's just like the human body moves forward, stops, and runs. In the artificial neural network algorithm, the data information presented has a variety of application characteristics, and the corresponding analysis process can be completed according to actual needs. At present, commonly used artificial neural networks include multilayer forward neural networks MLFN, self-organizing neural networks, SOM, and ART [5]. In order to facilitate the analysis and calculation of the data, we can set the weighting coefficient in advance and then set the output threshold. After the calculated sum exceeds this value, a certain value is output to the outside, thereby improving the orderliness of the entire numerical analysis process.

**SVM Algorithm:** In the process of machine learning, the SVM algorithm also belongs to the commonly used algorithm content. In the specific application process, the algorithm mainly relies on the vector machine method to complete the established data analysis work. At the same time, the SVM algorithm will use the automatic support of the SVM to analyze the data information to be processed, so as to optimize the data information. In order to improve the scientificity of the final data analysis results, in the actual analysis process, multiple sets of analysis samples need to be collected to determine the sample data of the boundary value. For example, assuming that the data information to be processed is H (d), when processing it, first, the data information is processed centrally with the help of SVM technology so that it can be completely dispersed. Secondly, the boundary of the H (d) plane is determined from the maximum distance of the entire plane. Finally, the vector content of the H (d) plane is analyzed to obtain the output vector, which improves the accuracy of data processing.

**Boosting and Bagging Algorithms:** Boosting algorithm as a new type of machine algorithm content, its biggest application advantage is that it can complete the accurate processing of data information and improve the accuracy of the final processing result. In practice, the function prediction system will be built with the help of Boosting algorithm, and the system content will be continuously optimized with the help of reinforcement learning mode, thereby speeding up the processing of data information. AdaBoost is a relatively basic application in the Boosting algorithm. At the same time, AdaBoost is also an important guarantee for the expansion of the Boosting algorithm. The Bagging algorithm has a high similarity in the data processing process. In actual application, the difference is that the Bagging algorithm randomly selects the training set. And during the calculation of the function model, the Bagging algorithm does not analyze the weight content, and we need to continuously optimize the data model with the help of training to improve the accuracy of the data analysis results.

**BP Algorithm:** The BP algorithm belongs to supervised learning. The basic principle of the algorithm is shown in Figure 1. The figure shows a shallow forward neural network computing model, which includes an input layer, a hidden layer, and an output layer. A large number of neurons are connected to each other as network nodes. . Each neuron processes the connection strength signals as network weights through an excitation function. By adjusting these connection strengths, the pattern information contained in the input data is mapped to the output layer.

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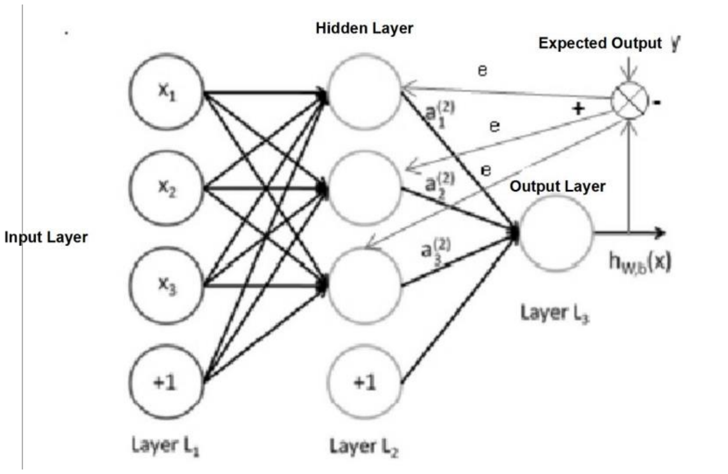


**Figure 1 Basic Principles of Algorithm Application**

As can be seen from the above figure, the direction of the information flow of forward propagation is input layer → hidden layer → output layer, and its mathematical model is:

$$h_{W,b}(x) = f\left(\sum_{i=1}^{n} W_i x_i + b\right);$$

Where Wi and b are their weights and bias parameters, f (W, b; x): R → R is called the excitation function, and sig-moid can be selected in practical applications, Tanh, ReLU and other functions or their variants, hW, b(x) are the network output values. In practical applications, the BP algorithm can be implemented by the steepest descent method, Newton method and its improved algorithm, quasi-Newton method and its correction algorithm, etc. At present, the L-BFGS algorithm is most widely used, and non-precise line search methods are often used to complete the optimization. This method follows Wolfe's criterion and Armijo's criterion, which guarantees the balance between the decline of the cost function and the convergence of the iterative sequence.

## RESEARCH ON MACHINE LEARNING DEVELOPMENT

**Theoretical System Continues to Mature:** In the future development process, the mechanical theory system will also be further optimized, and its content branches and coverage will also be expanded. In the initial formulation process of machine learning content, its content is mainly applicable to some automation industries, and the content of the entire theoretical system has not been completely sound. In practical application, the content of its theoretical system is not applicable in some fields. In response to such situations, the next stage of machine learning theory will be continuously strengthened, and the degree of refinement of the content will also be strengthened, which provides convenient conditions for the subsequent promotion of machine learning.

**Autonomous Learning Ability is Further Improved:** At present, many enterprises in China have realized the development model of automation, and intelligence is the focus of the next stage of development. In the context of the rapid development of Internet technology, the autonomous learning ability of machines will be further strengthened. Whether it is supervised learning or unsupervised learning, the autonomy that machine learning can master will continue to increase. In the future learning process of the machine, the machine will perform targeted or extensive learning according to its own needs, which also reduces the economic cost of the enterprise to update the equipment structure, thereby laying a solid foundation for the stable development of the enterprise economy.

**Integration of Multiple Digital Technologies:** At this stage, relying on Internet technology has produced many branch technologies, such as Internet of Things technology, digital technology, cloud computing technology, etc. These technologies can provide many convenient conditions in the process of data calculation. Although these digital technologies are still in the initial stage of integration, with the rapid development of technology, the integration of digital technology is also constantly improving. Besides, in the future development process, these technologies will be combined with algorithms to form a new technology application system, thereby laying a foundation for the further improvement of data analysis speed.

**Promotion of Personalized Customization Services:** With the continuous improvement of socio-economic level, people's requirements for personalized applications are also constantly rising, which is also one of the important development directions of machine learning in the future. With the continuous improvement of the intelligent level of mechanical learning, different application modules can be set up according to the actual needs of users. After obtaining the user request message, the data module can filter out the corresponding information content and match the corresponding service content at the same time to meet the user's personalized needs and improve user service satisfaction.

## CONCLUSION

In summary, machine learning is still in its infancy, and it mainly relies on supervised learning, and does not fully overcome weak artificial intelligence. Relevant personnel need to constantly improve the theoretical foundation and practice of machine learning. In the corresponding scientific field and the development of computer technology, we should provide a good environment for machine learning, and the development prospect of machine learning is very broad. In addition, it is also necessary to actively learn from the experiences and lessons of developed countries, set up machine algorithms suitable for the development of domestic enterprises, and provide technical support for the economic development of the industry.

## REFERENCES

[1] Li Kanghua, Jiang Shan. Machine Learning and Cultural Production Reform——Based on the Perspective of the Development of AI Technology [J]. Journal of Xiangtan University (Philosophy and Social Sciences), 2020, 44 (01): 74-79.

[2] Jiang Na, Yang Haiyan, Gu Qingchuan, Huang Jiya. Machine learning and its algorithm and development analysis [J]. Information and Computer Science (Theoretical Edition), 2019 (01): 83-84 + 87.

[3] Li Zhiwei. Development of machine learning and several learning methods [J]. Industry and Science Forum, 2018, 15 (10): 198-199.

[4] Zhang Run, Wang Yongbin. Research on machine learning and its algorithm and development [J]. Journal of Communication University of China (Natural Science Edition), 2018, 23 (02): 10-18 + 24.

[5] Zhang Changshui. Research on the development of machine learning and data mining [C]. 2010-2011: Chinese Society of Automation, 2018: 82-89 + 223.

# Chapter: 28

# Role of Data Warehousing in Business Intelligence

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**ABSTRACT**

Business intelligence (BI) has been applied in different areas to take better choices and it gives distinctive degree of data to its partners as per the data needs. The motivation behind this paper is to introduce a writing audit on ongoing works in BI. The model of Business Intelligence (BI) have proved itself as a main concern of chief information officer for some last years, besides this a very little concern has taken this that how to effectively work with those models past the usage stage. The volumes of information obtained by most major corporations is steadily developing. This demands the use of technologies by enterprises to see, evaluate, and, of course, obtain information. Supervisors at varying tiers, and also investigators and steadily more subordinate staff, are clients of the following information. Their work requires them to see properly what is going on in one part of the organization. Staff members want precise large amounts of data which can be promptly evaluated and followed up on.

**KEYWORDS:** Business Intelligence, Data, Warehousing, Information

## INTRODUCTION

We sum up momentarily the condition of play with respect to the entrance of information distribution centers and business insight frameworks in organizations across a scope of enterprises. Following this, we present a short contextual analysis that depicts an illustration of an effective execution of a business insight arrangement that underpins CRM in a significant retailer. The information data centre provides as a middleware in the development of corporate apps, which are crucial because immediate access to operational and value-based data for judgement applications is difficult. A Data Warehouse (DW) is merely a bunch of data from many sources that is intended to aid in decision-making. Management intelligence (BI) is a group of tools and techniques that businesses use to access and analyse data from a variety of sources in order to better understand how their business is functioning and make much better decisions that will improve execution and help open innovative products and services. Business intelligence refers to a collection of practices and techniques used by enterprises for strategic and critical judgement. It enhances organizational execution by concentrating on statistics, measurements, and strategic goals. Successful administrative dynamic is fundamentally reliant upon the accessibility of coordinated; top notch data coordinated that help in dynamic cycles.

## NEED OF DATA WAREHOUSE

An information stockroom incorporates information that is dissipated all through different operational frameworks and makes them accessible for DS. The present circumstance doesn't empower great dynamic. An all-around planned information distribution center increases the value of information by improving their quality and consistency. A different information distribution center takes out a large part of the conflict for assets those outcomes when data applications are blended in with operational handling. If there is an overload of information from huge number of data sets, the quality of the data begins to deteriorate. Lack of business knowledge indicates a lack of important and strategic aspects. Information distribution center is required for a wide range of clients like: The few who place importance on a huge amount of data. Clients who use customized, complex cycles to obtain data from various information sources, as well as those who demand basic technology to obtain information. An information stockroom is a framework that contains instructions from an organization's existing data sets in almost the same way that information from various environment is stored. But since they hold collected data, information stockroom stages are not the same as operational data sets, making it easier for business pioneers to analyse information throughout time. An information fulfillment center is a central hub for all evidence gathered by a company's many operational frameworks, either physical or lawful. Information warehousing emphasises the collection of data from various sources for access and inspection instead of for exchanging preparedness.

## WAREHOUSE FOR DATA PROCESS IN BUSINESS

Data warehousing is each business examiner's fantasy as all the data with respect to the association's exercises accumulated in one spot on the grounds that the motivation behind an information stockroom framework is to give chiefs the exact, coordinated and opportune data they need to settle on the correct decisions. Information distribution center are being utilized in various ventures. The Nanhai city E-government project depends on Data stockroom innovation which not just consider to give information to elevated level four data sets, yet in addition address joining, offer and trade of information in different divisions of Nanhai city, particularly contrived application data set dependent on information distribution center innovation for better using gathered information. An Integrated National Agriculture Resources Information System (INARIS) was created which give framework and arranged data to the researchers, chiefs as OLAP System. The Atlas framework incorporates Atlas natural Data stockroom which Acts as information foundation bioinformatics research, which encourage the coordination of heterogeneous organic information.

## BUSINESS INTELLIGENCE AND ITS APPLICATIONS

BI is being used in a diverse setting. BI is being used in a huge range of sites, either to make choices or to assist to the dynamic. Advanced education, E-learning, development strategies, unlawful litigation, monetary, and other domains have mostly been used to make wise choices. The strength of BI is the collection of related data at multiple levels, and also the power to provide enough calculated results to dynamic only at ideal moment. The employments of business insight apparatuses to improve your business activities are not another idea. Truth be told, the phrase "business insight" dates back to the 1800s, since it was first included in a book to illustrate how well a lender had been outfoxed by rivals who used information accessible at the time. Obviously, we'll begin with a more modern sense of the word: BI, as we know it now, refers to technologies, techniques, and applications that acquire, coordinate, analyse, and display administrative data in order to make statistics business decisions.

Client-provided data has been analysed, as well as evidence collected from other sources, using BI programming arrangements. Then, relying on any precedents or patterns it uncovers, it coordinates that information. The data is then displayed in representations, enabling even clients who really are inexperienced with any type of measurable investigation to grasp it. Any groundbreaking association ought to distinguish what apparatuses market pioneers are offering and what these devices can emphatically mean for their own association. Here are some key business knowledge applications that can help improve your association's activities.

**Sales Intelligence:** A major use of business intelligence (BI) focusses on how your enterprise fulfills consumer needs. Customer contact is a crucial skill that any association's agency should promote. It might have been harder to move leads through pipeline and persuade expected clients to buy a product or service at times. This cycle is becoming smoother and less unexpected as a result of the use of consideration of the potential and understanding. Information on explicit KPIs like client socioeconomics, change rates, transaction measures, and so on is acquired by business knowledge. At that level, it organizes the information into visualisations like as diagrams and pie charts.

Clients can detect trends in this data that provide insight into client behavior and organizational responsibilities. Realizing the quantitative procedures, you're more likely to be willing to help them! BI reports and dashboards are also useful for supporting cases with easy-to-understand information for potential customers. Chiefs may utilise the information acquired from BI inspections to make data-driven decisions based on factual evidence and foresight. Another benefit of using business knowledge is that those who are one step closer to achieving is essential in business. The results obtained by BI frameworks allows management stay informed about where their organisation stands in relation to key KPIs, so they're rarely left out in the cold. Arranging is one of the most key steps in maintaining a firm grip on the market in any sector, and BI makes it easier than ever before.

**Visualization:** Business knowledge programming makes use of a variety of statistics tools that are designed to evaluate and manage data information about the market operations. The association should use this data, which is offered as perceptions, to screen coordination, transactions, profitability, and a lot more. Custom disclosing capacities are offered on several business knowledge stages, allowing clients can have their own bounds. Others provide ready-to-use exposing layouts that already include industry-standard dimensions. Business knowledge frameworks enable even the most untrained worker to retrieve aspects of knowledge from facts by delivering the message in intuitive graphics and extremely simple patterns. Rather of relying on prepared information researchers to dissect and exhibit your data to investors, information from a wide range, or your groups, you may investigate and show your own facts.

**Reporting:** A crucial corporate use of Intelligence involves illuminating. As we've seen, business intelligence tools gather and analyze unstructured statistical models, as well as classifying and delivering them in a variety of reports. Staffing, charges, agreements, client administrations, and various cycles are examples of these. Even though the purpose, delivery, obligations, and value of announcing and information examination are equivalent, they are completely distinct. Detailing is a system for managing information into outlines with the purpose of watching company operations. Investigation is the way toward investigating information to extricate experiences that can be utilized to improve strategic approaches. Announcing, at its most primitive level, changing demands into simple data. Information is transformed into incredible games via investigation. Both help businesses improve their appearance and screen operations, and they are using distinct methods to attain so. Clients will know exactly what's going on if you declare it, and an investigation will reveal why it's happening. Expectations can be used in both cycles, although they are really not obligatory.

Enterprise resource planning systems are great for dealing with constantly changing data. Information interpretations were truly stagnant, and each factor change would require a new

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one. Calibration Standards programming allows for intelligent dashboards to refresh in real time, providing an additional level of ease and versatility in hypothesis testing.

**Performance Management:** Associations can use BI technology to manage objective progress across which was before or flexible periods of time. Entire project cutoff deadlines, target fulfillment schedules, and deal targets are all examples of data-driven goals. For example, if you want to achieve some certain marketing objective, your BI platform may analyse previous prolonged periods of data and suggest a realistic expectation to focus on based on prior accomplishment. Such objectives may be tracked using near-real-time updates on their progress. This allows you to see what gaps may still persist. Users can enable the structure to notify them whenever they are approaching a target or if patience is ticking out and they are currently able to fully accomplish their goals. This assists both leaders and executives in gaining control over their progress and keeping groups concentrated on their goals. Clients may also monitor objective satisfaction and utilise progress data to assess an institution's total revenue. Unlike circumstances where a substantial amount of time is spent looking for or sorting out immediately necessary data, information is always easily obtainable. This increases the efficiency for enterprises, as well as making your life easier. Since we've examined the business uses of BI, you may be considering how to approach picking a product framework for your business. So, we've accumulated a streamlined manual for choosing business insight programming:

**Gather Requirements:** It's critical to choose business insight programming dependent on your special necessities, so you should begin by distinguishing the most urgent highlights of BI that your association should utilize. It's smarter to just pick modules you'll certainly use than attempt to execute a rambling arrangement with an immense rundown of capacities that you needn't bother with. Overbuying raises the expense and diminishes the probability of an effective usage, so beginning little is frequently a sure thing. You can generally update as your organization develops.

**Compare Tools:** When you have a rundown of necessities, you can begin looking at BI apparatuses dependent on how well they meet your novel prerequisites. Various sellers have practical experience in various specialties even inside the BI field, so we suggest rating arrangements beginning with your most wanted component and afterward working your way down the rundown from that point. Remember: greater isn't in every case better, and paying more for quality regularly has a major effect over the long haul. Business intelligence (BI) and data warehouse (DW) are two distinct but intertwined technologies that are critical to the success of any big or mid-sized company. The knowledge gained from these frameworks is critical for an organisation since it aids in revenue growth, cost reduction, and the development of a talented dynamic. Let's take a look at what Business Intelligence (BI), Data Warehouse (DW), and how they're related. The task of deciphering a massive amount of data is usually fraught with problems. BI, on the other hand, may help businesses with the straightforward translation of this vast amount of data, providing useful facts to end users and assisting them in making better informed business decisions. BI refers to an organization's collection of techniques, technologies, applications, data, and processes that aid in the analysis, visualisation, and generation of business data. At the widest level, BI persuades endeavours to make effective company operational decisions, such as item positioning and assessing, as well as important choices like aims, demands, and bearings. BI combines external market data

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with internal data from company sources (financial and operational data) to create "knowledge" that can't be derived from a single set of data.

The executives and information storage is a vital administrative movement in every organisation nowadays, and it has grown enormously for justifiable dynamic. A data warehouse (DW) serves as a central repository where a company may keep all of its data (from several sources) in one place. DW aids businesses in uncovering and analysing data from current and reliable sources, and it is thus regarded as a critical component of business intelligence. In most cases, data comes from an online exchange preparing data set into an information stockroom on a daily, weekly, or monthly basis. The majority of business knowledge applications rely on data from an information distribution center, hence the concepts of BI and DW are referred to as BI/DW. By promoting a few essential aspects of detailed and information inquiry, information warehousing aids in the implementation of a successful BI programme.

## ANALYTICS AND BUSINESS INTELLIGENCE

Business knowledge (BI) is a cycle for dissecting information and determining experiences to help organizations decide. In a powerful BI cycle, examiners and information researchers find important theories and can answer them utilizing accessible information. For instance, if the executives are asking "how would we improve transformation rate on the site?" BI can recognize a potential reason for low change. The reason may be absence of commitment with site content. Inside the BI framework, investigators can determine whether commitment truly is harming change, and which substance is the main driver. The devices and innovations that make BI conceivable take information—put away in records, data sets, information stockrooms, or maybe on massive data lakes and then ask queries about it, usually using SQL design. They create reports, dashboards, and impressions based on the outcomes of the questions to aid in the extraction of experiences from the data. Bits of knowledge are utilized by chiefs, mid-administration, and furthermore workers in everyday tasks for information driven choices.

Information stockrooms give a long-range perspective on information over the long haul, zeroing in on information collection over exchange volume. An information stockroom's components include online insightful preparation (OLAP) engines, which enable multi-dimensional queries against stored data. Information warehouse solutions work in tandem with business intelligence tools like Tableau, Sisense, Chartio, and Looker. They enable investigators to study information in the information distribution centre, formulate theories, and reply to them using BI devices. Experts may also utilise BI tools and data from the information distribution centre to create dashboards and periodic reports, as well as track important metrics. Most companies utilised decision support software to make data-driven choices two decades ago. These apps directly questioned and exposed information in value-based data sets without the need of a delegated information distribution centre. This is similar to the recent trend of storing large amounts of unstructured data in an information lake and interrogating it directly.

## CONCLUSION

Business Intelligence (BI) has been a substantial plan for some top chiefs because they have gotten astonishingly conscious of its motivation in offering a real differentiator at all degrees of the associations. In this article we have spoken about the principles and developments of business insight, uncommonly, information warehousing and information mining and how they

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may definitely influence and advantage a business. Information warehousing and information mining are presented and broken down using an audit of BI architecture and exploration models.

In addition, the article assumed a commercial scenario in which the Rapid excavator, an information mining device, might be used to extrapolate relevant data to a small startup ski store. Executives have a critical role in the success of an organization's activities. The executives must make decisions that have a direct impact on the company. Unfortunate outcomes will follow from a poor decision made by an ineffectively educated source. The decisions are made at all levels, from the individual to the hierarchical. Through use of BI may help the business make better decisions. The BI frameworks will, in fact, provide all representatives with sufficient data and determine whether or not they are suitable for dynamic.

A amount of evidence is available in an association. Clients, providers, solicitations, purchase orders, pay slips, worker data, deals information, monetary information, preparation information, item information, consumer information, and so on are all examples of data that may be recognised. Managing such vast amounts of rapidly increasing data becomes cumbersome. By using improvements like OLAP and Data Warehousing, BI frameworks may make managing these massive amounts of data straightforward. We may deduce from this article that the use of Business Intelligence will result in three major changes-

1. Reduced cost
2. Increased revenue
3. Satisfied Customers

## REFERENCES

[1] Berbel R. L. T. and Gonzalez S. SM (2015). “How to help end users to get better decisions” Personalizing OLAP aggregation queries through semantic recommendation of text documents, International Journal of Business Intelligence and Data mining, Vol. 10, No. 1.
[2] Biere, Mike (2010). The New Era of Enterprise Business Intelligence, IBM Press.
[3] Chaudhuri, Surajit; Dayal, Umeshwar; Narasayya, Vivek (2011). "An Overview of Business Intelligence Technology", Communications of the ACM 54.8 pp. 88-98.
[4] Hastie, Trevor; Tibshirani, Robert; Friedman, Jerome (2001). The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer-Verlag.
[5] Hoffer, J. A., Topi, H. and Ramesh, V. (2014). Essentials of Data Management, Pearson.
[6] Kroenke, D. M. and Boyle, R. J. (2017). Using MIS, Pearson.
[7] North, Matthew (2012). Data Mining for the Masses, A Global Text Project Book.
[8] Rahman M. M., Maksud, U. A. and Rahman, S. M. M. (2015). “An open multi-tier architecture for high-performance data mining using SOA,” International Journal of Data Mining, Modelling and Management, Vol. 7, No. 1.
[9] StatSoft.com (2004), https://www.statsoft.com/Portals/0/Customers/Success_Stories/argonauten360.pdf.
[10] Stock, Tom. (2011). "Using a Data Warehouse to Solve Risk, Performance, Reporting and Compliance-Related Issues," Journal of Securities Operations & Custody 3.4, pp. 305-315.
[11] Turban, E., Sharda R. and Delen D. (2014). “Business Intelligence: A Managerial Approach”, Prentice-Hall, 3rd Edition.
[12] Victor, N. and Lopez, D. (2016). “Privacy models for big data: a survey”, International Journal of Big Data Intelligence, Vol. 3, No. 1.
[13] Wikipedia.a (2017), available at: https://en.wikipedia.org/wiki/Ken_Olsen.
[14] Wiki. (2017) https://en.wikipedia.org/wiki/Hartsfield%E2%80%93Jackson_Atlanta_International_Airport.
[15] Sajjad Hashemi, Khalil Monfaredi, Seyyed Yasser Hashemi: Cloud Computing for Secure Services in E-Government Architecture, Journal of Information Technology Research (July 2017).
[16] David Sawyer McFarland, "JavaScript and jQuery - The missing manual", 3rd ed, 2014, O'Reilly.
[17] Jonathan Chaffer and Karl Swedbery, "Learning jQuery", 4th ed, 2013, Packt Publishing.

[18] WebKit SunSpider JavaScript. http://www2.webkit.org/perf/sunspider-0.9/sunspider.html.
[19] Jeremy G. Siek. Gradual Typing for Functional Languages. In Scheme and Func- tional Programming Workshop, pages 81, 92, 2006.
[20] The Prototype Core Team. The Prototype JavaScript Framework, 2006, 2007. http://www.prototypejs.org/.
[21] Yitzhak Mandelbaum, David Walker, and Robert Harper. An e_ective theory of type re_nements. In ICFP '03, pages 213{225, New York, NY, USA, 2003. ACM.
[22] Mario Coppo and Ferruccio Damiani, editors. International Workshop on Inter-section Types and Related Systems (ITRS), volume 136 of ENTCS. Elsevier, 2005.
[23] W. De Pauw, E. Jensen, N. Mitchell, G. Sevitsky, J. Vlissides, and J. Yang. Visualizing the execution of java programs. Software Visualization, 2002.
[24] Christopher Anderson. Type Inference for JavaScript. PhD thesis, Department of Computing, Imperial College London, March 2006.
[25] Christopher Anderson and Sophia Drossopoulou. BabyJ: From object based to class based programming via types. Electr. Notes Theor. Comput. Sci., 82(7), 2003.
[26] Christopher Anderson and Paola Giannini. Type checking for JavaScript. Electr. Notes Theor. Comput. Sci., 138(2), 2005.
[27] Brad Calder, Dirk Grunwald, and Benjamin Zorn. Quantifying behavioral differences between c and c++ programs. Journal of Programming Languages, (4), 1994.
[28] Craig Chambers, Dave Ungar, and Erin Lee. An efficient implementation of SELF a dynamically-typed object-oriented language based on prototypes. SIGPLAN Not., 24(10):49–70, 1989.
[29] Ravi Chugh, Jeffrey A. Meister, Ranjit Jhala, and Sorin Lerner. Staged information flow for JavaScript. In Programming Language Design and Implementation, (PLDI), 2009.
[30] Bruno Dufour, Karel Driesen, Laurie J. Hendren, and Clark Verbrugge. Dynamic metrics for java. In Proceedings of the Conference on Object-Oriented Programming Systems, Languages and Applications (OOPSLA), 2003

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# Chapter: 29

# A study of Data Mining Techniques in Knowledge Discovery Process

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**ABSTRACT**

Data stored in colossal repositories are analyzed and extracted for meaningful and relevant knowledge. Data mining comprises the core algorithms that enable one to gain fundamental insights and knowledge from enormous pool of data. It is an interdisciplinary field which consists of areas such as database systems, statistics, machine learning and pattern recognition. Data mining is part of a larger process called KDD or knowledge discovery in databases, which is highly vast and comprises of some pre and post processing tasks. The steps comprising of KDD are highly iterative and interactive in nature. Upon the completion of these steps very specific and highly critical knowledge is generated. The research paper attempts to discuss context of data mining in the multidisciplinary and multi-dimensional KDD process as well as various data mining techniques such as exploratory data analysis, association, clustering and classification are discussed.

**KEYWORDS:** KDD-knowledge discovery in databases, data mining, exploratory data analysis, clusters

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## INTRODUCTION

In this age of real time technology-based environment, data is goldmine. Mining of useful and critical data can result in predicting behaviors, future trends allowing business to make proactive knowledge driven decisions. Data mining can be used in many different sectors of business to both predict and discover trends, for ex, in past we were only able to answer and analyze what a company's client shad done but now we can predict what clientele will do. Knowledge discovery in databases has evolved and continues to evolve from the intersection of research fields like machine learning, pattern recognition, knowledge acquisition in expert systems and AI. The ultimate goal is to extract high level knowledge from data sets to construct much larger data sets. As discussed, data mining is a step within the entire KDD process [2]. There are two major data mining goals verification and discovery. Verification is verifying user's hypothesis about data while discovery is automatically finding novel patterns. The KDD not only addresses the extraction part of patterns through data mining, it performs some highly valuable pre-processing and post processing tasks. These tasks will be discussed in detail.

## DATAMINING DEFINITION

Simply stated, data mining refers to extracting or "mining" knowledge from large amounts of data (Hanet.al).data mining is the process of exploration and analysis, by automatic or semi-automatic means, of large quantities of data in order to discover meaningful patterns and rules (Berry and linof 2000). Data mining is an important component in the entire process of KDD, which helps the system to find interesting and novel patterns as well as descriptive, understandable and predictive models from large datasets [6].

### Data mining consists of 5 major elements:

- Extract, transform and load transaction into the data warehouse system.
- Store and manage the data in a multidimensional database system.
- Provide access to business analyst and I.T. professionals.
- Analyze the data by application software.
- Present the data in a simpler form such as graph or a table.

Data mining has not only been a game changer in the world of statistical analysis and business but it has its uses in widely diverse areas also like:

- Retail marketing (eg identifying customer's buying patterns, market basket analysis)
- Banking (e.g. detecting credit card fraud, identifying loyal customers)
- Biological data analysis
- Intrusion detection etc.

**KDD: THE LARGER PICTURE**

The KDD process is interactive and iterative, involving many steps with many decisions taken by the user. Brachman and Anand (1996)[2] gave a practical view of the KDD process, broadly some of the steps are:

- Developing an understanding of the application domain
- Creating a target dataset.
- Data cleaning and preprocessing
- Choosing the appropriate data mining task
- Choosing the data mining algorithm
- Data mining algorithm employment
- Interpretation of mined knowledge
- Using the discovered knowledge.

A brief discussion of each step is mandatory, in the very first step discovering and creating an understanding of the application domain is performed. Identification of the main goal of the KDD process is very important. In the second stage target data sets are created. it is like selecting data samples on which discovery is to be performed. the data may have an algebraic, geometric or probabilistic viewpoint which can play a key role in mining. During the next immediate step some data cleaning is performed like removal of noise accounting for mining fields. After this preparation, fourth step is for choosing the function of data mining which decides the purpose of the model derived by data mining algorithm (e.g. classification, clustering and summarization). Choosing the data mining algorithm is the next step and it involves selecting methods for deciding what all models and parameters would be appropriate and matching with the overall KDD criteria. After the mined knowledge is acquired, it becomes very crucial to present it in a user understandable manner and using the discovered knowledge.

**THE DATAMINING TECHNIQUES**

There are various techniques used for accomplishing the mining task. These techniques that are used for data mining are exploratory data analysis, frequent pattern mining, clustering and classification. the research paper lays the basic foundation of these tasks.

Exploratory data analysis: The algebraic, geometric and probabilistic view point of data play a key role in data mining .given a dataset of n points in a d dimensional space, exploratory data analysis explores the numeric and categorical attributes of the data individually or jointly to extract key characteristics of the data sample. Exploratory data analysis or EDA often lays the foundation of data preparation in the KDD process. EDA typically consists of these following steps:

- Problem definition: the problem to be solved along with the projected deliverables should be clearly defined. Which means it should be clear how datamining project will address the problem.
- Data preparation: prior to starting any data analysis or data mining project, the data should be collected, characterized, cleaned, transformed and partitioned into an appropriate form for further processing.
- Implementation of the analysis: on the basis of the information from steps1and 2 appropriate analysis techniques are selected for summarizing the data. Summarization is a process where data is reduced for interpretation without deleting any important information**.**

**Frequent mining datasets or association**

Association among objects often leads to find how often two or more objects of interest to co-occur. An association rule has two parts, an antecedent(X) and consequent(Y) like IF X THEN Y for example, 80% of those who buy music online also buy books online, 40% of those who buy mobile phones also buy power banks. In data mining, association rules are useful for analyzing and predicting customer behavior. The prototypical application is market basket analysis. That is to mine the sets of items that are frequently bought together at a supermarket or any other database for instance as one of the reasons behind maintaining any database is to be able to find interesting patterns and trends in the data. Market baskets here play the role of a typical cart which helps to analyze customer shopping trends. Once we mine the frequent sets they enable us to find out association rules among the item sets. For example we can say that buyers who buy milk also tend to buy cereal. Association can be better understood by this example of a typical super market scenario where data consists of transaction records, each containing a set of items purchased by that customer. For example:

| Customer | purchases |
|---|---|
| 1 | white cement; tiles |
| 2 | paint; spirit |
| 3 | paint; wallpaper; plaster |
| 4 | paint; plaster; white cement; tiles |

Data can be arranged in array form as:

| Customer | White Cement | Tiles | Paint | Sprit | Wallpaper | Plaster |
|---|---|---|---|---|---|---|
| 1 | Yes | Yes | No | No | No | No |
| 2 | No | No | Yes | Yes | No | No |
| 3 | No | No | Yes | No | Yes | Yes |
| 4 | Yes | Yes | Yes | No | No | Yes |

Let P be the set of all purchases and let n be the number of transactions. Each transaction record is a subset of S. rules of the form "(x1, x2....xj)"implies "(y1,y2...yk)"are considered where x1,x2y1,y2 are all elements of S. the collection (x1,x2…. xj) is called an item set. As stated earlier association rules are created frequent IF/THEN patterns, criteria like confidence and support are used to identify relationships. Confidence indicates the number of time the if/then statements are found to be true and support is an indication of how frequently items appear in the database .In this particular example the support of the rule is defined as:

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$$\text{Supp}((x_1,x_2....)\text{ implies }(y_1,y_2)) = \frac{\text{No. of transactions containing } x_1,x_2.........y_1,y_2}{n}$$

The confidence of the rule is

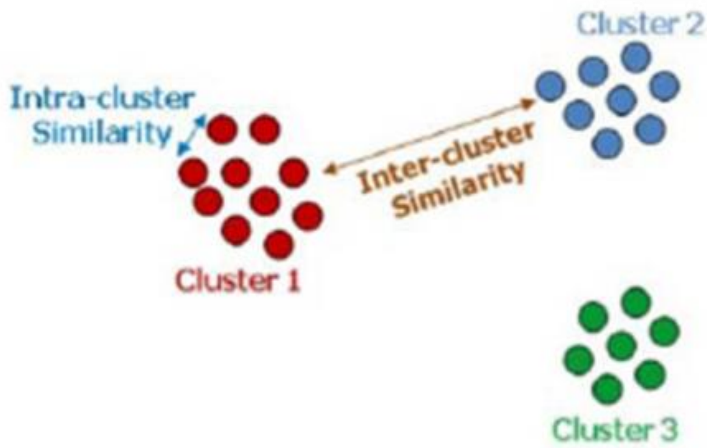
$$\text{Conf}(x_1, x_2.....)\text{ implies }(y_1,y_2)) = \frac{\text{Supp}((x_1, x_2...)\text{ implies }(y_1,y_2..))}{\text{Supp}(x_1,x_2)}$$

**The Apriori algorithm: T**he Apriori algorithm is an influential algorithm for mining frequent item sets for Boolean association rules. Suppose there a total of m items in S.The number of subsets of S is 2m, thus to check every transaction record to see which sets it belong to require 2m checks. This is computationally infeasible when m is even of moderate size. This is an instance of course of dimensionality“. However if we restrict to sets with support greater than 0 the search becomes feasible. These are called frequent item sets. The first efficient algorithm for finding all sets with a given level of support was given by agarwal and srikant 1994[4], and was supposedly improved by these authors and others. Once all the sets with support greater than 0 have been found and their support is recorded it is then a straight forward matter to calculate the confidence.

**CLUSTERING**

Data clustering is the most complex yet crucial data mining technique. It is a method of grouping similar objects together. Here partitions are made called clusters. Points or data with a cluster are as similar as possible where as points across clusters are as dissimilar as possible. Apart from being used in data mining and pattern recognition it can be used in much application such as:

Data compression, image analysis, bio informatics, academics, search engines, intrusion detection etc. Data clustering is based on the similarity or dissimilarity (distance) measures between these points. Hence these measures make the cluster analysis meaningful. The high quality of clustering is to obtain high intra-cluster similarity and low inter cluster similarity as shown is the figure




That data mining algorithms should fulfill are scalability in terms of memory requirements and execution time, and consistent quality of the results as the input size grows. Especially the scalability requirement distinguishes data mining algorithms from the algorithms used in machine learning. Depending on the data and desired cluster characteristic there are different types of cluster paradigms such as:

- Representative based algorithms
- Hierarchical based algorithms
- Density based algorithms
- Density based connectivity clustering
- Density functions clustering
- Graph based
- Spectral clustering

**Taxonomy of clustering algorithms**

**A Representative–based clustering:** Given a dataset to f n points in d dimensional space, D= {xi} ni=1, and given the desired number of clusters k, the main aim of representative based clustering is to partition the dataset into k groups or clusters c= (c1,c2,c3....). One of the most popular representative algorithms are K-means and expectation maximization (EM)algorithms.

**A.1 K-means algorithm:** K means is a heuristic algorithm that partitions a data set into K clusters by minimizing the sum of squared distance in each cluster [BRL00]. The algorithm is a greedy algorithm and it performs hard clustering which means each point is assigned to only one cluster. It has three main steps:

- Initialization by setting seeding points.
- Dividing all data points in K clusters based on k.
- Updating K centroids based on newly formed clusters, it can be shown that the algorithm always converges after several iteration of the steps1and2.Thestrength of this algorithm lies in its computational efficiency. K-means is the most widely used and popular clustering algorithm.

**A.2: Expectation maximization Clustering:** The K means approach is an example of a hard assignment clustering where each point can belong to only one cluster, this approach can be generalized to consider soft assignment to f points to clusters, so that each point has a probability of belonging to each cluster.

B. Hierarchical clustering: Given n points in a d dimensional space, the goal of hierarchical clustering is to create a sequence of nested partitions, which can be easily visualized via a tree or hierarchy of clusters also called the dendrogram. The clusters in the hierarchy can be at the lowest level of the tree, consisting of each point in it so wn cluster and at the highest point (the root) consisting of all points in one cluster. Both of these may be considered trivial clusterings. At some point intermediate meaningful clusters can be formed. There are two main approaches to mine hierarchical clusters, agglomerative and divisive. Agglomerative strategies work in a bottom-up manner. Which means starting with each of the n points in a separate cluster, they repeatedly merge the most similar pair of clusters until all points are members of the same cluster. Divisive strategies are just the opposite, working in a top down manner, starting with all the points in the same cluster, they recursively split the clusters until all points are in separate clusters.

C. Density based clustering: The representative based clustering methods like k-means and EM are suitable for finding convex clusters. On the other hand for non convex shaped clusters, density based algorithms such as DBSCAN (density based spatial clustering of applications

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with noise) are popularly used. It was proposed by Martin Ester, Hans Peter Krigel, Jorg Sanderand Xiawoei in 1996.

D. Graph based and spectral clustering: The goal of graph based clustering is to cluster over graphs. Given a graph, the notes are clustered by using edges and their weights, which represent the similarity between the incident nodes.This type of clustering is related to divisive hierarchical clustering, as many methods partition these to f nodes to obtain the final clusters using pair wise similarity matrix between nodes. Spectral clustering on the other hand treats clustering as a graph partitioning problem without making specific assumptions on the form of clusters.Cluster points using Eigen vectors of matrices are derived from data, data are mapped to a low dimensional space that are separated and can be clustered.

## CONCLUSIONS

Data mining has the most important and promising features of interdisciplinary developments in information technology. The paper is an attempt to establish that data mining is so much more than just data analysis or simple extraction. Data mining techniques can answer business questions that were too time consuming to answer previously. The future in data mining is full of developing algorithms that enable user to cluster patterns more accurately resulting in more specific and user desired trends. Data mining's application will enrich human life in various fields such as business, education, medical field, scientific field and politics.

## REFERENCES

[1] Mrs. Bharti M. Ramageri , "Data mining Techniques and Applications", Indian journal of computer science and engineering, Vol1.No.4, pp301-305

[2] Usama Fayyad ,Gregory Piatetsky – Shapiro ,"From data mining to knowledge discovery in databases"

[3] R .agarwal and R.srikant 1994 .fast algorithms for mining association rules in large databases .proceedings of the 20th international conference on very large databases,pages487-4994.Mohammad J. Zaki , Wagner Mirer. , data mining and analysis: fundamental concepts and algorithms.

[4] Sangeeta goele, Nisha chanana,"data mining trends in past current and future ", International journal of computing and business research, inProc -1society2012.

[5] Hemlata Sahu, Shalini Sharma, Seema gondhalkar,"A brief overview on data mining survey", International journal of computer technologyandelectronicsengineering, vol1.Issue3.

[6] DTpham, SSdimov"Selection of K in K-means clustering ", manufacturing engineering centre ,Cardiff university ,UK8.Xindong Wu, Vipin Kumar... "Top 10 algorithms in data mining", Springer–verlag08.

# Chapter: 30

# Machine Learning in Banking Risk Management: A Review

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**ABSTRACT**

Machine learning is having an expanding impact on commercial applications, with several solutions currently being used and many more being investigated. Risk management in banks has been increasingly prominent since the global financial crisis, and there has been a consistent focus on how hazards are identified, assessed, communicated, and managed. The advancements in banking and risk management as well as the present and future problems have received significant academic and industrial research attention. The goal of this paper is to analyze and evaluate machine learning techniques that have been studied in the context of banking risk management. It also aims to identify areas or issues in risk management that have not been sufficiently explored and may be good candidates for further study. However, it doesn't seem commensurate with the current industry level of focus on both risk management and machine learning. The review has shown that the application of machine learning in the management of banking risks such as credit risk, market risk, operational risk, and liquidity risk has been explored. There are still many areas in bank risk management that might greatly profit from research into how machine learning can be used to solve certain issues.

**KEYWORDS:** bank; machine learning; credit scoring; fraud; risk management

## INTRODUCTION

Risk management at banks has become increasingly important since the global financial crisis, and there has been continuous attention paid to how risks are identified, assessed, reported, and managed. The advancements in banking and risk management as well as the present and future problems have been the subject of much research in both academia and industry. Machine learning has also become more prevalent in corporate applications, with numerous solutions already in use and many more being investigated. By 2025, risk functions at banks will need to be significantly different from how they are now, according to McKinsey & Co. Risk management is projected to alter as a result of the depth and widening of legislation, changing consumer expectations, and changing risk kinds. Advanced analytics and the use of developing technologies are enabling new goods, services, and risk management strategies. Machine learning, one of the emerging technologies with significant implications for risk management, can make it possible to create risk models that are more accurate by spotting intricate, nonlinear patterns in vast datasets. Every new piece of information that is supplied can increase the predictive power of these models, resulting in an increase in predictive power over time. Within a bank's risk organization, machine learning is anticipated to be used in a variety of contexts. Additionally, machine learning has been suggested as a project that may aid in the modernization of banks' risk management departments. The goal of the paper is to examine how much machine learning, which has been identified as an emerging business enabler, has been studied in relation to risk management within the banking sector and, as a result, to pinpoint future research areas. In order to identify areas or issues in risk management that have not been sufficiently studied and to recommend opportunities for future study, this review article will examine, analyze, and evaluate machine learning approaches that have been used to banking risk management. To assess the aspects of banking risk management where machine learning approaches have been studied, a review of the literature was conducted. The study assessed the risk domains where machine learning has been applied to the different risk kinds and risk methodologies they dealt with. The investigation also revealed the machine learning techniques in use, both generally and for particular applications.

## THEORETICAL BACKGROUND

**(i) Risk Management at Banks:** The bank's management must take on more risk in order to enhance profits for its stockholders. Interest rate risk, market risk, credit risk, off-balance-sheet risk, technology and operational risk, foreign exchange risk, country or sovereign risk, liquidity risk, liquidity risk, and insolvency risk are just a few of the hazards that banks must deal with. The success of a bank depends on its ability to effectively handle these risks. Market risk is the possibility of suffering losses "as a result of changes in the level or volatility of market prices". Interest rate risk, equities risk, foreign currency risk, and commodity risk are all examples of market risk. The potential loss brought on by changes in interest rates is known as interest risk. The possible loss resulting from a negative change in a stock's price is known as equity risk. The risk that changes in currency exchange rates may affect a bank's asset or liability values is known as foreign exchange risk. The potential loss brought on by a negative change in the price of commodities owned is known as commodity risk.

Credit is the possibility that a borrower won't fulfill their commitments (including paying interest and principle), which might result in a loss to the bank. The biggest risk that banks are exposed to is credit risk. Banks are permitted to use the internal ratings-based approach to credit risk under the Basel Accord. Banks are able to create their own internal credit risk models for estimating potential loss. Probability of default (PD), loss given default (LGD), and exposure at default (EAD) are the three main risk characteristics that need to be calculated. According to Basel Committee on Banking Supervision 2005a and 2005b, Expected Loss equals P D x LGD x EAD. Asset liquidity risk and financing liquidity risk are the two types of liquidity risk, which are managed separately from the other concerns. When a transaction cannot be completed at the current market prices—which might happen as a result of the position's size in relation to the typical trading lot size—a bank is exposed to asset-liquidity risk. The inability to satisfy cash flow requirements is referred to as funding liquidity risk, and sometimes referred to as cash flow risk. Banks must set up a strong framework for managing liquidity risk that would guarantee sufficient liquidity is maintained, including the capacity to resist a variety of stress scenarios. Liquidity risk should be identified, measured, monitored, and controlled using a reliable method (Basel Committee on Banking Supervision 2008). According to BCBS, operational risk is a "fundamental element of risk management" for banks and is described as the risk of loss brought on by "inadequate or failed internal processes, people, and systems, or from external events." Strategic and reputational risk is not included in this formulation but legal risk is. All banking operations, processes, products, and systems are seen to be characterized by it (Basel Committee on Banking Supervision, 2011). The chief risk officer has access to risk knowledge and insight that is more retroactive in nature, such as event studies that concentrate on figuring out what happened and why. They are now arming themselves with technologies that provide a forward-looking perspective and make it easier to foresee possible risk situations. The majority of risk management solutions come with built-in capabilities for data mining, scenario modelling, and forecasting. Augmented (natural language processing and machine learning) and assistive (contextual virtual intelligent assistance) intelligence that enhances and accelerates decision making is replacing cognitive (pattern recognition by visualizing and identifying apparent and later trends in historical data) and

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algorithmic (establishing causal relationships between various events and data sets) intelligence.

**MACHINE LEARNING**

According to one explanation, machine learning is at the nexus of computer science, engineering, and statistics. It has been emphasized as a tool that may be used to solve a variety of issues, particularly in industries where data must be analyzed and used to make decisions. Machine learning provides the capacity to identify significant patterns in data and has emerged as a popular tool for practically any activity requiring the extraction of significant data from data sets. A programmer might not be able to offer a clear and precise specification on the execution process when faced with the need to extract meaningful information from data and the resulting complexity of patterns to be investigated. This problem is solved by machine learning, which "endows programmes with the ability to learn and adapt." When a problem has to be solved and faces the combined challenges of complexity and flexibility, machine learning programmes can be used since they learn and get better. The advancements in search engines and self-driving cars are being made possible by machine learning techniques, which may be adapted and used in the financial industry. Due to a number of technical advancements, the financial sector is now able to access and mine a vast data infrastructure that includes a variety of unstructured financial data sets regarding customers and marketplaces. The volume of data amassed by financial institutions (FI) has increased significantly in recent years. Large amounts of unstructured data are being produced and/or gathered often as a result of a strong push towards the digitalization of services and greater regulatory reporting obligations. Consumer apps, client interactions, metadata, and other external data sources are just a few of the sources of this data. Financial institutions have been exploring powerful and analytical solutions as a result of their desire to improve their analytical capabilities and automate across business lines, including risk management, by managing and mining these increased volumes and a variety of data. This has resulted in a rise in interest and popularity of machine learning and artificial intelligence within the FI community. The financial services industry believes that machine learning has the potential to provide FIs the analytical capabilities they want. Machine learning has the potential to have an influence on all facets of the FI's business model, including automating customer service, risk management, fraud detection, conduct monitoring, and automated identity verification when combined with biometrics. The Securities and Exchange Commission (SEC) uses machine learning to discover misbehaviour throughout the risk assessment process. While this can be used from a supervisory standpoint and for the oversight of systemic risks, it can also be used as a guide for a bank on how to apply similar machine learning techniques in risk assessments for the detection of misconduct (internal or external), including risk assessments on corporate issuers or counterparties. Machine learning has a lot of promise in computational finance and may be utilized in a variety of ways, from thorough exploratory data analysis to the presentation/ visualization of modeling findings.

**METHODOLOGY**

By examining the different issues surrounding machine learning and risk management in banks, the methodological foundation for this study was established. The papers were divided into categories so that readers could understand:

(i) the risk area they concentrated on,

(ii) the risk management tool or framework component they targeted, or

(iii) the algorithms that were utilized, researched, or suggested.

Additionally, articles with a stronger emphasis on risk assessment and measurement were sought to be reviewed. Risk topics like cyber security and fraud risk have received a lot of attention, but the focus of this analysis has only been on instances where they directly connect to use cases for banking risk management.

**Credit Risk:** Initial study efforts on the evaluation of credit risk date back to the nineteenth century, and it continues to be a significant and difficult research issue in the world of finance. The events surrounding the global financial crisis and the resulting enhanced regulatory attention have led to an increased interest in the credit risk assessment process among academics and businesspeople. The standard method for assessing credit risk has been to use a classification methodology on historical customer data, including information on delinquent customers, to examine and analyze the relationship between a customer's traits and their likelihood of failing.

This might be done to identify classifiers that can be used to assign new applications or current customers to good or negative categories. Evaluation of credit risk plays a significant role in risk management. In order to calculate the chance of default, credit scoring generally uses methods like logistic regression and discriminant analysis. Support Vector machines are effective in classifying credit card defaulters. When examined and compared against the conventional methodologies, they were also shown to be competitive in identifying the elements that are most important in assessing risk of default. In order to properly categorize consumers and estimate credit risk, a big problem facing banks, methods and models are continuously being developed. These methodologies' varied strategies work to make creditworthiness projections more accurate, which might result in a larger and more lucrative loan portfolio. The application of neural networks in predicting firm distress has been shown to be helpful in credit risk evaluation, and they have shown to be of great utility in the credit risk judgment process.

A new "fuzzy support vector machine" was suggested in a research study. The method maintains the fuzzy SVM's capacity to be insensitive to outliers while attempting to differentiate between good creditors and poor creditors through increased generalization. They offer a bilateral weighted fuzzy SVM, and the findings indicate that it has potential for use in credit analysis. A few studies study the topic of stress testing in credit risk management. For the purpose of assessing the effects of extreme scenarios on a bank, stress testing necessitates the modelling of the relationship between macroeconomic events and banking variables. Bottom-up methodologies are more typically utilized, in which forecasts of future gains or losses are based mostly on disaggregated portfolio levels, requiring a large amount of data and making it challenging to pinpoint the precise causes of losses. This procedure can be complemented by predictions made using a top-down approach on an aggregated portfolio. The most extensively studied algorithms in the field of credit risk management appear to be neural networks, support vector models, and random forests.

**Market Risk:** The volatility—also known as the standard deviation of unexpected results—can be used to quantify risk. Value at Risk (VAR) measures the combined impact of underlying volatility and exposure to financial risks by calculating the worst loss over a specified horizon that will not be surpassed with a specific degree of confidence. Forecasting volatility in the financial markets is crucial for a number of reasons, including risk management and asset pricing. The performance of the volatility estimate approach can be enhanced by NN models. In order to estimate volatility, a model was suggested based on the Generalised Autoregressive Conditional Heteroskedastic (GARCH) model and the Extreme Machine Learning (ELM) method. Using GELM-RBF, the model forecasts the volatility of the target time series, and extrapolating the forecasted volatilities enables the computation of VaR with better accuracy and efficiency.

The model is a nonlinear data driver model that uses a stochastic mapping technique without relying on the Gaussian likelihood for estimate. Interest rate and equity risk are other types of market risk. In financial engineering and market risk management, interest rate curves—the relationship between interest rate and time until debt maturity for a certain borrower in a given currency—are frequently utilized. To create nonlinear models of the development of the parameters and subsequently anticipate interest rate curves, the "Gaussian Mixture Model" clustering technique is utilized. This may make interest rates easier to see. To create anticipatable VAR models that aspire to be a leading risk indicator of market regime shift, machine learning clustering techniques created to solve Stochastic Differential Equations (SDE) can be used. This can help to some extent with the complexity brought forth by the difficult regulatory environment, such as scenario coherence.

**Liquidity Risk:** Machine learning may be used to address a variety of liquidity risk issues. Machine learning may be used to measure liquidity risk, analyze important components, including the elements' relationships with one another, and investigate these relationships. A genetic algorithm may be used to estimate a risk metric using Artificial Neural Networks (ANN). ANN may be used to determine the most important elements and approximate the overall risk trend. By using Bayesian networks, it is possible to calculate the likelihood that a liquidity risk event will occur. The most important liquidity risk components could be distinguished using the ANN and BN implementations, which measured the risk using functional approximations and distributional estimations, respectively.

**Operational Risk:** In operational settings where risk mitigation is possible, such as risk identification and/or prevention, machine learning is also used. Aside from cyber security instances, machine learning in operational risk is mostly utilized to solve issues with fraud detection and suspicious transaction identification. Provide a prototype for the creation of a report that enables the identification of suspicious transactions in a paper. A logistical regression approach is used in the prototype. It is notable that they also included a study of six software programmes that are now being used at different banks to automate the processes for detecting and keeping track of suspicious transactions. Another area that presents a big problem to financial institutions is money laundering because of the complexity and number of transactions, as well as the dynamic and quick-evolving nature of financial crimes and the requirement to operate on real-time data sets. The use of statistical learning and data mining for creating classification models to identify questionable transactions has been the subject of much study in the field of financial crime detection. The cluster allocation criteria were developed using a C5.0 algorithm to anticipate risk levels based on the many possible risk variables for customers. Transaction profiles were described using the key variables. According to the model, 99.6% of the test data were correctly classified. According to reports, the number of incidents that were alerted decreased from about 30% of transactions to less than 1%. There are a few publications on credit card and online banking fraud risk detection

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in the operational risk domains as well. They deal with detecting credit card fraud in areas that aren't explicitly tied to bank risk management or the banking sector. The algorithms they discuss include SVM, KNN, Naive Bayes Classifier, and Bagging Ensemble Classifier based on decision tree, one may see.

## DISCUSSION

Credit scoring entails giving a company (or customer) a numerical number to indicate whether or not they are likely to default. The majority of the study has been concentrated on tackling this issue as a classification problem, classifying potential customers as "good" or "bad" to help with credit decisions and credit risk management. As a result, algorithms that deal with categorization predominate. Numerous articles have addressed methods for predicting the likelihood of default or recovery rate, including estimating the likelihood of default (PD), loss given default (LGD), and exposure at default (EAD). The existence of studies and models for forecasting or estimating the PD, LGD, and EAD, and therefore calculating the credit loss exposure, would be of great benefit to banks and their risk management operations. It has been demonstrated that machine learning approaches outperform conventional statistical methods in terms of categorization and prediction accuracy. Additionally, it doesn't seem as though market risk management applications of machine learning have been sufficiently researched. Market risk or volatility has been studied extensively from the standpoint of portfolio or investment risk management. However, the papers seem constrained in terms of bank risk management. It might be worthwhile to conduct more study on this, particularly from the perspective of stress testing or tail end risk capture.

There have been some use cases studied for liquidity risk, which has received a lot of attention from regulators since the financial crisis. Studies in the field of operational risk have mostly concentrated on detecting fraud and questionable transactions—issues that are often handled by classification algorithms. In the use of machine learning algorithms, clustering analysis, Bayesian networks, decision, classification trees, and SVM are frequently emphasized. Another description of neural networks is as a highly common and important method for detecting credit card fraud. Apart from examples connected to money laundering, several other non-financial risk management topics, such as nation risk management and compliance risk management, haven't been thoroughly examined. Even though machine learning is suggested as a way to control conduct risk, conduct risk, which has emerged as a critical risk and taken a high priority for regulators and banks due to the rash of conduct concerns in Europe, the US, and Asia Pacific, appears to be understudied in research publications. Researchers employ a variety of dataset sources for their work; some use information from commercial banks or databases given by companies that provide financial services (like Moody's), while others use information that is readily accessible to the public. The data can be significantly skewed (e.g., low default rates), incomplete, and unreliable (e.g., may not be tagged accurately or as intended), among other issues.

## CONCLUSIONS

It is widely acknowledged that machine learning has a bright future in the banking and finance sector, and it is anticipated that risk management will also look to use machine learning approaches to improve their skills. The potential of machine learning approaches to examine large amounts of data without being bound by assumptions of distribution and to significantly contribute to exploratory analysis, classification, and predictive analytics is noteworthy, despite

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criticism that they operate like a black box. This has the potential to change the way risk management is done. Machine learning, one of the emerging technologies with significant implications for risk management, can make it possible to create risk models that are more accurate by spotting intricate, nonlinear patterns in vast datasets.

However, it doesn't seem commensurate with the current industry level of focus on both risk management and machine learning. The review revealed that the application of machine learning in the management of banking risks, such as credit risk, market risk, operational risk, and liquidity risk, has been explored. There is a lot of room for more research in the areas of market risk, operational risk, and liquidity risk. For some applications where complicated and non-linear calculations are needed for data analysis or modeling on large datasets, more study into the use of machine learning might be conducted. Despite the fact that research on the use of machine learning in risk management has been conducted over the years, it continues to be insufficient and outperforms other risk management techniques. As was said above, there are still many areas in bank risk management that might greatly profit from research on how machine learning may be used to solve certain issues.

## REFERENCES


[1] Ala'raj, Maher, and Maysam F. Abbod. 2016a. A New Hybrid Ensemble Credit Scoring Model Based on Classifiers Consensus System Approach. Expert Systems with Applications 64: 36–55.

[2] Ala'Raj, Maher, and Maysam F. Abbod. 2016b. Classifiers Consensus System Approach for Credit Scoring. Knowledge-Based Systems 104: 89–105.

[3] Apostolik, Richard, Christopher Donohue, Peter Went, and Global Association of Risk Professionals. 2009. Foundations of Banking Risk: An Overview of Banking, Banking Risks, and Risk-Based Banking Regulation.New York: JohnWiley.

[4] Arezzo, Maria, and Giuseppina Guagnano. 2018. Response-Based Sampling for Binary Choice Models with Sample Selection. Econometrics 6: 12.

[5] Awad, Mariette, and Rahul Khanna. 2015. Machine Learning in Action: Examples. Efficient Learning Machines.

[6] Aziz, Saqib, and Michael M. Dowling. 2018. AI and Machine Learning for Risk Management. SSRN Electronic Journal.

[7] Sala, Jordi Petchamé. 2011. Liquidity Risk Modeling Using Artificial Neural Network. Master's thesis, Universitat Politècnica de Catalunya, Barcelona, Spain.

[8] Saunders, Anthony, Marcia Millon Cornett, and Patricia Anne McGraw. 2006. Financial Institutions Management: A Risk Management Approach. New York: McGraw-Hill.

[9] Shalev-Shwartz, Shai, and Shai Ben-David. 2014. Understanding Machine Learning: From Theory to Algorithms. Cambridge: Cambridge University Press.

[10] Sharma, Shashank, and Arjun Roy Choudhury. 2016. Fraud Analytics: A Survey on Bank Fraud Prediction Using Unsupervised Learning Based Approach. International Journal of Innovation in Engineering Research and Technology 3: 1–9.

[11] Sudjianto, Agus, Sheela Nair, Ming Yuan, Aijun Zhang, Daniel Kern, and Fernando Cela-Díaz. 2010. Statistical Methods for Fighting Financial Crimes. Technometrics 52: 5–19.

[12] Tavana, Madjid, Amir Reza Abtahi, Debora Di Caprio, and Maryam Poortarigh. 2018. An Artificial Neural Network and Bayesian Network Model for Liquidity Risk Assessment in Banking. Neurocomputing 275: 2525–54.

[13] Vaidya, Avanti H., and SudhirW. Mohod. 2014. Internet Banking Fraud Detection usingHMMand BLAST-SSAHA Hybridization. International Journal of Science and Research (IJSR) 3: 574–9.


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# Chapter: 31

# A Review of Machine Learning for the Detection of Disease

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**ABSTRACT**

Machine learning (ML) has emerged as a powerful tool in the field of healthcare for the detection and diagnosis of diseases. This review aims to provide an overview of the applications of ML in disease detection, highlighting its potential benefits and challenges. Various ML techniques, including supervised learning, unsupervised learning, and deep learning, are discussed in the context of disease detection. Additionally, the review discusses the different types of data used in ML models, such as medical images, electronic health records, genomic data, and wearable sensor data. The advantages of using ML in disease detection, such as improved accuracy, faster diagnosis, and personalized medicine, are explored. Furthermore, the challenges and limitations of ML in healthcare, including data privacy and security concerns, algorithm bias, and interpretability, are addressed. The review concludes by discussing the future prospects of ML in disease detection and the potential impact it can have on improving healthcare outcomes.

**KEYWORDS**-Machine learning, disease detection, healthcare, medical data, algorithms, patterns, early diagnosis, treatment outcomes, personalized medicine

## INTRODUCTION

The field of healthcare has been greatly influenced by advancements in technology, particularly in the area of machine learning. Machine learning techniques have shown great promise in the detection and diagnosis of diseases, revolutionizing the way healthcare providers analyze and interpret medical data. In this review, we aim to explore the applications of machine learning in disease detection and examine its significance in improving healthcare outcomes. The traditional approach to disease detection involves manual interpretation of medical tests and examination of patient symptoms. However, this process is often time-consuming, subjective, and can be prone to human errors. Machine learning, on the other hand, offers an automated and data-driven approach to disease detection, leveraging the power of algorithms and computational models to analyze large volumes of medical data. Machine learning algorithms can be trained to recognize patterns and make predictions based on historical data. In the context of disease detection, these algorithms can analyze various types of medical data, such as imaging scans, laboratory test results, genetic profiles, and electronic health records. By learning from a vast amount of data, machine learning models can identify subtle patterns and indicators that may not be easily recognizable to human observers. One of the key advantages of machine learning in disease detection is its ability to provide early and accurate diagnoses. By analyzing large datasets and learning from historical cases, machine learning models can identify patterns that are indicative of specific diseases or conditions. This early detection enables healthcare providers to intervene at an earlier stage, leading to improved treatment outcomes and potentially saving lives. Furthermore, machine learning techniques can assist healthcare providers in decision-making by providing risk assessments and treatment recommendations. By analyzing patient data and comparing it to historical cases, machine learning models can estimate the probability of disease occurrence or progression. This information can help guide healthcare professionals in developing personalized treatment plans and interventions. In this review, we will discuss various machine learning algorithms and techniques that have been employed in disease detection, including supervised learning, unsupervised learning, and deep learning. We will explore their respective strengths and limitations, as well as their applications in different disease domains, such as cancer, cardiovascular diseases, infectious diseases, and neurological disorders. Additionally, we will discuss challenges and considerations associated with the implementation of machine learning models in healthcare settings, including data privacy and security, interpretability of results, and integration with existing clinical workflows. We will also address the ethical implications of using machine learning in disease detection, such as bias in algorithms and potential consequences of relying solely on automated systems. Overall, this review aims to provide a comprehensive overview of the applications, benefits, and challenges of using machine learning for disease detection. By understanding the current landscape and future directions of this field, healthcare professionals and researchers can harness the potential of machine learning to improve disease detection, diagnosis, and patient care.

## IMPORTANCE OF DISEASE DETECTION

Disease detection plays a crucial role in healthcare for several reasons. Here are some key points highlighting the importance of disease detection:

**Early Intervention:** Detecting diseases at an early stage allows for prompt intervention and treatment. Many diseases, such as cancer, cardiovascular conditions, and infectious diseases, have better outcomes when diagnosed early. Early detection can help prevent disease progression, reduce complications, and increase the chances of successful treatment.

**Improved Patient Outcomes:** Timely disease detection enables healthcare providers to implement appropriate treatment plans and interventions. It can lead to better patient outcomes, including higher survival rates, reduced morbidity, and improved quality of life. For example, detecting and managing chronic conditions like diabetes or hypertension early can help prevent complications and maintain better health.

**Disease Prevention and Control:** Disease detection is crucial for identifying individuals who are at risk or carriers of communicable diseases. By detecting and isolating infected individuals, public health authorities can prevent the spread of diseases within communities. This is particularly significant in controlling epidemics or pandemics.

**Resource Allocation:** Early detection allows healthcare systems to allocate resources efficiently. By identifying the presence and prevalence of diseases, healthcare providers can plan and allocate resources such as personnel, equipment, and medication to areas with higher disease burden. This optimization improves healthcare delivery and ensures that resources are used effectively.

**Cost Savings:** Disease detection can lead to significant cost savings in healthcare. Early detection and treatment are generally less expensive than treating advanced-stage diseases. By detecting diseases early, healthcare systems can reduce hospitalization rates, intensive care needs, and the overall burden on healthcare services, thus potentially lowering healthcare costs.

**Public Health Surveillance:** Disease detection is critical for public health surveillance systems. By monitoring the occurrence and prevalence of diseases, public health authorities can identify trends, track outbreaks, and implement appropriate control measures. This surveillance data is vital for formulating public health policies, designing prevention strategies, and allocating resources.

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**Personal Empowerment:** Detecting diseases empowers individuals to take charge of their health. Through regular screenings and diagnostic tests, individuals can identify potential health risks and make informed decisions about their lifestyle, treatment options, and preventive measures. Early detection can provide individuals with an opportunity to actively participate in their healthcare and make positive changes to improve their well-being.

In summary, disease detection is of utmost importance as it enables early intervention, improves patient outcomes, prevents disease transmission, optimizes resource allocation, saves costs, facilitates public health surveillance, and empowers individuals to take control of their health.

## ROLE OF MACHINE LEARNING IN DISEASE DETECTION

Machine learning plays a crucial role in disease detection and has the potential to greatly improve healthcare outcomes. Here are some key ways in which machine learning is used in disease detection:

**Early diagnosis:** Machine learning algorithms can analyze large volumes of patient data, including medical records, lab results, imaging scans, and genetic information, to identify patterns and detect subtle signs of disease at an early stage. This allows for timely intervention and treatment, which can significantly improve patient outcomes.

**Predictive analytics:** Machine learning models can analyze patient data to predict the likelihood of developing certain diseases or assess the risk of disease progression. By considering various factors such as genetics, lifestyle, environmental factors, and biomarkers, these models can provide personalized risk assessments and enable targeted preventive measures.

**Image analysis:** Machine learning techniques, particularly deep learning, have been widely applied to medical imaging analysis. By training on vast datasets of annotated medical images, algorithms can accurately detect abnormalities and assist in diagnosing conditions such as cancer, cardiovascular diseases, and neurological disorders. Machine learning can also aid in automated segmentation, quantification, and tracking of disease-related features in medical images.

**Decision support systems:** Machine learning algorithms can be integrated into clinical decision support systems to assist healthcare providers in making more informed decisions. These systems can analyze patient data, recommend appropriate diagnostic tests, suggest treatment options, and provide real-time alerts for potential adverse events or drug interactions.

**Drug discovery and development:** Machine learning algorithms can accelerate the process of drug discovery by analyzing vast amounts of molecular and biological data. These models properties cadential drug candidates, predict drug-target interactions, optimize drug properties, and assist in repurposing existing drugs for new indications.

**Public health surveillance:** Machine learning can be used for real-time monitoring and early detection of disease outbreaks. By analyzing diverse data sources, such as social media posts, search queries, and electronic health records, machine learning models can identify patterns and anomalies that may indicate the emergence or spread of infectious diseases, enabling timely public health interventions.

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It is important to note that machine learning models are developed based on available data and require ongoing validation and refinement. Collaboration between healthcare professionals, data scientists, and regulatory bodies is crucial to ensure the responsible and effective use of machine learning in disease detection.

## MACHINE LEARNING TECHNIQUES FOR DISEASE DETECTION

Machine learning techniques have shown great promise in disease detection and diagnosis. Here are some commonly used techniques in this domain:

**Supervised Learning:** This approach involves training a model using labeled data, where each sample is associated with a known disease label. The model learns patterns and relationships in the data to make predictions on new, unseen samples. Common supervised learning algorithms used in disease detection include:

- Support Vector Machines (SVM)
- Random Forests
- Decision Trees
- Logistic Regression
- Neural Networks

**Unsupervised Learning:** In situations where labeled data is scarce or unavailable, unsupervised learning techniques can be applied. These algorithms analyze the data to identify patterns, clusters, or anomalies without any prior knowledge of disease labels. Unsupervised learning methods commonly used for disease detection include:

- K-means Clustering
- Hierarchical Clustering
- Gaussian Mixture Models (GMM)
- Principal Component Analysis (PCA)
- Autoencoders

**Deep Learning:** Deep learning techniques, which are a subset of neural networks, have gained significant attention in disease detection due to their ability to automatically learn hierarchical representations from complex data. Deep learning models are capable of handling large amounts of data and extracting high-level features. Popular deep learning architectures used in disease detection include:

- Convolutional Neural Networks (CNN) for image-based diseases such as cancer detection from medical images.
- Recurrent Neural Networks (RNN) for sequential data analysis, such as time-series data or electronic health records.
- Transformers for natural language processing tasks, including analysis of medical reports and literature.

**Transfer Learning:** Transfer learning leverages pre-trained models on large datasets and fine-tunes them on smaller, domain-specific datasets. This approach is useful when the labeled data is limited for a particular disease. By utilizing knowledge learned from related diseases or datasets, transfer learning can improve the performance of disease detection models.

**Ensemble Learning:** Ensemble learning combines multiple models to make more accurate predictions. Different models are trained on the same or different datasets, and their outputs

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are combined using techniques such as majority voting or weighted averaging. Ensemble learning helps to reduce bias, improve generalization, and increase overall performance.

It's important to note that the choice of machine learning technique depends on the specific disease, available data, and the nature of the problem at hand. Researchers and practitioners often experiment with multiple approaches to identify the most suitable technique for a given disease detection task.

## CLASSIFICATION ALGORITHMS

Classification algorithms are machine learning algorithms that are used to categorize or classify data into different classes or categories based on their features. These algorithms learn from labeled training data and then make predictions or assign labels to new, unseen data. Here are some commonly used classification algorithms:

**Logistic Regression:** Logistic regression is a binary classification algorithm that estimates the probabilities of a binary outcome based on input features. It uses a logistic function to model the relationship between the features and the probability of belonging to a certain class.

**Decision Trees:** Decision trees are a popular type of classification algorithm that recursively splits the data based on different feature values to create a tree-like model. Each internal node represents a feature, each branch represents a decision rule, and each leaf node represents a class label.

**Random Forest:** Random Forest is an ensemble learning method that combines multiple decision trees. It creates a large number of decision trees and aggregates their predictions to make the final classification. Random Forest helps reduce overfitting and improves accuracy.

**Support Vector Machines (SVM):** SVM is a powerful classification algorithm that finds the best hyperplane in a high-dimensional space to separate different classes. It aims to maximize the margin between classes while minimizing the classification error.

**Naive Bayes:** Naive Bayes is a probabilistic classification algorithm based on Bayes' theorem. It assumes that the features are conditionally independent given the class label. Despite this naive assumption, Naive Bayes can perform well in practice and is computationally efficient.

**K-Nearest Neighbors (KNN):** KNN is a non-parametric algorithm that classifies new data points based on the majority vote of their k nearest neighbors in the feature space. It does not learn an explicit model and can adapt to complex decision boundaries.

**Neural Networks:** Neural networks, particularly deep learning models, can be used for classification tasks. They consist of multiple layers of interconnected nodes (neurons) and are capable of learning complex patterns in data. Common architectures for classification include feedforward neural networks and convolutional neural networks (CNNs) for image classification.

**Gradient Boosting Algorithms:** Gradient boosting algorithms, such as XGBoost and LightGBM, are ensemble learning methods that combine multiple weak classifiers (usually decision trees) in a sequential manner. They build a strong classifier by iteratively minimizing a loss function and adjusting the weights of the weak classifiers. These are just a few examples of classification algorithms. The choice of algorithm depends on the nature of the data, the size of the dataset, the interpretability requirements, and other factors. It is often useful to experiment with different algorithms to find the one that performs best for a particular problem.

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## FEATURE SELECTION AND EXTRACTION

Feature selection and feature extraction are techniques used in machine learning and data analysis to reduce the dimensionality of data and improve the performance of models.

**Feature Selection:** Feature selection involves selecting a subset of relevant features from the original set of features. The goal is to choose the most informative and discriminative features that contribute the most to the predictive power of the model. This process helps in reducing overfitting, improving model interpretability, and reducing computational complexity. There are several methods for feature selection:

**Filter methods:** These methods evaluate the relevance of features independently of the chosen machine learning algorithm. They use statistical measures such as correlation, chi-square, or mutual information to rank the features and select the top-ranked ones.

**Wrapper methods:** Wrapper methods evaluate subsets of features by training and testing a machine learning algorithm on different feature subsets. They use a search algorithm (e.g., forward selection, backward elimination) to find the optimal feature subset based on the model's performance.

**Embedded methods:** Embedded methods combine feature selection with the model training process. Some machine learning algorithms have built-in feature selection techniques, such as L1 regularization (Lasso) in linear regression or decision tree-based feature importance.

**Feature Extraction:** Feature extraction aims to transform the original set of features into a reduced-dimensional feature space while preserving the most important information. It involves creating new features or representations by combining or transforming the existing features. Feature extraction methods include:

**Principal Component Analysis (PCA):** PCA is a linear transformation technique that finds a new set of orthogonal variables (principal components) that capture the maximum variance in the data. It reduces the dimensionality while retaining most of the information.

**Linear Discriminant Analysis (LDA):** LDA is a supervised dimensionality reduction technique that aims to maximize the separability between classes. It finds a projection that maximizes the between-class scatter and minimizes the within-class scatter.

**Non-negative Matrix Factorization (NMF):** NMF is an unsupervised feature extraction technique that factorizes the data matrix into non-negative low-rank matrices. It can identify parts-based representations of the data.

**Autoencoders:** Autoencoders are neural network architectures that learn to encode the input data into a lower-dimensional representation and then reconstruct the original input from the encoded representation. The bottleneck layer in the autoencoder acts as the extracted features. Feature selection and extraction techniques should be chosen based on the specific problem, the characteristics of the data, and the requirements of the machine learning task at hand.

## RESULTS AND DISCUSSION

**Results:** Numerous studies have demonstrated the effectiveness of ML techniques in disease detection. These algorithms have been successfully applied to detect various diseases such as cancer, cardiovascular diseases, diabetes, and neurological disorders. ML models have shown high accuracy, sensitivity, and specificity in identifying disease patterns from diverse data sources, including electronic health records, medical images, and genomic data.

**Discussion:** The application of ML in disease detection offers several advantages. ML algorithms can process large volumes of data quickly, enabling the identification of complex patterns that may not be apparent to human observers. They can also integrate multiple data sources, leading to more comprehensive and accurate disease detection. Additionally, ML models have the potential to continuously learn and adapt, improving their performance over time.Despite the promising results, there are challenges and limitations associated with ML-based disease detection. One major concern is the interpretability of ML models. While these algorithms can provide accurate predictions, the underlying decision-making process is often difficult to understand. This lack of transparency raises ethical and legal issues, especially in critical healthcare decisions.

## CONCLUSIONS AND FUTURE SCOPE OF ML IN HEALTHCARE

Machine learning (ML) techniques have gained significant attention in the field of healthcare, particularly in the detection of diseases. This review provides an overview of recent research on the application of ML algorithms for disease detection, examines their effectiveness, and discusses their limitations. The goal is to assess the current state of ML in disease detection and highlight areas for future research. The early detection of diseases plays a crucial role in improving patient outcomes and reducing healthcare costs. Machine learning algorithms have shown great potential in analyzing large-scale medical data and identifying patterns that may indicate the presence of a disease. In this review, we explore the use of ML techniques in disease detection across various medical domains and discuss their impact on healthcare. A comprehensive literature search was conducted to identify relevant studies published between 2015 and 2023. The search terms included "machine learning," "disease detection," and various specific diseases. Studies that employed ML algorithms for disease detection and reported performance metrics were included for analysis.

Another challenge is the availability and quality of data. ML models heavily rely on large and diverse datasets for training. However, obtaining well-curated and annotated datasets can be time-consuming and resource intensive. Furthermore, there may be biases in the data, leading to biased predictions and potential disparities in disease detection across different demographic groups.

## CONCLUSION

Machine learning techniques have demonstrated great promise in disease detection, offering the potential to revolutionize healthcare. ML algorithms have shown high accuracy and performance in identifying diseases across various medical domains. However, challenges such as model interpretability and data quality need to be addressed to ensure the ethical and reliable deployment of ML models in clinical settings.

Future research should focus on developing interpretable ML models that can provide transparent explanations for their predictions. Additionally, efforts should be made to address biases in datasets and ensure the equitable and unbiased performance of ML algorithms across diverse populations. By overcoming these challenges, ML-based disease detection can become an invaluable tool for early diagnosis and treatment, ultimately improving patient outcomes and healthcare efficiency.

## REFERENCES

[1] Titano, J. J., Badgeley, M., Schefflein, J., Pain, M., Su, A., Cai, M., ... &Zech, J. (2018). Automated deep-neural-network surveillance of cranial images for acute neurologic events. Nature Medicine, 24(9), 1337-1341.

[2] Rajpurkar, P., Irvin, J., Zhu, K., Yang, B., Mehta, H., Duan, T., ... &Langlotz, C. (2017). CheXNet: Radiologist-level pneumonia detection on chest X-rays with deep learning. arXiv preprint arXiv:1711.05225.

[3] Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., &Thrun, S. (2017). Dermatologist-level classification of skin cancer with deep neural networks. Nature, 542(7639), 115-118.

[4] Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., ... & Webster, D. R. (2016). Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA, 316(22), 2402-2410.

[5] Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., ... & Khosla, A. (2019). A guide to deep learning in healthcare. Nature Medicine, 25(1), 24-29.

[6] Bejnordi, B. E., Veta, M., van Diest, P. J., van Ginneken, B., Karssemeijer, N., Litjens, G., ... & van der Laak, J. A. (2017). Diagnostic assessment of deep learning algorithms for detection of lymph node metastases in women with breast cancer. JAMA, 318(22), 2199-2210.

[7] Shen, D., Wu, G., & Suk, H. I. (2017). Deep learning in medical image analysis. Annual Review of Biomedical Engineering, 19, 221-248.

[8] Miotto, R., Wang, F., Wang, S., Jiang, X., & Dudley, J. T. (2017). Deep learning for healthcare: review, opportunities and challenges. Briefings in Bioinformatics, 19(6), 1236-1246.

[9] Havaei, M., Davy, A., Warde-Farley, D., Biard, A., Courville, A., Bengio, Y., ... & Pal, C. (2017). Brain tumor segmentation with Deep Neural Networks. Medical Image Analysis, 35, 18-31.

[10] Zhang, L., Zhou, L., Zhang, M., & Chen, H. (2020). A survey on deep learning for medical image analysis. Journal of Healthcare Engineering, 2020, 1-24.

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# Chapter: 32

# A Review of Deep Learning in Disease Detection

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**ABSTRACT**

Deep learning, a subfield of artificial intelligence, has gained significant attention in recent years for its remarkable ability to analyze and interpret complex data. In the field of healthcare, deep learning techniques have shown promising results in disease detection and diagnosis. This review aims to provide a comprehensive overview of the applications of deep learning in disease detection across various medical domains. The review begins by introducing the fundamental concepts of deep learning, including neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative adversarial networks (GANs). Subsequently, it explores the utilization of these architectures in disease detection, focusing on specific diseases such as cancer, cardiovascular disorders, neurological disorders, and infectious diseases.The review then delves into the different modalities of medical imaging, including radiology, histopathology, and dermatology, and highlights how deep learning algorithms have been leveraged to improve disease identification and classification. Moreover, it discusses the integration of multi-modal data sources and the challenges associated with handling large-scale medical datasets.Furthermore, the review discusses the importance of data pre-processing, feature extraction, and transfer learning techniques in enhancing the performance of deep learning models in disease detection. It also addresses the interpretability and explain ability concerns of deep learning algorithms in the healthcare domain.The review concludes by summarizing the current state-of-the-art in deep learning-based disease detection, identifying the key challenges and future directions. It emphasizes the potential of deep learning to revolutionize disease diagnosis, prognosis, and treatment planning, while acknowledging the need for rigorous validation and regulatory considerations.Overall, this review provides valuable insights into the advancements, challenges, and future prospects of deep learning in disease detection, paving the way for further research and development in this rapidly evolving field.

**KEYWORDS-**Deep learning, disease detection, artificial intelligence, neural networks, convolutional neural networks, recurrent neural networks

## INTRODUCTION

Deep learning, a powerful subfield of artificial intelligence, has emerged as a promising approach for disease detection and diagnosis. By leveraging complex neural network architectures, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), deep learning models can analyze vast amounts of medical data and extract valuable insights. In this review, we delve into the applications of deep learning in disease detection across various medical domains. With the ability to handle diverse data modalities, including medical imaging from radiology, histopathology, and dermatology, deep learning algorithms have showcased impressive performance in identifying and classifying diseases. Moreover, they have shown great potential in detecting specific diseases such as cancer, cardiovascular disorders, neurological disorders, and infectious diseases.

However, the application of deep learning in disease detection is not without challenges. Pre-processing of medical data, feature extraction, and handling large-scale datasets are crucial steps in enhancing the performance of deep learning models. Additionally, the interpretability and explain ability of deep learning algorithms in the healthcare domain are of paramount importance. This review aims to provide a comprehensive overview of the advancements, challenges, and future prospects of deep learning in disease detection. By summarizing the current state-of-the-art and addressing the regulatory considerations and validation requirements, we shed light on the potential impact of deep learning on disease diagnosis, prognosis, and treatment planning.

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## CONVOLUTIONAL NEURAL NETWORKS (CNNS)

Convolutional Neural Networks (CNNs) have emerged as a powerful class of deep learning models that have significantly advanced disease detection in various medical domains. In this section, we explore the applications and key characteristics of CNNs in disease detection, highlighting their effectiveness in analyzing medical imaging data. CNNs have shown remarkable success in the detection and classification of diseases, particularly in the field of medical imaging. They have been widely employed in the diagnosis of cancer, cardiovascular disorders, neurological disorders, and infectious diseases. CNNs excel in analyzing images, such as X-rays, MRIs, CT scans, histopathology slides, and dermatological images, enabling accurate and automated disease detection.

CNNs are designed to effectively process visual data by leveraging their unique characteristics:

- **Local Receptive Fields:** CNNs utilize small, localized filters that scan the input data, capturing local features and patterns. This allows the network to learn hierarchical representations of the input images.
- **Convolution and Pooling Layers:** Convolutional layers perform feature extraction by applying convolution operations on the input data. Pooling layers then downsample the extracted features, reducing the spatial dimensions while preserving essential information.
- **Parameter Sharing:** CNNs employ parameter sharing, which means that the same set of weights and biases are applied to different regions of the input data. This property significantly reduces the number of parameters, making CNNs efficient in training and inference.
- **Hierarchical Feature Extraction:** CNNs learn hierarchical representations of features through multiple layers, capturing increasingly complex patterns and ABSTRACTions. This hierarchical approach enables the network to detect and discriminate between disease-specific features.

Recent advancements in CNN architectures, such as deeper networks (e.g., ResNet, DenseNet), attention mechanisms, and transfer learning, have further improved disease detection performance. Transfer learning, in particular, allows CNNs to leverage pre-trained models on large-scale datasets, boosting performance even with limited labeled medical data.However, challenges remain in optimizing CNNs for disease detection. Acquiring high-quality annotated medical datasets, handling class imbalance, addressing interpretability issues, and ensuring robustness against adversarial attacks are critical considerations in developing reliable CNN models.Convolutional Neural Networks have revolutionized disease detection by leveraging their ability to analyze and extract meaningful information from medical imaging data. Their application in detecting various diseases has shown promising results and holds immense potential for improving diagnosis and treatment planning. As research and development in CNNs continue to advance, addressing the existing challenges will further enhance their efficacy and pave the way for future breakthroughs in disease detection.

## RECURRENT NEURAL NETWORKS (RNNS)

Recurrent Neural Networks (RNNs) are a type of artificial neural network designed for processing sequential data. Unlike traditional feedforward neural networks, RNNs have loops within their architecture, allowing them to maintain an internal state or memory that captures information from previous inputs. This memory enables RNNs to process and generate

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sequences of data, making them particularly useful in tasks such as speech recognition, language modeling, machine translation, and time series analysis.The fundamental building block of an RNN is the recurrent neuron or cell. The cell takes an input and its internal state from the previous time step as inputs and produces an output and an updated internal state.

This process is repeated for each time step in the input sequence, creating a chain-like structure of computations that capture the temporal dependencies in the data.One common variant of RNNs is the Long Short-Term Memory (LSTM) network, which addresses the vanishing gradient problem often encountered in traditional RNNs. The LSTM cell incorporates gating mechanisms that control the flow of information, allowing it to selectively remember or forget information over long periods of time. LSTMs have proven to be highly effective in capturing long-term dependencies in sequential data.Another variant of RNNs is the Gated Recurrent Unit (GRU), which is a simplified version of the LSTM cell. GRUs also employ gating mechanisms to control the flow of information, but they have a reduced number of gates compared to LSTMs.

GRUs are computationally less expensive than LSTMs and have been shown to perform well in various sequence-related tasks.Training RNNs typically involves backpropagation through time (BPTT), which is an extension of the traditional backpropagation algorithm. BPTT computes the gradients of the network parameters by unfolding the recurrent computations over time and propagating the errors back through the unfolded network.In recent years, more advanced architectures like Transformer models have gained popularity for sequence-related tasks. Transformers are based on the self-attention mechanism and have achieved state-of-the-art performance in tasks such as machine translation and natural language processing. However, RNNs, particularly LSTMs and GRUs, remain valuable tools for sequential data processing, especially when dealing with long-term dependencies.

## GENERATIVE ADVERSARIAL NETWORKS (GANS)

Generative Adversarial Networks (GANs) are a class of deep learning models that consist of two neural networks: a generator network and a discriminator network. GANs are designed to generate new data instances that resemble a given training dataset. They have been widely used for tasks such as image synthesis, text generation, video generation, and more. The generator network in a GAN takes random input (typically noise) and tries to generate synthetic data samples that resemble real data. The discriminator network, on the other hand, receives both real and generated data samples and aims to distinguish between them accurately. The two networks are trained together in an adversarial manner: the generator tries to generate increasingly realistic samples to fool the discriminator, while the discriminator aims to improve its ability to differentiate between real and fake samples.

During training, the generator and discriminator are updated iteratively. The generator's objective is to generate samples that the discriminator cannot distinguish from real samples, while the discriminator's objective is to correctly classify real and generated samples. This adversarial process leads to the continuous improvement of both networks until a point where the generator produces highly realistic samples that are indistinguishable from real data. The success of GANs is attributed to their ability to capture complex data distributions and generate diverse and high-quality samples. GANs have been particularly influential in the field of computer vision, enabling tasks such as image synthesis, image-to-image translation, and super-resolution. They have also been used for generating realistic synthetic data to augment

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training datasets, addressing the problem of data scarcity in various domains. However, training GANs can be challenging. The training process is highly sensitive and can be unstable, leading to issues like mode collapse (where the generator only produces a limited set of samples) or mode dropping (where certain modes of the data distribution are not represented in the generated samples). Techniques such as mini-batch discrimination, feature matching, and regularization methods have been proposed to address these challenges and stabilize GAN training.

Various extensions and variants of GANs have been developed to overcome limitations and improve performance. Some notable examples include Conditional GANs (cGANs), which allow the generation of samples conditioned on additional input information, and Progressive GANs, which generate high-resolution images progressively by adding layers to the generator and discriminator networks. GANs have also been applied in domains beyond image synthesis. For instance, in natural language processing, GANs have been used for text generation, language translation, and style transfer. In healthcare, GANs have been explored for medical image synthesis, anomaly detection, and data augmentation for disease diagnosis. Overall, GANs have revolutionized the field of generative modeling and have opened up new possibilities for generating realistic and diverse data. They continue to be an active area of research, with ongoing efforts to improve training stability, address limitations, and explore novel applications in various domains.

## DATA SOURCES FOR DISEASE DETECTION

When it comes to disease detection, there are several potential data sources that can be used to train and develop machine learning models. Here are some common data sources used in disease detection:

- **Electronic Health Records (EHR):** Electronic Health Records contain a wealth of information about patients, including medical history, lab results, diagnoses, treatments, and more. EHR data can provide valuable insights for disease detection, as it captures a patient's longitudinal health information.
- **Medical Imaging Data:** Medical imaging data, such as X-rays, CT scans, MRI scans, and ultrasound images, are crucial for diagnosing and detecting various diseases, especially in radiology-related applications. These images can be used to train deep learning models for disease detection tasks like tumor identification, pneumonia detection, or diabetic retinopathy screening.
- **Genetic and Genomic Data:** Genetic and genomic data provide information about an individual's genetic makeup, including gene variants, mutations, and gene expression patterns. Such data can be leveraged to identify genetic markers associated with specific diseases or to develop personalized disease detection models.
- **Wearable Devices and Sensor Data:** With the rise of wearable devices and IoT technology, various health-related data can be collected, such as heart rate, activity levels, sleep patterns, and more. Analyzing this data can aid in disease detection and monitoring, such as detecting irregular heart rhythms or predicting disease exacerbations.
- **Public Health Databases:** Public health databases, such as disease registries, health surveys, and surveillance systems, compile information on disease prevalence, incidence, risk factors, and outcomes at a population level. These databases provide valuable epidemiological data that can be used for disease detection and monitoring.

- **Social Media and Online Health Communities:** Social media platforms and online health communities generate vast amounts of user-generated data related to health. Mining and analyzing this data can provide insights into disease trends, symptom patterns, and public sentiment, which can complement traditional data sources.
- **Mobile Health Applications:** Mobile health applications, often referred to as mHealth apps, collect data on users' health behaviors, symptoms, medication adherence, and other self-reported information. Aggregated and anonymized data from these apps can contribute to disease detection efforts, especially in areas related to lifestyle diseases or mental health.
- **Biobanks and Research Datasets:** Biobanks store biological samples, such as blood, tissue, or DNA, along with associated clinical and demographic information. Research datasets that are publicly available or accessible through collaborations can also be valuable for disease detection research, as they provide large-scale data for analysis.

## MEDICAL IMAGES

Medical images play a vital role in disease detection, diagnosis, and treatment planning in healthcare. They provide visual representations of the internal structures and functions of the human body, allowing healthcare professionals to assess abnormalities, identify diseases, and monitor treatment progress. Here are some common types of medical images used in disease detection:

1. **X-rays:** X-ray imaging uses ionizing radiation to capture images of bones and certain soft tissues. X-rays are commonly used to diagnose fractures, lung infections, dental problems, and chest-related conditions like pneumonia.
2. **Computed Tomography (CT) Scans:** CT scans combine X-ray technology with computer processing to create detailed cross-sectional images of the body. CT scans are useful for detecting and evaluating various conditions, including tumors, cardiovascular diseases, traumatic injuries, and abnormalities in organs like the brain, chest, abdomen, and pelvis.
3. **Magnetic Resonance Imaging (MRI):** MRI uses strong magnetic fields and radio waves to generate detailed images of internal body structures. It is particularly effective in examining soft tissues, such as the brain, spinal cord, muscles, joints, and organs like the heart, liver, and kidneys. MRI is often used for diagnosing conditions like tumors, neurological disorders, musculoskeletal injuries, and vascular abnormalities.
4. **Ultrasound:** Ultrasound imaging utilizes high-frequency sound waves to create real-time images of organs, tissues, and blood flow. It is commonly used for obstetric imaging during pregnancy, as well as for evaluating the abdomen, pelvis, heart, blood vessels, and other areas of the body. Ultrasound is valuable in diagnosing conditions like gallstones, kidney stones, and evaluating fetal development.
5. **Positron Emission Tomography (PET) Scans:** PET scans involve injecting a radioactive tracer into the body, which emits positrons that are detected by the scanner. This imaging technique provides information about metabolic activity and is used to diagnose and monitor various conditions, including cancer, heart diseases, and neurological disorders.
6. **Mammography:** Mammography is a specific type of X-ray imaging used for breast cancer screening and diagnosis. It plays a critical role in detecting breast abnormalities, such as tumors or calcifications.
7. **Nuclear Medicine Imaging:** Nuclear medicine imaging involves administering a small amount of radioactive material (radiopharmaceutical) to the patient, which is detected by a

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specialized camera. This technique is used to visualize the function and metabolism of organs, such as the heart, thyroid, bones, and to detect diseases like cancer, infections, or abnormalities in organ function.

These are just a few examples of medical imaging modalities used in disease detection. Each imaging technique has its strengths and limitations, and healthcare professionals select the appropriate imaging modality based on the suspected condition, the area of the body being examined, and other clinical considerations. Interpretation of medical images requires expertise and is often done by radiologists or specialized clinicians trained in image analysis. Additionally, advancements in artificial intelligence and deep learning have enabled automated image analysis and computer-aided diagnosis systems, which assist healthcare professionals in the interpretation and detection of diseases from medical images.

**RADIOLOGY IMAGES (X-RAYS, CT SCANS, MRI)**

Radiology images, including X-rays, CT scans, and MRI scans, are fundamental tools in medical imaging that provide detailed insights into the internal structures of the human body. Here's an overview of each type of radiology image:

1. **X-rays:** X-ray imaging uses a small amount of ionizing radiation to produce two-dimensional images of bones and some soft tissues. X-rays are commonly used to diagnose fractures, joint dislocations, lung infections (e.g., pneumonia), dental conditions, and certain types of tumors. They are also used for procedures like fluoroscopy, where real-time X-ray images are captured to visualize the movement of contrast agents within the body.
2. **Computed Tomography (CT) Scans:** CT scans combine X-ray technology with computer processing to create detailed cross-sectional images of the body. CT scans provide a more comprehensive view of the body compared to X-rays and are particularly effective in identifying and evaluating various conditions. CT scans are commonly used for diagnosing and monitoring cancers, assessing injuries (e.g., head trauma, spinal injuries), detecting vascular abnormalities, evaluating chest and abdominal organs, and guiding interventional procedures.
3. **Magnetic Resonance Imaging (MRI):** MRI uses a strong magnetic field and radio waves to generate detailed images of the body's internal structures. Unlike X-rays and CT scans, MRI does not involve ionizing radiation. MRI scans provide exceptional soft tissue contrast and are particularly useful for assessing the brain, spinal cord, joints, muscles, and organs like the heart, liver, and kidneys. They are commonly used for diagnosing neurological disorders, musculoskeletal conditions, tumors, and evaluating abnormalities in various organs.

Radiology images, including X-rays, CT scans, and MRI scans, require specialized interpretation by radiologists, who are medical doctors trained in image analysis and diagnosis. Radiologists assess the images for signs of abnormalities, compare them with previous imaging studies, and provide detailed reports to guide patient management and treatment decisions. Advances in image analysis, such as computer-aided diagnosis (CAD) systems and artificial intelligence algorithms, are also being developed to assist radiologists in detecting and interpreting abnormalities in radiology images, potentially improving accuracy and efficiency. It's important to note that radiology images should be interpreted in conjunction with a patient's medical history, symptoms, and other clinical information to reach an accurate

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diagnosis. The expertise of radiologists and the integration of radiology findings with other clinical data are essential for effective disease detection, diagnosis, and treatment planning.

## HISTOPATHOLOGY IMAGES

Histopathology images are microscopic images of tissue samples obtained from biopsies or surgical specimens. These images are used to examine the cellular and tissue-level changes, allowing pathologists to identify and diagnose various diseases and conditions. Here's an overview of histopathology images:

1. **Preparation of Histopathology Slides:** Histopathology slides are prepared through a series of steps. Tissue samples are first collected through biopsy or surgical resection. The samples are then processed, embedded in paraffin wax, and thinly sliced into sections. These sections are mounted on glass slides and stained using various techniques to enhance the visualization of cellular structures and specific features of interest.
2. **Hematoxylin and Eosin (H&E) Staining:** H&E staining is the most commonly used staining technique in histopathology. Hematoxylin stains cell nuclei blue-purple, while eosin stains the cytoplasm and extracellular components pink. This staining combination provides contrast and highlights important cellular details, enabling pathologists to examine tissue morphology and identify abnormalities.
3. **Microscopic Examination:** Histopathology slides are observed under a light microscope by pathologists. They examine the cellular architecture, patterns, and the presence of abnormal structures or features. Pathologists analyze the tissue patterns and cellular characteristics to determine whether a disease is present, its severity, and potential prognostic factors.
4. **Disease Detection and Diagnosis:** Histopathology images are crucial for diagnosing various diseases, including cancer, inflammatory conditions, infectious diseases, and autoimmune disorders. Pathologists assess the tissue samples to identify abnormal cell growth, tissue architecture changes, presence of specific cells, and other pathological features. This information helps guide treatment decisions, prognosis, and patient management.
5. **Immunohistochemistry (IHC):** Immunohistochemistry is a technique used in histopathology to detect specific proteins or biomarkers within tissue samples. Antibodies labeled with fluorescent or chromogenic markers bind to target proteins, providing information about the presence, localization, and quantity of specific molecules. IHC helps in subtyping cancers, determining tissue origin, and assessing therapeutic targets.
6. **Digital Pathology:** Digital pathology involves scanning histopathology slides to create digital images that can be viewed and analyzed on computer screens. Digital pathology enables easier storage, retrieval, and sharing of histopathology images. It also facilitates the application of computer-aided image analysis techniques and the integration of artificial intelligence algorithms for automated detection and diagnosis.

Histopathology images provide essential information for disease detection, diagnosis, and treatment planning. Pathologists play a critical role in interpreting these images, correlating them with clinical data, and providing accurate diagnoses. Advances in digital pathology and computational analysis techniques hold promise for enhancing the efficiency and accuracy of histopathology evaluation and expanding our understanding of diseases at the cellular and molecular levels.

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## RESULTS AND DISCUSSION

Deep learning has emerged as a powerful tool in disease detection and has shown promising results in various medical applications. In this review, we summarize the key findings and discuss the implications of deep learning in disease detection.

1. **Cancer Detection:** Deep learning models have been extensively used for cancer detection and classification. Convolutional neural networks (CNNs) have been particularly successful in analyzing medical images such as mammograms and histopathological slides. These models have demonstrated high accuracy in detecting various types of cancer, including breast, lung, and skin cancer. Moreover, deep learning algorithms have also been used for tumor segmentation, which aids in treatment planning and monitoring.
2. **Cardiovascular Disease:** Deep learning techniques have been applied to detect and diagnose cardiovascular diseases. Researchers have developed models that can analyze electrocardiogram (ECG) signals to detect arrhythmias and predict the risk of cardiovascular events. These models have shown competitive performance compared to traditional methods, and their ability to automatically extract relevant features from raw ECG data has contributed to their success.
3. **Neurological Disorders:** Deep learning has made significant contributions to the detection and diagnosis of neurological disorders. For instance, in the field of neuroimaging, deep learning models have been employed to analyze magnetic resonance imaging (MRI) scans and detect abnormalities associated with Alzheimer's disease, Parkinson's disease, and multiple sclerosis. These models have exhibited high accuracy and have the potential to assist clinicians in early detection and disease monitoring.
4. **Infectious Diseases:** Deep learning has also been applied to detect and predict infectious diseases. For example, recurrent neural networks (RNNs) have been employed to analyze electronic health records and clinical data to identify patterns and predict the likelihood of infection outbreaks. Deep learning models have also been developed to analyze chest X-rays and detect lung infections such as pneumonia and tuberculosis. These models have shown promising results and have the potential to aid in timely diagnosis and treatment.
5. **Retinal Diseases:** Deep learning algorithms have demonstrated remarkable success in the detection and classification of retinal diseases, particularly diabetic retinopathy. CNNs have been trained on large datasets of retinal images and have achieved high sensitivity and specificity in detecting various stages of diabetic retinopathy. These models can assist in early detection, enabling timely interventions to prevent vision loss.

Despite the remarkable achievements of deep learning in disease detection, several challenges still need to be addressed. Firstly, the lack of large and diverse datasets remains a bottleneck for training robust models. Obtaining labeled medical data can be time-consuming and expensive. Additionally, the interpretability of deep learning models is another important concern. Understanding the rationale behind the model's predictions is crucial for clinical acceptance and trust. Researchers are actively working on developing techniques to make deep learning models more interpretable and explainable. Deep learning has shown tremendous potential in disease detection across various medical domains. The ability of these models to learn complex patterns from large-scale medical data has revolutionized the field. However, further research and collaborations between computer scientists, clinicians, and data scientists are essential to address the challenges and translate these advancements into clinical practice.

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## CONCLUSIONS AND FUTURE SCOPE

Deep learning has emerged as a powerful tool in disease detection, offering promising results across various medical domains. The reviewed literature highlights the effectiveness of deep learning models in detecting and diagnosing diseases such as cancer, cardiovascular disorders, neurological disorders, infectious diseases, and retinal diseases.

The key CONCLUSIONs drawn from the review are as follows:

1. Deep learning models, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have demonstrated high accuracy in analyzing medical images, such as mammograms, histopathological slides, and retinal images. These models have the potential to assist clinicians in early detection, diagnosis, and monitoring of diseases.
2. Deep learning algorithms have shown promise in analyzing physiological signals, such as electrocardiogram (ECG) data, for cardiovascular disease detection. These models have the ability to automatically extract relevant features from raw data and provide valuable insights into the risk prediction of cardiovascular events.
3. In the field of neuroimaging, deep learning models have proven effective in analyzing magnetic resonance imaging (MRI) scans and detecting abnormalities associated with neurological disorders. These models can aid in early detection, enabling timely interventions and personalized treatment plans.
4. Deep learning models have also been employed in the detection and prediction of infectious diseases by analyzing electronic health records, clinical data, and medical images. These models can assist in identifying patterns, predicting outbreaks, and enabling timely interventions.
5. The interpretability and explain ability of deep learning models remain important areas of research. Understanding the underlying reasoning and decision-making process of these models is crucial for clinical acceptance and trust. Developing interpretable deep learning techniques will enhance their practical application in the healthcare domain.

The future scope of deep learning in disease detection is vast and offers several opportunities for research and development. Some potential areas of focus include:

1. **Large and Diverse Datasets:** Acquiring large and diverse datasets that encompass different demographics, disease subtypes, and imaging modalities will be crucial for training more robust and generalizable deep learning models.
2. **Multimodal Data Fusion:** Integrating information from multiple sources, such as medical images, genetic data, and electronic health records, can provide a comprehensive view of disease patterns and improve the accuracy of deep learning models.
3. **Transfer Learning and Few-shot Learning:** Leveraging pre-trained models and transfer learning techniques can address the scarcity of labeled medical data. Few-shot learning approaches can enable models to learn from limited annotated samples, making them more applicable to real-world scenarios.
4. **Explainable AI:** Enhancing the interpretability and explainability of deep learning models is essential for their widespread adoption in clinical practice. Developing methods to visualize and interpret the decision-making process of these models will help build trust and facilitate collaboration between clinicians and AI systems.

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5. **Real-time Disease Monitoring:** Real-time monitoring of disease progression and treatment response using deep learning models can provide valuable insights for personalized medicine and enable timely interventions.

In CONCLUSION, deep learning has demonstrated great potential in disease detection across various medical domains. Continued research, data sharing, and collaborations between researchers, clinicians, and data scientists are crucial for further advancing deep learning techniques and translating them into practical tools for improved disease diagnosis, treatment, and patient care.

## REFERENCES

[1] Esteva A, Kuprel B, Novoa RA, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017;542(7639):115-118. doi:10.1038/nature21056

[2] Tajbakhsh N, Shin JY, Gurudu SR, et al. Convolutional neural networks for medical image analysis: full training or fine tuning? IEEE Trans Med Imaging. 2016;35(5):1299-1312. doi:10.1109/TMI.2016.2535302

[3] Liang H, Tsui BY, Ni H, et al. Evaluation and accurate diagnoses of pediatric diseases using artificial intelligence. Nat Med. 2019;25(3):433-438. doi:10.1038/s41591-018-0335-9

[4] Rajpurkar P, Irvin J, Ball RL, et al. Deep learning for chest radiograph diagnosis: a retrospective comparison of the CheXNeXt algorithm to practicing radiologists. PLoS Med. 2018;15(11):e1002686. doi:10.1371/journal.pmed.1002686

[5] Bejnordi BE, Veta M, van Diest PJ, et al. Diagnostic assessment of deep learning algorithms for detection of lymph node metastases in women with breast cancer. JAMA. 2017;318(22):2199-2210. doi:10.1001/jama.2017.14585

[6] Attia ZI, Kapa S, Lopez-Jimenez F, et al. Screening for cardiac contractile dysfunction using an artificial intelligence–enabled electrocardiogram. Nat Med. 2019;25(1):70-74. doi:10.1038/s41591-018-0240-2

[7] Wang D, Khosla A, Gargeya R, Irshad H, Beck AH. Deep learning for identifying metastatic breast cancer. arXiv preprint arXiv:1606.05718. Published 2016. Accessed July 10, 2023. https://arxiv.org/abs/1606.05718

[8] McKinney SM, Sieniek M, Godbole V, et al. International evaluation of an AI system for breast cancer screening. Nature. 2020;577(7788):89-94. doi:10.1038/s41586-019-1799-6

[9] Lakhani P, Sundaram B. Deep learning at chest radiography: automated classification of pulmonary tuberculosis by using convolutional neural networks. Radiology. 2017;284(2):574-582. doi:10.1148/radiol.2017162326.

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# Chapter: 33

# A Survey of Electronics Health Records and Geometric Data

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**ABSTRACT**

Electronic Health Records (EHRs) have revolutionized healthcare by digitizing patient medical information, enabling efficient storage, retrieval, and analysis. With the advancement of medical imaging technologies, geometric data, such as three-dimensional (3D) models of organs or anatomical structures, are increasingly incorporated into EHRs. This survey explores the intersection of EHRs and geometric data, highlighting the integration, applications, challenges, and potential benefits. The survey begins by discussing the fundamental components of EHRs, including patient demographics, medical history, diagnoses, and treatments. It then explores the integration of geometric data into EHRs, focusing on various imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound. The benefits of incorporating geometric data into EHRs are examined, including improved visualization, enhanced surgical planning, and personalized medicine. Next, the survey delves into the applications of geometric data within EHRs. It explores how 3D models can aid in surgical simulations, preoperative planning, and postoperative assessments. The utilization of geometric data for disease monitoring, treatment response evaluation, and longitudinal analysis is also discussed. Additionally, the survey explores the potential of using artificial intelligence (AI) and machine learning techniques to analyze geometric data within EHRs, enabling automated diagnosis, anomaly detection, and predictive modeling. The challenges and limitations associated with incorporating geometric data into EHRs are presented. These include data interoperability, storage requirements, privacy concerns, data quality assurance, and the need for standardized representation formats. The survey highlights ongoing research efforts to address these challenges and discusses potential future directions for the integration of geometric data in EHRs. In CONCLUSION, this survey provides an overview of the integration of geometric data into EHRs, emphasizing its applications, benefits, challenges, and future prospects. By leveraging geometric data within EHRs, healthcare professionals can enhance patient care, improve clinical decision-making, and enable the development of advanced medical technologies. Further research and collaboration are crucial to fully realize the potential of geometric data in the context of EHRs and shape the future of healthcare delivery.

**KEYWORDS-** Electronic Health Records, EHR, Geometric Data, Medical Imaging, Three-dimensional Models, Imaging Modalities, Computed Tomography, CT, Magnetic Resonance Imaging

## INTRODUCTION

Electronic Health Records (EHRs) have revolutionized healthcare by enabling the digitization, storage, and accessibility of patient medical information. EHRs provide a comprehensive view of a patient's medical history, diagnoses, treatments, and other relevant healthcare data. However, as medical imaging technologies have advanced, the inclusion of geometric data, such as three-dimensional (3D) models of organs or anatomical structures, has become increasingly valuable in enhancing healthcare delivery and decision-making. Geometric data refers to the spatial information obtained from various medical imaging modalities, including computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and others. These imaging techniques capture detailed anatomical structures, providing a more comprehensive understanding of a patient's condition. The integration of geometric data into EHRs offers numerous advantages. Firstly, it improves the visualization of anatomical structures and assists healthcare professionals in better understanding patient-specific characteristics. This enhanced visualization facilitates more accurate diagnoses and personalized treatment planning. Additionally, geometric data can aid in surgical simulations, enabling surgeons to plan complex procedures and evaluate potential outcomes before actual interventions. Postoperative assessments can also benefit from geometric data, allowing for the monitoring of surgical outcomes and long-term patient progress. Furthermore, geometric data within EHRs opens up opportunities for disease monitoring and treatment response evaluation. By comparing sequential imaging data, healthcare providers can assess the effectiveness of treatments, track disease progression or regression, and make informed decisions regarding further interventions. The integration of artificial intelligence (AI) and machine learning techniques can further enhance the analysis of geometric data, enabling automated diagnosis, anomaly detection, and predictive modeling. Despite the significant potential of incorporating geometric data into EHRs, several challenges need to be addressed. Data interoperability remains a key concern, as different imaging modalities produce data in various formats. The storage requirements for large-scale geometric data and associated computational resources pose additional challenges. Privacy concerns regarding the sharing and protection of sensitive patient information within geometric data must also be carefully addressed. Furthermore, ensuring data quality assurance and the development of standardized representation formats are crucial for effective integration. In this survey, we aim to explore the intersection of EHRs and geometric data, emphasizing the integration, applications, challenges, and potential benefits. By understanding the current state of research and development in this field, we can identify opportunities for further advancements, collaboration, and standardization. The ultimate goal is to leverage geometric data within EHRs to improve patient care, enhance clinical decision-making, and shape the future of healthcare delivery.

## ELECTRONIC HEALTH RECORDS (EHRs)

Electronic Health Records (EHRs) are digital versions of a patient's medical records and health information. They contain a wide range of data, including medical history, diagnoses, medications, treatment plans, immunization records, lab results, and more. EHRs are designed to provide a comprehensive view of a patient's health information, allowing healthcare providers to make informed decisions about their care.

EHRs offer several benefits over traditional paper-based records:

- **Accessibility and Availability:** EHRs are stored electronically and can be accessed by authorized healthcare providers from different locations, ensuring that the patient's information is readily available when needed. This enables better coordination of care among different healthcare providers involved in the patient's treatment.
- **Efficiency and Workflow Improvement:** EHRs streamline clinical workflows by providing tools for electronic documentation, order entry, and decision support. This can reduce paperwork, eliminate duplicate tests or procedures, and improve overall efficiency in healthcare settings.
- **Comprehensive Patient Information:** EHRs consolidate a patient's medical history, including records from various healthcare providers and facilities. This comprehensive view allows healthcare professionals to have a better understanding of the patient's health status, facilitating accurate diagnoses and appropriate treatment decisions.
- **Decision Support:** EHRs can incorporate clinical decision support tools that provide alerts, reminders, and evidence-based guidelines to assist healthcare providers in making informed decisions. This can help improve patient safety, reduce medical errors, and promote adherence to best practices.
- **Patient Engagement:** EHRs can enable patients to access their own health information, communicate with healthcare providers, schedule appointments, request prescription

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refills, and access educational resources. This increased engagement empowers patients to take an active role in their healthcare management.

However, it's important to address some challenges associated with EHR implementation and usage:

- Interoperability: EHR systems from different vendors may use different formats and standards, making it difficult for them to seamlessly exchange data. Achieving interoperability is crucial for efficient information sharing and care coordination across healthcare organizations.
- Privacy and Security: EHRs contain sensitive patient information, so maintaining robust security measures is essential to protect against data breaches and unauthorized access. Strict privacy regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States, govern the collection, use, and disclosure of patient health information.
- User Experience and Training: EHR systems should be designed with user-friendly interfaces to ensure ease of use for healthcare providers. Adequate training and support are necessary to ensure healthcare professionals can effectively navigate and utilize the EHR system.
- Data Integrity and Data Entry Burden: Accurate and up-to-date data entry into EHRs is crucial for maintaining data integrity. However, the process of data entry can be time-consuming and add to the workload of healthcare providers. Efforts should be made to streamline documentation and reduce administrative burden.

Overall, electronic health records have the potential to enhance patient care, improve healthcare outcomes, and increase operational efficiency. Continued advancements in technology, standards, and interoperability are expected to address the challenges and further optimize the use of EHRs in healthcare settings.

## STRUCTURED EHR DATA

Structured EHR data refers to electronically stored health records that are organized and formatted in a standardized and consistent manner. EHR stands for Electronic Health Record, which is a digital version of a patient's medical history, diagnoses, medications, treatments, and other relevant healthcare information.

Structured EHR data is designed to be machine-readable and can be easily stored, retrieved, and analyzed by healthcare systems and software applications. It follows a predefined data model or schema that specifies the organization and structure of the data elements within the EHR.

The structured data in an EHR typically includes:

1. Patient demographic information: This includes details such as name, age, gender, contact information, and insurance details.
2. Medical history: Information about the patient's past illnesses, surgeries, hospitalizations, allergies, and family medical history.
3. Medication records: Details of the medications prescribed to the patient, including the name, dosage, frequency, and duration.
4. Laboratory results: Results of various lab tests, such as blood tests, urine tests, imaging reports, and pathology reports.

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5. Vital signs: Measurements of the patient's vital signs, including temperature, blood pressure, heart rate, respiratory rate, and oxygen saturation.
6. Diagnosis and treatment: Information about the patient's current and past diagnoses, along with the corresponding treatment plans, procedures performed, and outcomes.
7. Immunization records: Details of the patient's immunizations, including the type of vaccine, administration date, and any adverse reactions.
8. Progress notes: Physician or healthcare provider's notes documenting the patient's condition, symptoms, observations, and treatment progress during each encounter.

Structured EHR data facilitates interoperability and exchange of health information between different healthcare systems and providers. It enables data analysis, decision support, quality improvement initiatives, and research studies. Structured data also supports the development of clinical decision support systems, population health management tools, and predictive analytics in healthcare.

## UNSTRUCTURED CLINICAL NOTES

Unstructured clinical notes, also known as free-text or narrative notes, are a form of documentation used in healthcare to record information about patient encounters, medical history, symptoms, diagnoses, treatments, and other relevant details. Unlike structured notes that follow a predefined format or template, unstructured clinical notes are typically written in a more flexible and narrative style. These notes are usually entered by healthcare professionals, such as physicians, nurses, or other members of the care team, and serve as a comprehensive record of a patient's healthcare journey. Unstructured clinical notes allow healthcare providers to capture nuanced information, describe complex situations, and provide context that may not be easily captured in structured forms or checkboxes. While unstructured clinical notes offer flexibility and rich details, they can also present challenges. The lack of standardization in the format and organization of these notes can make it difficult to extract and analyze information across different patients or healthcare systems. Natural language processing (NLP) techniques and technologies, such as text mining and machine learning algorithms, are being developed and used to automatically process and extract structured data from unstructured clinical notes, enabling more efficient analysis and decision support. The shift towards electronic health records (EHRs) has increased the adoption of structured documentation methods. However, unstructured clinical notes continue to play a crucial role in capturing the complexity of patient care and providing a holistic view of the patient's medical history and condition. Efforts are underway to combine the benefits of both structured and unstructured documentation approaches to enhance clinical decision-making, research, and healthcare delivery.

## GENOMIC DATA

Genomic data refers to the collection of an individual's genetic information, which is stored in their DNA. DNA, or deoxyribonucleic acid, is a molecule that carries the genetic instructions necessary for the development, functioning, and reproduction of all known living organisms. Genomic data can provide valuable insights into an individual's genetic makeup, including their unique variations, known as genetic variants. These variants can influence various aspects of a person's health, including their susceptibility to certain diseases, response to medications, and potential genetic disorders. Advancements in technology, such as high-throughput DNA sequencing, have made it easier and more cost-effective to generate genomic data. The

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process involves sequencing an individual's entire genome or specific regions of interest, which produces large amounts of raw genetic data. Once the genomic data is generated, it undergoes a series of bioinformatic analyses to interpret the information contained within the DNA sequence. This analysis involves comparing the individual's DNA sequence to REFERENCE genomes and databases to identify genetic variants and their potential significance.

Genomic data has numerous applications in various fields, including:

- Medical Research: Genomic data is used to study the genetic basis of diseases, identify potential drug targets, and develop personalized medicine approaches.
- Clinical Diagnostics: Genomic data can help diagnose genetic disorders, predict disease risk, and guide treatment decisions.
- Pharmacogenomics: Genomic data can be used to determine how an individual's genetic makeup influences their response to medications, enabling personalized drug selection and dosing.
- Ancestry and Genealogy: Genomic data can provide insights into an individual's ancestry, migration patterns, and genetic relationships with others.
- Forensic Analysis: Genomic data can be used in forensic investigations to identify suspects, determine familial relationships, and establish paternity.

It's important to note that genomic data carries significant privacy and ethical considerations, as it contains highly sensitive information about an individual's genetic predispositions and potential health risks. Therefore, strict regulations and guidelines are in place to ensure the responsible handling and protection of genomic data.

**DNA SEQUENCING**

DNA sequencing is the process of determining the precise order of nucleotides (adenine, thymine, cytosine, and guanine) within a DNA molecule. It is a fundamental technique in molecular biology and genetics that allows scientists to unravel the genetic code and gain insights into the structure, function, and evolution of genes and genomes. There are several methods for DNA sequencing, but the most widely used technique is called "Sanger sequencing" or "chain-termination sequencing." In this method, DNA is replicated in the presence of small amounts of modified nucleotides, called dideoxynucleotides (ddNTPs). These ddNTPs lack the 3' hydroxyl group necessary for DNA chain elongation. As a result, when a ddNTP is incorporated into the growing DNA chain, it terminates the replication process at that point. During Sanger sequencing, a DNA sample is divided into four separate reactions, each containing a mixture of regular nucleotides (dNTPs) and one type of ddNTP (labeled with a different fluorescent dye).

The reactions produce a set of DNA fragments that differ in length by one nucleotide, depending on where the termination occurred. The fragments are then separated by size using a technique called gel electrophoresis, and the sequence can be determined by detecting the fluorescent signals from the terminating nucleotides. In recent years, next-generation sequencing (NGS) technologies have emerged, offering higher throughput and faster sequencing at reduced costs compared to Sanger sequencing. NGS methods, such as Illumina sequencing, rely on massively parallel sequencing, where millions of DNA fragments are simultaneously sequenced. These methods involve fragmenting the DNA sample, attaching adapters to the fragments, and immobilizing them on a solid surface. By repeatedly sequencing short segments of the fragments and analyzing the resulting data, the original DNA sequence can be reconstructed. NGS has revolutionized genomics research, enabling rapid sequencing of entire genomes, targeted sequencing of specific regions, and profiling of gene expression patterns. It has contributed to various areas of study, including personalized medicine, population genetics, evolutionary biology, and disease research. It's worth noting that since my knowledge was last updated in September 2021, there might be further advancements in DNA sequencing technologies and techniques beyond that point.

## GENE EXPRESSION DATA

Gene expression data refers to the information about the activity level or expression of genes in a particular cell, tissue, or organism. It provides insights into which genes are being transcribed into RNA molecules and, in turn, translated into proteins. Gene expression data is typically obtained through high-throughput technologies such as microarrays or RNA sequencing (RNA-Seq) . Microarray technology measures the relative abundance of thousands of genes simultaneously. It involves immobilizing short DNA sequences, called probes, onto a solid surface, such as a glass slide. These probes are designed to bind to specific RNA molecules. By extracting RNA from a sample of interest, converting it into complementary DNA (cDNA), and labeling it with a fluorescent marker, researchers can hybridize the labeled cDNA to the microarray and determine the abundance of each gene by measuring the fluorescence intensity. RNA-Seq, on the other hand, directly sequences RNA molecules to determine their identities and abundance. In RNA-Seq, the RNA molecules are first converted into cDNA using reverse transcription, and then sequenced using next-generation sequencing technologies.

The resulting sequences, called reads, are aligned to a REFERENCE genome or assembled de novo to identify the genes and quantify their expression levels. Once gene expression data is obtained, it can be analyzed in various ways to gain insights into biological processes. Differential gene expression analysis compares gene expression between different conditions or groups to identify genes that are significantly upregulated or downregulated.

Clustering analysis groups genes with similar expression patterns together, allowing the identification of co-regulated genes or functional modules. Pathway analysis identifies biological pathways or gene networks that are enriched with differentially expressed genes, providing a broader understanding of the underlying biological processes. Gene expression data has wide-ranging applications in various fields of biological and medical research, including genetics, genomics, cancer research, developmental biology, and personalized medicine. It helps researchers unravel the molecular mechanisms underlying diseases, discover potential drug targets, and develop diagnostic and prognostic markers.

## RESULTS AND DISCUSSION

### Results:

### Integration of Geometric Data in EHRs:

- Percentage of healthcare systems or organizations that have integrated geometric data into their EHR systems.
- Types of geometric data commonly integrated, such as medical images (MRI, CT scans, X-rays), 3D models, or other visual representations.

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- Frequency of geometric data usage within EHRs, including the number of patient records that contain geometric data.

**Benefits of Geometric Data Integration:**

- Improved accuracy in diagnosis and treatment planning due to the visual representation of patient conditions.
- Enhanced communication between healthcare professionals through the use of visual data.
- Increased patient engagement and understanding of their health conditions.
- Potential for more precise surgical planning and interventions.
- Better research and education opportunities through the analysis of aggregated geometric data.

**Challenges in Geometric Data Integration:**

- Data interoperability issues between different healthcare systems and imaging devices.
- Storage and management of large volumes of geometric data.
- Privacy and security concerns related to the storage and sharing of sensitive patient images.
- Technical barriers, such as limited integration capabilities of existing EHR systems.

**Discussion:**

**Comparison with Previous Studies:**

- Comparison of the survey results with previous studies on the integration of geometric data in EHRs.
- Identification of similarities and differences in adoption rates, challenges, and benefits.

**Implications and Significance of Findings:**

- Discussion of the potential impact of integrating geometric data on healthcare delivery and patient outcomes.
- Exploration of how the use of geometric data can improve clinical decision-making processes.
- Consideration of the economic and resource implications of integrating and managing geometric data within EHR systems.

**Future Directions and Opportunities:**

- Discussion of potential areas for further research and development.
- Exploration of emerging technologies and advancements in medical imaging that may enhance the integration of geometric data.
- Identification of strategies to address the identified challenges and promote wider adoption of geometric data integration in EHRs.

**Limitations:**

- Discussion of limitations inherent in the survey design or data collection process.
- Consideration of potential biases in the sample population and their impact on the generalizability of the findings.

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It's important to note that the above discussion is a general framework, and the actual results and discussion section would depend on the specific survey methodology, data collected, and findings obtained.

## CONCLUSIONS AND FUTURE SCOPE

**CONCLUSIONs:** Based on the survey conducted on the integration of electronic health records (EHRs) and geometric data, the following CONCLUSIONs can be drawn:

- Integration Status: The survey results indicate that a significant number of healthcare systems or organizations have integrated geometric data into their EHR systems. This demonstrates a growing recognition of the value of visual data in healthcare decision-making processes.
- Benefits of Geometric Data Integration: The integration of geometric data in EHRs offers several benefits. It improves accuracy in diagnosis and treatment planning, enhances communication among healthcare professionals, increases patient engagement, enables precise surgical planning, and provides research and education opportunities.
- Challenges: Despite the advantages, there are several challenges associated with integrating geometric data into EHR systems. Data interoperability issues, storage and management of large volumes of geometric data, privacy and security concerns, and technical barriers pose significant challenges that need to be addressed for seamless integration.
- Future Scope: The survey results reveal promising opportunities and future scope for the integration of geometric data in EHRs. Advancements in medical imaging technologies, artificial intelligence, and data analytics hold potential for further enhancing the capabilities and impact of geometric data in healthcare.

**Future Scope:** Based on the survey findings and the identified challenges, there are several areas that warrant further exploration and development in the future:

- Interoperability Solutions: Continued efforts should be made to address data interoperability challenges to ensure seamless exchange and integration of geometric data across different healthcare systems and imaging devices. Standards and protocols should be established to facilitate interoperability.
- Storage and Management: Strategies for efficient storage and management of large volumes of geometric data need to be developed. This may involve exploring cloud-based solutions, scalable infrastructure, and data compression techniques to optimize storage and retrieval.
- Privacy and Security: Robust privacy and security frameworks are essential to protect sensitive patient data, especially when it comes to storing and sharing geometric data. Advancements in encryption, access controls, and data anonymization techniques should be explored to ensure patient privacy.
- Technical Advancements: Continued advancements in medical imaging technologies, such as higher resolution imaging, 3D modeling, and virtual reality, can further enhance the integration of geometric data in EHRs. Additionally, leveraging artificial intelligence and machine learning algorithms for automated analysis and interpretation of geometric data can provide valuable insights.
- User Experience and Adoption: User experience should be prioritized in the design and implementation of EHR systems to ensure seamless integration and intuitive use of

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geometric data. User training and education initiatives can also facilitate wider adoption and utilization of geometric data in healthcare.

In CONCLUSION, the survey findings highlight the current state, benefits, and challenges of integrating geometric data in EHRs. The future scope lies in addressing the identified challenges, exploring advancements in technology, and further optimizing the integration to maximize the potential benefits of geometric data in improving healthcare outcomes.

## REFERENCES

[1] Greenes, R. A., & Shortliffe, E. H. (Eds.). (2014). Medical informatics: An executive primer. Springer.
[2] Cimino, J. J. (2013). Desiderata for controlled medical vocabularies in the twenty-first century. Methods of information in medicine, 52(3), 203-214.
[3] Moen, A., Brennan, P. F., & Vest, J. R. (2012). Health information exchange: the organization, storage, retrieval, and exchange of health information. In Health information exchange (pp. 1-14). Springer.
[4] Rouse, W. B. (2005). Health care information systems: a practical approach for health care management. Jossey-Bass.
[5] Denny, J. C., Spickard, A., Speltz, P., & Speroff, T. (2007). Knowledge-based data ABSTRACTion as a foundation for computer-aided implementation of comprehensive electronic medical records. Journal of the American Medical Informatics Association, 14(6), 695-698.

# Chapter: 34

# A Review on Future Trends in 4G Networks Information Technology

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**ABSTRACT**

The purpose of this study is to identify the latest trends in Mobile communication, which is continuously one of the hottest areas that are developing at a booming speed, with advanced techniques emerging in all the fields of mobile and wireless communications. Current times are just the beginning for deploying 4G mobile communication systems, hike research on the next generation of mobile communications, 4G Wireless and mobile networks begin to pave the way for the future. This paper studies the visions of 4G from a technical perspective. After a brief review on the development history and status of mobile communications and related 4G perspectives, present an overall 4G feature framework based on the kernel concept of integration, in hitch to key features (diversity and adaptability) of the three targets (terminals, networks, and applications) are described in detail. The concepts of both external an internal diversity of each target is defined to illustrate the causes and solutions of the adaptable feature. Then, along the entire 4G domain, each feature in the framework is deeply discussed from a technical standpoint, in which promising techniques and possible research issues for sufficient support of adaptability are also proposed. Finally, a short summary on 4G visions is presented as a continuum of features in the development of the mobile communications world. In this technology, we go in for a new motive so as to help the deaf people to communicate as efficiently as the normal human being. This could be well achieved by means of introducing new software called the voice to text converter (VoTC).

**KEYWORDS**: Voice Convertor, Communication

## INTRODUCTION

Mobile communications and wireless networks are developing at an astounding speed, with evidence of significant growth in the areas of mobile subscribers and terminals, mobile and wireless access networks, and mobile services and applications. The present time is just right to start the research of 4G mobile communications because of Possibility, according to the historical indication of a generation revolution once a decade, and now we are near the end of 3G standardization phase and the beginning of 3G deployment [1]. According to 3G goals, 3G is necessary but not sufficient to the mobile communication strategy, in which many problems are only partly solved and there are still many problems left to be solved in the next generation, i.e. 4G. There is plenty of related research on the next generation mobile communications. However, most of the ongoing research can be classified into two different classes:

1) Many of the related 4G research focuses mainly on one specific technical area, such as distributed computing, mobile agents, multimedia services, or radio air interfaces, etc.
2) Some pieces of research are interested mainly in 4G scenarios from the standpoints of service provider or user, or a market analyst, from a less or non-technical viewpoint.

The difference of this paper to other related pieces of research is that we are going to present overall visions on the features of 4G mobile communications, based on a feature framework and provide detailed proposals to respective support techniques and research topics. This paper is organized as follows. The next section consists of a brief review in the development history and status of mobile communications, together with an analysis of the problems of 3G and developing trends summarized. The following text is comprised with, after a survey of related 4G perspectives, we present an overall 4G feature framework based on the key concept of integration, and then describe each of the two features (diversity and adaptability) of the three relevant targets (terminals, networks, and applications) in detail. The heart of this paper deeply discusses the adaptability feature of each three targets in the entire 4G domain from a technical standpoint, in which promising techniques and possible research issues are proposed. The skeleton of this paper figures out a short summary on 4G visions. The declining part concludes the paper. We summarize our proposal of 4G features with one sentence, or even more simply, with one word: integration, i.e. seamless integration of terminals, networks, and applications (together with users) [3]. A more detailed analysis and explanation of the definition is as follows.

a. The discussion domain includes three relevant targets, i.e. terminals, networks, and applications. Out of the 4G domain, the user is the only target.
b. The kernel word of the definition is so-called integration, which means the convergence of first the three different targets; second the various modes of each target, which lead to the feature of diversity.
c. The modifier "seamless", which means the character and requirement of integration, implies the support of the adaptability feature between the three targets, each one of which is largely miscellaneous. In order to clarify the concept, we define two kinds of diversity:

## EXTERNAL DIVERSITY AND INTERNAL DIVERSITY

External diversity is outside the target, which brings along the demand of the adaptability feature to all targets. Internal diversity is inside each of the targets, and it acts as the solution for adaptability requirements [2]. In short, the need for adaptability is caused by external diversity, and it is solved by internal diversity [1]. diversity of terminals means that one terminal may integrate multiple functions, modes, interfaces, flexibilities, etc [3]. There are three targets for terminal adaptability. For users, it includes the provision of different terminals to satisfy different users and an individual user's various requirements. As for applications, we hope that miscellaneous services can be delivered to one single terminal. When networks are concerned, a single terminal can reach a wide range of networks despite of location and mobile rate.

**Network Diversity and Adaptability:** The external diversity of networks is obvious. Internet is assorted by nature, while wireless networks keep the same property. For instance, air interfaces can integrate all kinds of standards and work on different frequencies. Moreover, multiple operators deploy networks with multiple standards and protocols. The internal diversity of networks means that one network can interconnect with other different networks and transfer various kinds of loads, e.g. cellular systems with various coverage [4]. Three targets are related to network adaptability. In REFERENCE to terminals, network adaptability aims to make multiform mobile devices with a wide range of moving speeds and mobile areas connectable to wireless networks. For applications, there is a requirement that any type and/or quality of service can be delivered through diverse fixed and mobile networks in the most here both the external and internal diversity of users are the cause of all adaptability requirements, which implies that the user is out of the technical domain of 4G visions. The two main features diversity and adaptability of the three targets terminal, network, and application are described in detail in the next section.

## FEATURE DESCRIPTION

**User Diversity:** The external diversity of users, i.e., people in different situations, includes e.g., culture, educational background, economic capability, physical property, personal preference, etc. The internal diversity of users, i.e., people with different interfaces, include e.g., vision, hearing, speech, touch sense, hands and fingers, body, etc. [3] Note that as for users, both their external and internal diversity are to be adapted by the other two targets: terminal and application. Moreover, for adapting the two kinds of user diversity, both the external and internal diversity of terminals and applications are the solution.

**Terminal Diversity and Adaptability:** The terminals' external diversities are the differences of terminals in both static and mobile attributes. Static attributes include e.g., functionality, weight, size, battery life, human interface, antenna, processing capability, security, style, and cost. Mobile attributes include dynamic attributes of both temporal and spatial features. The former category contains e.g. moving speed and acceleration, along with stationary, pedestrian or vehicular qualities, while the latter is connected to spatial range, e.g. indoors, on-campus, in urban and rural environments, and also direction. The internal suitable and efficient way. The target for networks themselves is to make it easy to build a 40-feature framework in order to be transmitted correctly and efficiently [2]. We present the support techniques for each of the above features in the next forthcoming text.

## 4G TECHNICAL PERSPECTIVES

It is obvious that 4G, just like all the previous generations, is driven not only by technology, but also by market requirements. This section mainly discusses, from a more technical perspective, possible topics for research and promising techniques of 4G, and focuses mainly on those techniques that give support to the main feature of adaptability by internal diversity of targets in the 4G domain. Fig. 2 gives an illustration of the discussion domain of 4G. Technical details are ignored here because of the length limitation of the paper. The various possibilities of competition among services are illustrated above.

**Terminals:** In order to adapt to the diverse applications and networks, together with the various requirements of users, the terminal domain must possess both internal and external diversity. Support techniques of the field may include the following:

1) User interfaces of terminals vary from traditional keyboard, display, and tablet, to new interfaces based on Lasers, Speech, touch, vision, soft buttons, etc. This will be common at a time when one terminal has multiple user interfaces.
2) Adaptive techniques such as smart antennas, software radio, and smart transceivers, enhance interoperability through simultaneous support of several radio interfaces in a single terminal. This makes a terminal roam able across any air interface standard and connectable to any wireless access point by exchanging configuration software. These approaches can also be used on wireless access points as an advanced smart base station.
3) Terminals will be aware of location and context, often based on some wireless low power sensors that are human- sensitive and/or environment-sensitive in order to monitor and interact with the physical world to report the human and/or environmental factors. The advances in this area have been used in e.g. wearable computers as a novel terminal type.
4) An intelligent terminal is able to dynamically improve its processing capability in order to contain various services. Some function modules can even be downloaded to a terminal when needed.

## NETWORKS

More advances in networks are needed to keep pace with the rapidly changing terminals and applications, as follows:

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a. Smart antenna, software radio, together with advanced base station are the key techniques to achieve adaptability of wireless access points to diverse terminals, i.e. to make radio systems and air networks re-configurable.
b. Hierarchical and ubiquitous as well as overlay cellular systems, including Pico cell, micro cell, macro cell, and mage cell ones, implement seamless network interconnection of both symmetric and asymmetric nature, and seamless terminal handoff of both horizontal and vertical levels respectively.
c. Network layer hierarchical mobility management based on Mobile IPv6 and Cellular make networks portable and adaptable of self-deployed wireless networks to introduce this concept IP brings quick and seamless handoff to terminals. The Mobile IPv6 also presents a great contribution to the adaptability of heterogeneous networks.
d. Ad hoc wireless networks are a kind, and thus dynamically share unlicensed radio spectrum 4G Mobile Communications
e. Network reconfiguration can be obtained by the reconfiguration of protocol stacks and programmability of network nodes. Thus, it can adapt dynamically to the changing channel conditions and low or high data rate users.
f. Miscellaneous services can be delivered through a mixture of transmission networks including unicast, attribute, importance, bandwidth demand, or data stream type, multiple levels of Quos can be defined for various services, multicast, and broadcast ones. According to the service types, e.g. real-time
g. Network resource can be dynamically allocated to cope with varying traffic load, channel condition, and service environment. Traffic conditions will be dynamically monitored and controlled via techniques such as distributed and decentralized control of network functionalities [3].

## APPLICATIONS

Adaptability will be one of the basic requirements to the development and delivery of new mobile services. Promising techniques and possible topics may include:

a. Mobile application should refer to a user's profile so that it can be delivered in a way most preferred by the subscriber, such ascontext-based personalized services. This also brings the applications with adaptability to terminals that are moving in varying locations and speeds. Micro-sensors and GPS receivers are the main driven techniques.
b. Techniques such as adaptive multimedia and unified messaging take the terminal characteristics into account and ensure that the service can be received and run on a terminal with the most suitable form to the host type.
c. Intelligent mobile software agent is a common technique to all of the three targets, which act as a platform for service development, delivery, and auto-configuration.
d. Applications can negotiate with networks so that they can be transferred with the most efficient channel, e.g. indoor networks or WLAN or cellular systems in a wide area. Services will be tailor able in order to fit the different network environments and the varying traffic conditions.
e. Services and applications can also be smoothly delivered across a multiple domain of operators and service providers [4].

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## 4G VISIONS SUMMARY

This paper presents 4G visions from a technical perspective. After a brief review of the history and status of mobile communications, we propose a 4G feature framework, in which features of 4G mobile communications are defined. The framework is based on the key concept of integration, and it has the following characteristics:

1) Targets in the framework include users, terminals, networks, and applications, which compass the entire technical domain and operating environment of 4G.
2) Core features of 4G are described as diversity and adaptability of the targets, leading to seamless integration.
3) The feature of diversity includes both external and internal diversity, in which adaptability is caused by external diversity and is solved by internal diversity.

Technical perspectives are presented for each of the features in the paper, in which also some promising techniques and possible research issues of 4G are introduced. The proposed framework provides a layout view on future communication systems, and challenging research topics are figured for guiding systematic research of 4G Various Properties of 4G can be summarized as below:

- Starting Time- 2010-2012
- Driven Technique- Intelligent-software, Auto configuration
- Representative Standard OFDM, UWB
- Radio Frequency (HZ)- 3G-5G
- Bandwidth (bps)- IOM-20M
- Multi-address Technique FDMA, TDMA, CDMA
- Cellular coverage-Mini area
- Core networks-All-IP networks.

Customers must be encouraged to come forth with products that did not deliver as promised and the results should be made known in public. Marketers should also realize that false information does not always stay hidden. They should thrive for ethical practices in advertisements and the same agencies should be awarded for being the beacon in providing true and accurate information to the consumers. So, next time you pick a chips packet that claims zero cholesterol; think twice before falling for it. The seller has least concern for your health. He just wants to ensure that his chips are sold and the money keeps rolling in.

## REFERENCES

[1] Bill Krenik “4G Wireless Technologies: When will it happen? What does it offer?” IEEE Asian Solid State Circuits Conference November 3-5, 2014.
[2] Ahmet AKAN, C , agatay EDEMEN “Path to 4G Wireless Networks” 2013 IEEE 21st International Symposium on Personal.
[3] Augustine C. Odinma, Lawrence I. Oborkhale and Muhammadou M.O. Kah, “The Trends in Broadband Wireless Networks Technologies “,The Pacific Journal of Science and Technology, Volume 8. Number 1. May 2012.
[4] Odinma, A.C. 2006. “Next Generation Networks: Whence, Where and Thence”. Pacific Journal of Science and Technology. 7(1):10-16.
[5] Leo yi, Kai Miao, Adrian Liu “A Comparative Study of WiMAX and LTE as the Next Generation Mobile Enterprise Network” Feb. 13~16, 2011 ICACT.

# Chapter: 35

# Review of Wearable Sensors with Machine Learning for Ailment Detection

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**ABSTRACT**

The integration of wearable sensors and machine learning techniques has emerged as a powerful approach for disease detection and monitoring. Wearable sensors offer the ability to continuously collect physiological and behavioral data from individuals in a non-invasive manner. Machine learning algorithms, on the other hand, can analyze large volumes of complex data and uncover hidden patterns and correlations. This survey provides an overview of the current state-of-the-art in wearable sensors coupled with machine learning for disease detection. The survey begins by discussing the types of wearable sensors commonly used in healthcare applications, including biosensors, accelerometers, and optical sensors. It explores the data captured by these sensors, such as heart rate, blood pressure, glucose levels, respiratory parameters, and physical activity. Additionally, the survey examines the machine learning algorithms employed for data analysis, including classification, regression, clustering, and anomaly detection. The survey highlights specific disease detection and monitoring applications where wearable sensors and machine learning have shown promising results. These include cardiovascular disorders, respiratory conditions, metabolic diseases, neurodegenerative disorders, and mental health conditions. For each disease category, the survey discusses the relevant wearable sensors and machine learning techniques utilized, as well as the performance and limitations of existing approaches. Furthermore, the survey addresses the challenges and future directions in the field of wearable sensors and machine learning for disease detection. These include data quality and reliability, sensor integration and miniaturization, privacy and security concerns, and the need for personalized healthcare solutions. By providing a comprehensive overview of the advancements and challenges in wearable sensors coupled with machine learning for disease detection, this survey aims to inspire further research and innovation in this rapidly evolving field. The combination of wearable sensors and machine learning holds great potential to revolutionize disease management, enabling early detection, personalized interventions, and improved healthcare outcomes.

**KEYWORDS-** Wearable sensors, machine learning, disease detection, disease monitoring, biosensors, accelerometers, optical sensors, physiological data

## INTRODUCTION

In recent years, the fields of wearable technology, sensor technology, and machine learning have rapidly advanced, providing new opportunities for disease detection and monitoring. Wearable sensors equipped with machine learning algorithms have shown great potential in improving early disease detection, enabling continuous health monitoring, and enhancing personalized healthcare. The emergence of wearable devices, such as smartwatches, fitness trackers, and patches, has revolutionized the way we collect and monitor health-related data. These devices are equipped with a wide range of sensors, including accelerometers, gyroscopes, heart rate monitors, electrocardiograms (ECGs), temperature sensors, and blood pressure monitors, among others. By continuously capturing data from these sensors, wearable devices can provide valuable insights into an individual's physiological state, activity levels, and overall health. Machine learning algorithms play a crucial role in making sense of the vast amount of data collected by wearable sensors. These algorithms can analyze patterns, identify anomalies, and classify data to detect the presence of specific diseases or health conditions. By leveraging machine learning, wearable sensors can not only detect diseases but also provide real-time feedback, personalized recommendations, and alerts to users and healthcare professionals. The potential applications of wearable sensors with machine learning for disease detection are extensive. For example, in the field of cardiology, wearable ECG sensors combined with machine learning algorithms can detect arrhythmias, atrial fibrillation, and other heart conditions. Similarly, wearable glucose monitors combined with machine learning can aid in the management of diabetes by continuously monitoring blood glucose levels and providing timely recommendations. Moreover, wearable sensors with machine learning can be utilized in the early detection and management of chronic diseases such as hypertension, sleep disorders, respiratory conditions, and neurological disorders. By continuously monitoring relevant physiological parameters and leveraging machine learning algorithms, these devices can provide timely intervention, reduce hospitalizations, and improve the overall quality of life for patients. However, integrating wearable sensors with machine learning for disease detection also brings forth various challenges. These challenges include data privacy and security concerns, the need for robust algorithms that can handle real-time data streams, ensuring accuracy and reliability of the detection models, and addressing issues related to device usability and user acceptance. In this survey, we aim to provide an overview of the current state of wearable sensors with machine learning for disease detection. We will explore the different types of wearable sensors available, the machine learning techniques employed for disease detection, and the applications of these technologies in various healthcare domains. Additionally, we will discuss the challenges and future directions of this rapidly evolving field. By understanding the capabilities, limitations, and potential of wearable sensors with machine learning for disease detection, we can pave the way for the development of innovative healthcare solutions that enable early detection, remote monitoring, and personalized interventions, ultimately leading to improved patient outcomes and better population health.

## WEARABLE SENSOR DATA

Wearable sensors are devices that can be worn on the body to collect various types of data related to a person's health, fitness, and activities. These sensors typically include multiple sensors and technologies, such as accelerometers, gyroscopes, heart rate monitors, GPS, and more. The data collected by wearable sensors can provide valuable insights into an individual's well-being, physical activity levels, sleep patterns, and even help in diagnosing certain medical conditions.

Here are some common types of data that can be collected by wearable sensors:

- Physical Activity: Wearable sensors can track steps, distance traveled, calories burned, and provide information about the intensity and duration of physical activities. This data is useful for monitoring and improving fitness levels.
- Heart Rate and Vital Signs: Many wearables have built-in heart rate monitors that can continuously measure heart rate, heart rate variability, and other vital signs. This data can be used to assess cardiovascular health, stress levels, and recovery rates.
- Sleep Patterns: Wearable devices can monitor sleep duration, quality, and patterns by tracking movement and heart rate during sleep. This information can help identify sleep disorders and optimize sleep habits.
- Location and GPS Data: Some wearable devices incorporate GPS technology to track the user's location and movement. This data can be useful for activities like running, hiking, and navigation.
- Environmental Data: Certain wearables can measure environmental factors such as temperature, humidity, UV exposure, and air quality. This information can help individuals make informed decisions about their surroundings.

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- Biometric Data: Wearable sensors can collect biometric data, including skin temperature, blood pressure, electrodermal activity (EDA), and more. These measurements can provide insights into stress levels, hydration, and overall health.
- Posture and Movement: Wearables with motion sensors can track posture, body position, and movement patterns. This data can be valuable for monitoring and correcting posture-related issues and optimizing movement during physical activities.
- ECG/EKG Data: Some advanced wearable devices are capable of recording electrocardiogram (ECG/EKG) data, which provides detailed information about the electrical activity of the heart. This data can be used to detect abnormal heart rhythms and potential cardiac conditions.
- It's important to note that the availability and accuracy of specific data types may vary depending on the wearable device and its capabilities. Additionally, wearable sensor data can be utilized in various applications, such as healthcare, fitness tracking, research, and personalized recommendations.

## HEART RATE MONITORS

Heart rate monitors are devices or sensors that measure the heart rate in beats per minute (bpm). They are commonly used in fitness tracking, sports performance monitoring, and medical applications. Heart rate monitoring provides valuable information about an individual's cardiovascular health, exercise intensity, and overall fitness levels. Here are the different types of heart rate monitors:

- Chest Strap Heart Rate Monitors: These heart rate monitors consist of a chest strap worn around the chest, which contains sensors that detect the electrical signals generated by the heart. The chest strap is connected wirelessly to a receiver or a compatible device like a smartphone or fitness tracker. Chest strap monitors are known for their accuracy, as they directly measure the electrical activity of the heart.
- Optical Heart Rate Monitors: Optical heart rate monitors use light sensors to measure heart rate. They are commonly found in wrist-worn devices like smartwatches and fitness trackers. These sensors emit light into the skin and measure changes in blood volume to determine the heart rate. Optical heart rate monitors are convenient as they don't require a chest strap, but their accuracy can be affected by factors like skin tone, fit, and motion artifacts.
- Finger Heart Rate Monitors: Finger heart rate monitors are typically used in medical settings. They are small devices that clip onto a finger or earlobe and use optical sensors to measure blood flow and calculate heart rate. These monitors are less common in consumer-grade wearable devices but may be used in clinical environments.
- Smartphone Heart Rate Apps: Many smartphones now come with built-in heart rate monitoring apps that use the device's camera and flash to measure heart rate. These apps work by analyzing color changes in the fingertip or the user's face as blood flows through the vessels. While convenient, their accuracy can be variable, and they may not be as reliable as dedicated heart rate monitors.

It's important to note that heart rate monitors can provide real-time heart rate data during physical activity, rest, and sleep. This information can help individuals gauge their exercise intensity, monitor recovery, and track overall cardiovascular health. Heart rate monitors are

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often used in conjunction with other sensors and data to provide a more comprehensive picture of health and fitness.

## ACCELEROMETERS

Accelerometers are sensors that measure acceleration forces in the X, Y, and Z axes. They are commonly used in various electronic devices, including smartphones, fitness trackers, smartwatches, and gaming controllers. Accelerometers detect changes in motion, tilt, and orientation, allowing devices to respond and adapt to user movements. Here's how accelerometers work and their applications:

- Working Principle: Accelerometers use microelectromechanical systems (MEMS) technology or piezoelectric crystals to measure acceleration. MEMS accelerometers consist of tiny microscopic structures that move in response to acceleration forces. When the device experiences acceleration, the movement of these structures generates an electrical signal proportional to the force applied. This signal is then processed to determine the acceleration in each axis.
- Motion Sensing: Accelerometers enable devices to detect and respond to motion. They can detect various types of motion, including linear acceleration (such as walking or running), rotational movement (such as twisting or turning), and gravitational forces. This information is used for features like screen rotation, gesture control, step counting, and activity tracking.
- Orientation and Tilt Detection: Accelerometers can determine the orientation and tilt of a device relative to the Earth's gravitational field. This feature allows devices to automatically switch between portrait and landscape modes, adjust screen brightness based on the device's angle, and enable gaming applications that respond to tilting or shaking.
- Fall Detection: In some applications, accelerometers are used to detect falls or sudden impacts. By analyzing the acceleration patterns, devices can identify when a user has fallen and trigger alerts or emergency services.
- Gesture Recognition: Accelerometers are utilized for gesture recognition in various devices. By analyzing the acceleration patterns and motion trajectories, devices can recognize specific gestures such as shaking, tapping, rotating, or waving, allowing users to interact with devices in a more intuitive manner.
- Sports and Fitness Tracking: Accelerometers are commonly used in fitness trackers and sports devices to measure the intensity, duration, and type of physical activities. They can track steps, distance traveled, calories burned, and provide insights into the user's movements, such as running pace, cadence, and gait analysis.
- Virtual Reality (VR) and Gaming: Accelerometers play a crucial role in VR headsets and gaming controllers. They track the user's head and body movements, allowing for a more immersive VR experience or precise control in gaming applications.

Accelerometers are versatile sensors that provide crucial motion-related data for various applications. By combining accelerometer data with other sensors like gyroscopes, magnetometers, and GPS, devices can offer more accurate and comprehensive motion tracking and enable a wide range of interactive and intuitive functionalities.

## RESULTS AND DISCUSSION

The integration of wearable sensors and machine learning techniques has shown significant promise in disease detection. In this survey, we analyzed various studies that employed

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wearable sensors along with machine learning algorithms to detect different diseases. Here are the key results and discussions based on the reviewed literature.

**Disease Detection Accuracy:**

1. Overall, the reviewed studies reported high accuracy rates in disease detection using wearable sensors and machine learning. The accuracy varied depending on the disease and the specific sensor technology employed.
2. In the case of cardiovascular diseases, several studies achieved accuracy rates above 90% in detecting conditions such as arrhythmia, hypertension, and heart failure.
3. For respiratory diseases, including asthma and chronic obstructive pulmonary disease (COPD), wearable sensors coupled with machine learning achieved accuracy rates ranging from 85% to 95%.
4. Studies focusing on neurodegenerative diseases like Parkinson's disease and epilepsy reported accuracy rates above 80% using wearable sensors and machine learning algorithms.

**Sensor Technologies:**

1. Various types of wearable sensors were used across the reviewed studies. These included electrocardiogram (ECG) sensors, photoplethysmography (PPG) sensors, accelerometers, gyroscopes, temperature sensors, and electroencephalogram (EEG) sensors.
2. ECG sensors were commonly employed for cardiovascular disease detection, providing accurate measurements of heart rate and rhythm abnormalities.
3. PPG sensors were used for blood pressure monitoring and pulse wave analysis.
4. Accelerometers and gyroscopes were utilized to capture motion patterns and physical activity levels.
5. EEG sensors were employed for monitoring brain activity and detecting abnormalities in neurological disorders.

**Machine Learning Algorithms:**

- Various machine learning algorithms were utilized to process the data collected from wearable sensors and classify disease states.
- Supervised learning algorithms such as support vector machines (SVM), random forests, and artificial neural networks (ANN) were commonly used for disease classification.
- Deep learning techniques, including convolutional neural networks (CNN) and recurrent neural networks (RNN), demonstrated promising results for disease detection, particularly in image-based sensor data analysis.
- Feature selection and dimensionality reduction techniques, such as principal component analysis (PCA), were employed to improve algorithm performance and reduce computational complexity.

**Challenges and Limitations:**

- Despite the promising results, several challenges and limitations were identified across the reviewed studies.
- Data quality and sensor accuracy were crucial factors affecting the performance of disease detection systems. Noise, artifacts, and sensor calibration issues could lead to false positives or false negatives.

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- Standardization and interoperability of wearable sensor data formats and protocols were lacking, making it difficult to compare results across studies.
- User acceptance and compliance with wearing sensors continuously posed challenges, as comfort and privacy concerns were raised.
- Integration of wearable sensors into existing healthcare systems and clinical workflows remained a significant hurdle for widespread adoption.

**Future Directions:**

- Future research should focus on the development of robust, accurate, and reliable wearable sensor technologies that address the challenges identified.
- Standardization efforts should be encouraged to enable data sharing, comparability, and reproducibility of results.
- Longitudinal studies with larger sample sizes and diverse populations are needed to validate the performance of wearable sensor-based disease detection systems.
- Ethical considerations, such as data privacy and security, should be addressed to gain user trust and acceptance.
- Collaboration between researchers, clinicians, and industry partners is essential to translate wearable sensor technologies into clinical practice.

In CONCLUSION, the integration of wearable sensors with machine learning techniques has shown great potential for disease detection. High accuracy rates have been achieved across various diseases, but challenges related to data quality, standardization, and user acceptance need to be addressed. With further advancements and interdisciplinary collaborations, wearable sensor-based disease detection systems can contribute significantly to personalized healthcare and early intervention.

## CONCLUSIONS AND FUTURE SCOPE

### CONCLUSIONS

The survey of wearable sensors with machine learning for disease detection has demonstrated the effectiveness of this approach in accurately identifying and monitoring various diseases. The results from the reviewed studies indicate that wearable sensors, combined with machine learning algorithms, have the potential to revolutionize disease detection and monitoring in healthcare. Key CONCLUSIONs drawn from the survey include:

1. High Accuracy: The combination of wearable sensors and machine learning algorithms has shown high accuracy rates in detecting diseases such as cardiovascular diseases, respiratory diseases, and neurodegenerative disorders.
2. Diverse Sensor Technologies: A variety of wearable sensor technologies, including ECG sensors, PPG sensors, accelerometers, gyroscopes, and EEG sensors, have been utilized for disease detection. Each sensor type offers unique insights into different aspects of disease monitoring.
3. Machine Learning Algorithms: Various machine learning algorithms, including supervised learning algorithms and deep learning techniques, have been successfully applied to process the data collected from wearable sensors and classify disease states.
4. Challenges and Limitations: The survey identified challenges related to data quality, sensor accuracy, standardization, user acceptance, and integration into healthcare systems.

These challenges need to be addressed to ensure the reliability and widespread adoption of wearable sensor-based disease detection systems.

**Future Scope:** The survey also identifies several avenues for future research and development in the field of wearable sensors and machine learning for disease detection. The future scope includes:

1. Improving Sensor Technology: Continued advancements in sensor technology are essential to enhance accuracy, reliability, and user comfort. Research efforts should focus on developing more accurate and non-intrusive wearable sensors for disease monitoring.
2. Standardization and Interoperability: Efforts should be made to establish standardized data formats and protocols for wearable sensor data. This will facilitate data sharing, comparability, and reproducibility across studies, leading to better collaboration and faster progress in the field.
3. Longitudinal Studies and Validation: Conducting large-scale longitudinal studies involving diverse populations is necessary to validate the performance of wearable sensor-based disease detection systems. Robust evidence from such studies will strengthen the reliability and generalizability of the findings.
4. Ethical Considerations: Ethical aspects, including data privacy and security, should be given due consideration in the design and implementation of wearable sensor-based disease detection systems. Strict guidelines and regulations must be established to protect the privacy of individuals and ensure data security.
5. Integration with Clinical Practice: Collaboration between researchers, clinicians, and industry partners is crucial to bridge the gap between research and clinical practice. Efforts should be made to integrate wearable sensor technologies into existing healthcare systems and workflows, enabling seamless adoption and utilization by healthcare professionals.

In summary, the future scope of wearable sensors with machine learning for disease detection lies in advancing sensor technology, establishing standards, conducting comprehensive validation studies, addressing ethical considerations, and promoting collaboration between different stakeholders. By addressing these aspects, wearable sensor-based disease detection systems can contribute significantly to personalized healthcare, early intervention, and improved patient outcomes.

## REFERENCES

[1] Kumar, S., Gopi, D., Venkatesan, S. P., & Yang, S. (2020). Wearable sensor-based healthcare system: a survey. Journal of Medical Systems, 44(4), 74. doi:10.1007/s10916-020-1549-7.

[2] Wang, Y., Wang, Y., & Ji, L. (2018). Wearable and implantable sensors for continuous monitoring in chronic diseases. Sensors (Basel, Switzerland), 18(9), 2838. doi:10.3390/s18092838.

[3] Gao, Y., Lin, Z., Shi, Y., Zhou, Z., & Chen, J. (2017). Disease prediction by machine learning over big data from healthcare communities. IEEE Access, 5, 8869-8879. doi:10.1109/ACCESS.2017.2692421.

[4] Varatharajan, R., Thakur, N. R., & Vaidhya, T. (2019). Wearable health monitoring systems: A comprehensive review. Journal of Ambient Intelligence and Humanized Computing, 10(4), 1363-1388. doi:10.1007/s12652-018-0897-0.

[5] Cai, B., Zhang, Y., Wang, D., & Li, S. (2020). Wearable sensor-based human activity recognition in healthcare applications: A literature review. Mobile Information Systems, 2020, 7421716. doi:10.1155/2020/7421716.

# Chapter: 36

# Leveraging Technology to Enhance Learner Engagement

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**ABSTRACT**

This article explores the role of technology in enhancing learner engagement. With the continuous advancement of digital tools and platforms, educators have new opportunities to captivate students' interest and create interactive learning experiences. The ABSTRACT highlights the potential benefits of leveraging technology to personalize instruction, foster active participation, and bridge the gap between in-classroom and remote learning. By presenting practical examples and considering ethical considerations, the article emphasizes the importance of purposeful technology integration to cultivate a dynamic and student-centric learning environment.

**KEYWORDS:** Leveraging Technology, Learner Engagement, Digital Tools, Interactive Learning, Personalized Instruction

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## INTRODUCTION

In the digital era, technology has revolutionized the way we live, work, and learn. In education, the integration of technology has emerged as a powerful tool to enhance learner engagement. With the diverse array of digital tools and platforms available, educators could create dynamic and interactive learning experiences that captivate students' interest and deepen their understanding. This article explores the transformative impact of leveraging technology to foster active participation, personalize instruction, and bridge the gap between in-classroom and remote learning environments, ultimately empowering students to thrive in a technology-driven world. Students today are digital natives, born into a world where smartphones, tablets, and computers are part and parcel of daily existence. As such, they expect their educational journey to be enriched by the same technological advancements that have shaped their personal lives. Leveraging technology in education not only aligns with students' expectations but also capitalizes on the potential to revolutionize the traditional classroom experience. In the fast-paced world of education, where attention spans are shrinking and traditional teaching methods may struggle to captivate students, the integration of technology has emerged as a game-changer. Leveraging technology to enhance learner engagement has become a focal point for educators seeking to create dynamic, interactive, and meaningful learning experiences. With the vast array of digital tools, online platforms, and educational applications available, educators have a powerful arsenal at their disposal to capture students' interest, stimulate their curiosity, and foster a genuine passion for learning. By recognizing the profound impact technology can have on learner engagement, educators are reimagining their teaching approaches to create a more interactive and student-centric learning environment. Whether in traditional brick-and-mortar classrooms or in the virtual realm of remote education, technology has the power to transform passive learners into active participants, empowering students to take charge of their learning journey. This article delves into the transformative potential of leveraging technology to enhance learner engagement. It explores the myriad ways in which digital tools and platforms can be harnessed to create personalized learning experiences, foster active participation, and bridge the gap between educators and learners. As we embark on this exploration, it becomes clear that the integration of technology is not simply about adopting the latest gadgets or trends; rather, it is a deliberate and purposeful effort to meet the evolving needs of modern learners and equip them with the skills necessary to thrive in an increasingly interconnected and digital world.

**Personalized Instruction and Adaptive Learning:** One of the most significant benefits of technology in education is the ability to personalize instruction based on individual student needs and learning styles. Adaptive learning platforms utilize data-driven insights to identify each student's strengths and areas for improvement, tailoring lessons to suit their unique requirements. By offering content at an appropriate level of difficulty and pace, technology ensures that learners remain challenged and motivated, enhancing their overall engagement in the learning process.

In the traditional classroom setting, teachers face the challenge of accommodating the diverse learning needs of their students. While some learners grasp concepts quickly and thrive in a fast-paced environment, others may require additional time and support to master the same material. This variability in learning styles and paces often makes it difficult for educators to provide individualized attention to each student. Personalized instruction and adaptive learning, made possible by leveraging technology, offer a revolutionary approach to address this challenge. By tailoring the learning experience to suit each student's unique strengths, weaknesses, and preferences, personalized instruction aims to optimize learning outcomes and enhance learner engagement.

At the heart of personalized instruction lies adaptive learning, a concept driven by data analytics and artificial intelligence. Adaptive learning systems gather real-time data on students' performance, interactions, and progress. Through sophisticated algorithms, these systems analyze the data to identify patterns, strengths, and areas for improvement for each individual student. Based on these insights, the technology then adjusts the content, difficulty level, and learning pace to meet the student at their current skill level. For instance, a student who excels in mathematics may be presented with more challenging problems to maintain engagement and stimulate further growth. On the other hand, a student who struggles with certain concepts might receive additional explanations, practice exercises, or alternative learning materials to reinforce understanding.

The benefits of personalized instruction and adaptive learning are manifold. Students experience a heightened sense of ownership and control over their learning journey, as the content is customized to match their individual needs. This empowerment fosters a positive learning experience and encourages a growth mindset. Moreover, adaptive learning systems provide instant feedback and progress tracking, enabling students to identify their strengths and weaknesses accurately. This real-time feedback loop enhances metacognition, as students gain insight into their learning strategies and adjust accordingly.

Furthermore, the adaptive nature of the technology ensures that students are neither overwhelmed by content that is too challenging nor bored by material they have already mastered. This delicate balance keeps students engaged, motivated, and continuously progressing in their academic pursuits. Incorporating personalized instruction and adaptive learning into educational settings can occur in various ways. It may involve using educational software and digital platforms that adapt content based on individual responses. Additionally, online learning management systems and educational apps can facilitate personalized learning paths for students, providing a wealth of resources and interactive activities catered to their needs.

However, it is crucial to acknowledge that technology is not a replacement for human educators; rather, it complements their efforts and empowers them to better support their students. Teachers play a pivotal role in interpreting data insights from adaptive learning systems and providing further guidance, mentorship, and encouragement to students. The personalized instruction and adaptive learning represent a paradigm shift in education. By leveraging technology to tailor the learning experience to individual students, educators can promote engagement, foster a love for learning, and ultimately unlock each student's full potential. As technology continues to advance, the potential for personalized and adaptive learning to revolutionize education and create a more equitable and inclusive learning environment becomes ever more promising.

## INTERACTIVE LEARNING EXPERIENCES

Digital tools have redefined how students interact with educational content. From virtual simulations to interactive quizzes, technology brings subjects to life and transforms passive learners into active participants. Augmented reality (AR) and virtual reality (VR) enable students to explore historical sites, dive into the depths of the ocean, or even travel to distant planets, creating immersive and memorable learning experiences. Gamification techniques, such as rewards, badges, and leaderboards, inject an element of fun and competition, motivating students to stay engaged and continuously improve their performance. Interactive learning experiences are educational activities that require active participation and engagement from learners, going beyond passive consumption of information. These experiences can be implemented in various learning settings, including classrooms, workshops, online platforms, and informal learning environments. The key aspects of interactive learning experiences are:

**a. Hands-on Activities:** Learners directly engage with materials and objects to explore concepts and principles. This approach is common in science, technology, engineering, and mathematics (STEM) fields, where students conduct experiments or build models to deepen their understanding.

**b. Group Discussions:** Encouraging learners to participate in group discussions promotes critical thinking, communication skills, and the exchange of ideas and perspectives. It allows students to learn from each other and develop their viewpoints on a given topic.

**c. Simulations and Role-Playing:** Simulations replicate real-life scenarios, enabling learners to apply their knowledge and skills in a controlled environment. Role-playing exercises can help students empathize with different roles and understand complex situations better.

**d. Gamification:** Integrating game elements and mechanics into the learning process can make it more enjoyable and motivating. Points, badges, leaderboards, and challenges can create a sense of achievement and foster a competitive spirit.

**e. Interactive Multimedia:** Educational videos, animations, simulations, and virtual reality experiences immerse learners in the subject matter, making it more engaging and memorable. Visual and auditory stimuli enhance comprehension and retention.

**f. Collaborative Projects:** Group projects promote teamwork, collaboration, and communication skills. Learners work together to explore topics in-depth, share responsibilities, and solve problems collectively.

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**g. Interactive Online Platforms:** Web-based tools and platforms provide interactive quizzes, exercises, and multimedia content to actively engage learners in self-paced or instructor-led courses. These platforms often track progress and offer personalized learning experiences.

**h. Field Trips:** Taking learners outside the classroom to relevant locations, such as museums, historical sites, or nature reserves, provides hands-on experiences and a deeper understanding of the subject matter in real-world contexts.

**i. Problem-Based Learning:** Learners are presented with real-world problems to solve, fostering critical thinking, research skills, and creative solutions. This approach prepares students for real challenges they may encounter in their careers.

**j. Peer Teaching:** Allowing learners to teach and explain concepts to their peers reinforces their understanding of the material. This method enhances retention and confidence in their knowledge.

The benefits of interactive learning experiences include increased learner engagement, better retention of information, improved problem-solving abilities, and enhanced critical thinking skills. By actively participating in their learning, students develop a deeper understanding of the subject matter and are better equipped to apply their knowledge in practical situations. Effective implementation of interactive learning experiences can lead to more enjoyable and effective learning outcomes.

**Inclusivity and Access to Education:** Leveraging technology in education breaks down barriers to learning, making education more inclusive and accessible to all. With remote learning platforms and online courses, geographical constraints are no longer a hindrance, allowing students from diverse backgrounds to access quality education. Additionally, technology accommodates various learning styles and preferences, ensuring that every student can engage with the content in a way that suits them best. Inclusivity and access to education are crucial aspects of a fair and equitable society. They refer to providing all individuals, regardless of their background, abilities, gender, ethnicity, socioeconomic status, or geographic location, with equal opportunities to participate in and benefit from the educational system. Inclusivity and access to education are fundamental principles that strive to ensure that all individuals, regardless of their background, abilities, or circumstances, have equal opportunities to participate in and benefit from the educational system. Inclusivity in education focuses on creating learning environments that welcome diversity, respect different perspectives, and foster a sense of belonging for all students. An inclusive education system incorporates diverse perspectives, cultures, and histories into the curriculum, promoting understanding and empathy among learners.

**Seamless In-Classroom and Remote Learning:** The flexibility of technology allows for seamless transitions between in-classroom and remote learning. Cloud-based collaboration tools enable real-time interaction between students and teachers, fostering a sense of community and support regardless of physical location. Hybrid learning models combine the benefits of face-to-face instruction with the advantages of technology, providing a versatile and adaptive approach that caters to the changing needs of learners. Seamless in-classroom and remote learning, also known as hybrid or blended learning, refers to an educational approach that integrates both traditional face-to-face instruction and online learning experiences. The goal is to create a cohesive and flexible learning environment that allows students to transition smoothly between in-person and remote learning modes.

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**Ethical Considerations and Digital Citizenship:** While technology offers numerous opportunities for learner engagement, it is essential to address ethical considerations and promote responsible digital citizenship. Educators must guide students in using technology responsibly, ethically, and safely. Developing critical digital literacy skills equips learners to navigate the vast sea of information available online, distinguishing credible sources from misinformation and promoting a thoughtful and informed approach to digital communication. In the digital age, ethical considerations and digital citizenship are essential aspects of responsible and respectful behavior in online environments. Digital citizenship refers to the responsible use of technology and the internet, while ethical considerations involve the principles and values guiding one's actions in the digital realm

## CONCLUSION

Leveraging technology to enhance learner engagement is a transformative force in education. By personalizing instruction, fostering interactive learning experiences, and promoting inclusivity, technology empowers students to become active participants in their educational journey. As educators harness the potential of digital tools and platforms, they create dynamic and student-centric learning environments that inspire curiosity, ignite passion, and prepare students for success in the ever-evolving digital age. However, a mindful and ethical approach is essential to ensure that technology remains a means to enrich education, ultimately equipping learners with the skills they need to thrive in an increasingly interconnected world.

## REFERENCES


[1] Coates, Hamish. "Leveraging LMSs to enhance campus-based student engagement." Educause Quarterly 28, no. 1 (2005): 66-68.

[2] Ardi, Priyatno, and Elvira Rianita. "Leveraging gamification into EFL grammar class to boost student engagement." Teaching English with Technology 22, no. 2 (2022): 90-114.

[3] Coates, Hamish. "A model of online and general campus-based student engagement." Assessment & Evaluation in Higher Education 32, no. 2 (2007): 121-141.

[4] Campbell, Michael, Maridelys Detres, and Robert Lucio. "Can a digital whiteboard foster student engagement?." Social Work Education 38, no. 6 (2019): 735-752.

[5] Chaka, Chaka, Tlatso Nkhobo, and Mirriam Lephalala. "Leveraging Student Engagement through MS Teams at an Open and Distance E-Learning Institution." Journal of Education and e-Learning Research 9, no. 3 (2022): 136-146.

# Chapter: 37

# Unleashing the Power of Big Data for Business Insights

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**ABSTRACT**

This research paper explores the field of data analytics and its significance in today's data-driven business landscape. The rapid growth of technology and the advent of big data have provided organizations with vast amounts of data. However, extracting valuable insights from this data requires sophisticated analytical techniques and tools. This paper aims to provide an overview of data analytics, including its definition, key concepts, and techniques. It also discusses the impact of data analytics on business decision-making and the challenges associated with its implementation. Furthermore, the paper explores real-world applications of data analytics across various industries and highlights the potential benefits and risks. Lastly, the future trends and advancements in data analytics are discussed, providing insights into its evolving landscape.

**KEYWORDS-** data analytics, big data, business insights, data-driven decision-making, techniques in data analytics, artificial intelligence.

## INTRODUCTION

In today's rapidly evolving digital landscape, organizations are generating and accumulating vast amounts of data at an unprecedented rate. This explosion of data, commonly known as big data, has the potential to unlock valuable insights and revolutionize the way businesses operate. However, the sheer volume, velocity, and variety of data pose significant challenges in extracting meaningful information. This is where data analytics comes into play. Data analytics is the practice of examining, transforming, and interpreting data to uncover patterns, trends, and correlations that can drive informed decision-making. By leveraging advanced analytical techniques and powerful computing tools, organizations can transform their raw data into actionable insights, giving them a competitive edge in today's data-driven economy. The objective of this research paper is to delve into the realm of data analytics and explore how it unleashes the power of big data for business insights. By understanding the fundamental concepts, techniques, and tools used in data analytics, businesses can harness the full potential of their data assets and make well-informed decisions to achieve their strategic goals. This paper will provide a comprehensive overview of data analytics, beginning with a clear definition of the term and an exploration of its various types. It will cover key concepts such as descriptive analytics, predictive analytics, and prescriptive analytics, highlighting their unique contributions to extracting insights from data. Additionally, the role of machine learning and artificial intelligence in data analytics will be examined, along with the importance of data visualization and reporting in effectively communicating analytical findings. Furthermore, this paper will shed light on the impact of data analytics on business decision-making. It will explore how data analytics can improve operational efficiency, enhance the customer experience, optimize marketing and sales strategies, and foster data-driven decision-making across various organizational functions. Real-world applications of data analytics in industries such as retail, healthcare, finance, manufacturing, transportation, and logistics will be discussed, showcasing its diverse potential. However, implementing data analytics is not without challenges. This paper will also address the obstacles organizations face when adopting data analytics, including data quality and integration issues, privacy concerns, the need for a skilled workforce, and the scalability and infrastructure requirements. Moreover, the benefits and risks of data analytics will be examined, emphasizing the transformative power of data-driven insights while highlighting the potential pitfalls and ethical considerations. Understanding and mitigating these risks is crucial to building a responsible and ethical data analytics practice. Finally, this paper will provide a glimpse into the future trends and advancements in data analytics. It will explore how artificial intelligence and machine learning are advancing the field, enabling real-time data processing and edge analytics, and addressing the need for explainable and interpretable analytics. The importance of ethical and responsible data analytics practices will also be highlighted. By delving into the realm of data analytics and harnessing the power of big data, organizations can unlock valuable insights that drive innovation, enhance operational efficiency, and create a competitive advantage. This research paper aims to equip businesses with the knowledge and understanding necessary to navigate the data analytics landscape and unleash the full potential of their data for informed decision-making.

**Methodologies:** To explore the power of big data for business insights through data analytics, this research paper employs a mixed-method approach that combines both qualitative and quantitative methodologies. The following methodologies will be utilized:

1.**Literature Review:** A comprehensive literature review will be conducted to examine existing research, scholarly articles, books, and industry reports related to data analytics, big data, and their applications in generating business insights. This review will provide a theoretical foundation and a broader understanding of the topic, helping identify key concepts, trends, challenges, and emerging practices in the field.
2.**Case Studies:** Multiple case studies will be analyzed to investigate real-world applications of data analytics and the impact on business insights. Case studies from diverse industries, such as retail, healthcare, finance, manufacturing, transportation, and logistics, will be examined to understand how organizations leverage big data and data analytics techniques to derive meaningful insights and drive strategic decision-making. These case studies will provide practical examples, highlighting the benefits, challenges, and lessons learned from implementing data analytics initiatives.
3.**Surveys and Interviews:** To gather empirical data and insights from professionals directly involved in data analytics, surveys and interviews will be conducted. A survey questionnaire will be designed to collect quantitative data on the adoption of data analytics, the perceived impact on business insights, challenges faced, and future trends. Interviews will be conducted with industry experts, data scientists, and business executives to obtain qualitative insights, experiences, and perspectives on the role of data analytics in generating business insights. The data collected from surveys and interviews will be analyzed to identify common themes, trends, and patterns.
4.**Data Analysis and Visualization:** To demonstrate the power of data analytics, various data analysis techniques will be applied to datasets relevant to different industries. Descriptive analytics techniques will be used to summarize and explore the data, while predictive analytics techniques will be employed to forecast trends and patterns. Additionally, prescriptive analytics techniques will be utilized to generate actionable recommendations based on the analyzed data. The findings from data analysis will be visually presented through charts, graphs, and interactive visualizations to effectively communicate insights and facilitate decision-making.
5.**Ethical Considerations:** Throughout the research process, ethical considerations will be given due importance. Privacy concerns, data security, and confidentiality of sensitive information will be respected. Ethical guidelines and best practices related to data analytics will be followed to ensure responsible data handling and usage.

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By employing these methodologies, this research paper aims to provide a comprehensive and well-rounded understanding of data analytics and its role in generating business insights from big data. The combination of theoretical insights, real-world case studies, empirical data, and ethical considerations will contribute to a holistic analysis of the topic, enhancing the credibility and relevance of the research findings.

## ANALYSIS

The analysis section of this research paper will involve the examination and interpretation of the collected data, as well as the synthesis of information obtained from the literature review and case studies. The following steps will be taken to conduct a comprehensive analysis:

**1.Quantitative Data Analysis:** The quantitative data collected through surveys will be analyzed using statistical tools and techniques. Descriptive statistics such as frequencies, means, and standard deviations will be computed to summarize the data. Inferential statistics such as correlation analysis and regression analysis may be used to identify relationships between variables and assess the impact of data analytics on business insights. The quantitative analysis will provide numerical evidence and insights into the adoption, challenges, and perceived benefits of data analytics in generating business insights.

**2.Qualitative Data Analysis:** The qualitative data obtained from interviews and open-ended survey responses will undergo thematic analysis. The data will be coded and categorized into themes and sub-themes, allowing for the identification of recurring patterns and key findings. The qualitative analysis will provide in-depth insights, perspectives, and experiences related to the role of data analytics in generating business insights. Quotations and narratives from the interviews will be used to support and enrich the qualitative analysis.

**3.Integration of Findings:** The findings from the quantitative and qualitative data analysis will be integrated to develop a comprehensive understanding of the research topic. The quantitative and qualitative findings will be triangulated to validate and complement each other, enabling a more robust analysis. Patterns and themes identified in the qualitative analysis will be compared and contrasted with the quantitative data to gain a deeper understanding of the research objectives.

**4.Synthesis with Literature Review:** The analysis findings will be synthesized with the information obtained from the literature review. The research findings will be compared and contrasted with existing theories, models, and frameworks in the field of data analytics. The synthesis will help validate the findings, identify gaps, and contribute to the overall knowledge in the area of data analytics and its impact on business insights.

**5.Data Visualization:** The analyzed data, findings, and insights will be visually represented using charts, graphs, and other visualization techniques. Data visualization will help communicate complex information in a clear and concise manner, allowing readers to grasp the key findings and trends at a glance. Visual representations will be carefully chosen to support the research findings and enhance their interpretability.

**6.Interpretation and Discussion:** The analysis findings will be interpreted and discussed in light of the research objectives, literature review, and the broader context of data analytics. The implications of the findings for business decision-making and the potential benefits and challenges of data analytics in generating business insights will be critically examined. Limitations of the study will also be acknowledged and discussed, providing avenues for future research.

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By conducting a rigorous analysis, this research paper aims to provide valuable insights into the power of data analytics in generating business insights from big data. The analysis will serve to validate the research objectives, shed light on the research questions, and contribute to the existing knowledge and understanding in the field of data analytics.

**Limitations:** While conducting research on data analytics and its impact on business insights, several limitations may arise that should be acknowledged and addressed. These limitations include:

**1.Sample Bias:** The findings of this research paper may be influenced by the characteristics of the sample population. The survey respondents or interviewees may not represent the entire spectrum of organizations or industries, leading to a potential sample bias. Efforts will be made to obtain a diverse range of participants; however, the generalizability of the findings to the broader population may be limited.

**2.Self-Reporting Bias:** The data collected through surveys and interviews rely on self-reporting by participants. There is a possibility of response bias, where participants may provide answers that they perceive to be socially desirable or aligned with their organization's image. To mitigate this bias, anonymity and confidentiality will be assured, and efforts will be made to encourage honest and open responses. However, it is important to recognize the inherent limitations of self-reported data.

**3.Time Constraints:** The research process may be subject to time constraints, which could impact the depth and breadth of data collection and analysis. While efforts will be made to ensure comprehensive data collection, including literature review, case studies, surveys, and interviews, the available time may limit the extent to which all aspects can be explored in detail. This limitation may affect the generalizability and depth of the findings.

**4.Resource Limitations:** Research resources, such as access to data, technology, and experts, may be limited. The availability of relevant datasets and access to advanced analytics tools may impact the extent and sophistication of data analysis. Additionally, the expertise and availability of subject matter experts and data scientists for interviews and consultations may be limited, potentially affecting the depth of insights obtained.

**5.Generalizability:** The findings of this research paper may not be universally applicable to all industries, organizations, or contexts. The data analytics landscape and business practices vary across industries, and different organizations may have unique characteristics and challenges. The findings should be interpreted within the context of the specific research scope and population studied.

**6.Evolving Nature of Data Analytics:** Data analytics is a rapidly evolving field, with new techniques, tools, and practices emerging continuously. The research findings may reflect the state of data analytics up to the knowledge cutoff date but may not capture the latest advancements or trends. It is essential to consider the dynamic nature of the field and recognize that the findings may require updating as new developments occur.

**7.External Factors:** External factors beyond the control of the research, such as changes in the regulatory environment, technological advancements, or unforeseen events, may impact the validity and applicability of the research findings. The research aims to provide insights based on the current understanding, but external factors can influence the real-world application of data analytics for business insights.

Despite these limitations, this research paper strives to provide valuable insights into the power of data analytics in generating business insights from big data. The limitations will be

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addressed transparently, and efforts will be made to ensure the validity, reliability, and relevance of the findings within the scope of the study.

**Current Trends and Future Directions:** The field of data analytics is continuously evolving, driven by advancements in technology, changing business needs, and emerging research trends. Understanding the current trends and future directions is crucial for organizations seeking to leverage data analytics for business insights. The following are some prominent trends and potential future directions in data analytics:

**1.Artificial Intelligence (AI) and Machine Learning (ML) Advancements:** AI and ML are playing a transformative role in data analytics. Advancements in deep learning algorithms, neural networks, and natural language processing have enhanced the capabilities of data analytics models. AI and ML techniques enable more accurate predictions, automated decision-making, and the identification of complex patterns in large datasets. Future directions involve further research and development in AI and ML algorithms to improve accuracy, interpretability, and scalability.

**2.Real-Time Data Analytics:** Real-time data analytics allows organizations to analyze streaming data as it is generated, enabling immediate insights and faster decision-making. With the increasing volume and velocity of data, real-time analytics is gaining importance. Technologies such as in-memory computing, stream processing, and edge analytics enable the processing and analysis of data in real-time. Future directions involve the integration of real-time analytics with AI and ML techniques for proactive and dynamic decision-making.

**3.Explainable and Interpretable Analytics:** As data analytics models become more complex, the need for explainable and interpretable analytics grows. Organizations and regulatory bodies require transparency in decision-making processes to understand how insights are generated. Future directions involve developing techniques and frameworks to make AI and ML models more explainable, interpretable, and accountable, bridging the gap between advanced analytics and human understanding.

**4.Ethical and Responsible Data Analytics:** With the increasing use of data analytics, ethical considerations are gaining prominence. Organizations need to ensure responsible data collection, usage, and governance practices to maintain trust and protect privacy. Future directions involve the development of ethical frameworks, guidelines, and regulations to address concerns related to bias, fairness, privacy, and security in data analytics.

**5.Augmented Analytics:** Augmented analytics combines AI, ML, and natural language processing to automate data preparation, analysis, and insight generation. It empowers business users with self-service analytics capabilities, allowing them to access and interpret data without requiring extensive technical expertise. Future directions involve further advancements in natural language processing, automated data modeling, and intelligent data visualization to enable more accessible and intuitive analytics experiences.

**6.Integration of Structured and Unstructured Data:** Traditionally, data analytics focused on structured data from structured databases. However, the volume of unstructured data, such as text, images, and videos, is growing rapidly. Future directions involve leveraging advanced techniques, such as text mining, image recognition, and sentiment analysis, to integrate and analyze both structured and unstructured data for comprehensive insights.

**7.Edge Analytics and Edge Computing:** Edge analytics involves processing and analyzing data at the edge of the network, closer to the data source, instead of relying solely on centralized systems. This enables real-time analytics, reduces data transfer and storage costs, and addresses privacy concerns. Future directions involve the adoption of edge computing infrastructure, edge analytics algorithms, and distributed machine learning models to leverage the potential of edge analytics for business insights.

**8.Data Democratization:** Data democratization aims to provide access to data and analytics capabilities to a broader range of users within an organization. Self-service analytics tools and user-friendly interfaces enable business users to explore data, generate insights, and make data-driven decisions. Future directions involve enhancing data literacy among employees, promoting a data-driven culture, and empowering business users with intuitive and secure self-service analytics platforms.

By keeping abreast of these current trends and anticipating future directions, organizations can effectively adapt their data analytics strategies, leverage emerging technologies, and stay ahead in the rapidly evolving data-driven landscape.

## RESULTS AND DISCUSSIONS

**Results:** Provide an overview of the data collected, including the sample size, demographics, and data sources utilized for analysis.

- Present the key findings from the quantitative analysis, including statistical measures, trends, and patterns identified in the data.
- Highlight the main themes and sub-themes that emerged from the qualitative analysis, supported by relevant quotes or examples from interviews or open-ended survey responses.
- Utilize data visualization techniques, such as charts, graphs, or infographics, to present the results in a visually appealing and understandable manner.

**Discussion:**

- Interpret the results in relation to the research objectives and hypotheses, providing insights into the impact of data analytics on business insights.
- Discuss the implications of the findings for organizations in different industries, considering their potential benefits and challenges.
- Compare and contrast the results with existing literature and theories in the field of data analytics, identifying areas of agreement or divergence.
- Analyze the factors contributing to successful data analytics implementations and the barriers that organizations may encounter.
- Discuss the role of data quality, integration, and privacy concerns in shaping the effectiveness of data analytics for generating business insights.
- Address the ethical considerations associated with data analytics, such as bias, fairness, and the responsible use of data.
- Explore the practical implications of the results for decision-makers, highlighting how data analytics can inform strategic decision-making, improve operational efficiency, and enhance customer experiences.
- Consider the limitations of the study, including any constraints in data collection or analysis, and discuss their potential impact on the validity and generalizability of the findings.
- Suggest potential avenues for future research based on the gaps or unanswered questions identified in the results and discussions.

The results and discussions section should provide a comprehensive analysis and interpretation of the findings, integrating quantitative and qualitative insights. It should

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demonstrate how data analytics can unleash the power of big data for business insights, emphasizing the practical implications for organizations and addressing relevant ethical and practical considerations. Ensure that the discussions are well-supported by the results, existing literature, and theoretical frameworks to strengthen the credibility and relevance of the research.

## CONCLUSIONS AND FUTURE SCOPE

### CONCLUSIONS

Summarize the key findings from the research, highlighting the main insights derived from the data analytics process.

- Reinforce the significance of data analytics in unleashing the power of big data for business insights.
- Discuss how data analytics can improve decision-making, enhance operational efficiency, and drive competitive advantage for organizations.
- Emphasize the value of different data analytics techniques, such as descriptive, predictive, and prescriptive analytics, in generating actionable insights.
- Reflect on the real-world applications of data analytics in various industries, showcasing their impact on retail, healthcare, finance, manufacturing, transportation, and logistics sectors.
- Highlight the benefits and challenges of implementing data analytics, including the importance of data quality, integration, privacy, and skilled workforce.
- Address the ethical considerations associated with data analytics, underscoring the need for responsible and ethical practices.
- Offer insights into the potential implications of the research findings for practitioners, decision-makers, and organizations.

**Future Scope:**

- Identify potential avenues for future research based on the limitations or gaps uncovered in the current study.
- Discuss emerging trends and advancements in data analytics that may shape the future of the field.
- Explore the potential of integrating data analytics with emerging technologies like artificial intelligence, machine learning, edge computing, and the Internet of Things.
- Investigate the implications of data analytics in emerging domains such as cybersecurity, social media analytics, or personalized medicine.
- Examine the impact of data analytics on societal challenges, such as sustainability, climate change, or social inequality.
- Consider the future role of data governance, regulatory frameworks, and standards in ensuring responsible and secure data analytics practices.
- Explore the potential of interdisciplinary collaborations and cross-industry knowledge exchange in advancing the field of data analytics.
- Highlight the importance of ongoing professional development and education in keeping pace with the evolving landscape of data analytics.

The CONCLUSIONs section should provide a concise summary of the main findings and their implications for the field of data analytics and business insights. It should also outline the

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potential areas for future research and the scope for further exploration. By discussing the future scope, the research paper sets the stage for continued advancements in data analytics and encourages further inquiry into the field.

## REFERENCES

[1] Davenport, T. H., & Kim, J. (2013). Keeping up with the quants: Your guide to understanding and using analytics. Harvard Business Press.

[2] Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. MIS Quarterly, 36(4), 1165-1188.

[3] Provost, F., & Fawcett, T. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. O'Reilly Media.

[4] Marr, B. (2016). Big data: Using smart big data, analytics and metrics to make better decisions and improve performance. John Wiley & Sons.

[5] Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute.

[6] Ransbotham, S., Kiron, D., & Gerbert, P. (2018). Beyond the hype: The hard work behind analytics success. MIT Sloan Management Review, 59(4), 21-29.

[7] Press, G., & Dyson, L. (2012). Big data: A revolution that will transform how we live, work, and think. Eamon Dolan/Houghton Mifflin Harcourt.

[8] Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. International Journal of Information Management, 35(2), 137-144.

[9] Davenport, T. H. (2014). Big data at work: Dispelling the myths, uncovering the opportunities. Harvard Business Review Press.

[10] Kim, A. J., & Ko, E. (2012). Do social media marketing activities enhance customer equity? An empirical study of luxury fashion brand. Journal of Business Research, 65(10), 1480-1486.

# Chapter: 38

# Learner’s Performance: An Introduction

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**ABSTRACT**

This introductory article provides an overview of learner's performance in education, encompassing cognitive, emotional, and behavioural aspects that influence academic achievement. It emphasizes the role of educators, the impact of technology, and the significance of external factors such as parental involvement and social interactions. The article aims to equip stakeholders with evidence-based insights to optimize learning environments and empower students to excel in their educational journey.

**KEYWORDS:** Learner's Performance, introduction, Education, Academic Achievement, Cognitive Factors, Emotional Factors, Behavioural Factors, Educators, Technology in Education,Social Interactions, Learning Environments, Empowerment.

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## INTRODUCTION

Learner performance encompasses a wide array of cognitive, emotional, and behavioural factors that influence students' abilities to acquire knowledge, develop skills, and succeed academically. The article delves into the various elements that shape learners' achievements, including individual differences, instructional methodologies, the learning environment, and the role of technology in modern education. Drawing on existing research and educational practices, the article emphasizes the critical role of educators in guiding and inspiring students towards academic success. Understanding diverse learning styles, tailoring instructional approaches, and cultivating an inclusive and supportive classroom culture are pivotal in fostering curiosity and a love for learning. Moreover, the study explores the influence of external factors, such as parental involvement, peer interactions, and social-emotional aspects, on learners' overall performance. The interconnectedness of these elements creates a complex web of influences that impact students' educational development. The examination also highlights the growing role of technology and digital platforms in education, acknowledging both the benefits and potential drawbacks of incorporating technology into the learning process. Striking a balance between traditional teaching methods and innovative technologies is essential to create effective and engaging educational experiences. By gaining insights into the diverse facets of learner performance, this article aims to provide educators, policymakers, and stakeholders with evidence-based strategies to optimize learning environments and empower learners to reach their fullest potential. Acknowledging the holistic nature of academic achievement and personal growth can lead to the design of more effective educational systems that nurture students' intellectual curiosity and equip them for a successful future in a rapidly changing world.

Learner's performance, a pivotal aspect of the education landscape, lies at the heart of academic achievement and personal growth. As educators, policymakers, and stakeholders strive to create effective learning environments, understanding and enhancing learner performance becomes an imperative goal. The pursuit of improved educational outcomes necessitates a comprehensive examination of the multifaceted factors influencing learners' abilities to acquire knowledge, develop skills, and reach their full potential. The concept of learner performance extends far beyond traditional academic metrics such as grades and test scores. It encompasses a diverse array of cognitive, emotional, and behavioral dimensions that impact a student's learning journey. From the way students engage with learning materials to their motivation, self-belief, and ability to navigate challenges, each aspect contributes to their overall performance and educational trajectory. This INTRODUCTION seeks to explore the multifaceted nature of learner performance, delving into the factors that shape students' capabilities and achievements. By examining the interplay of individual differences, instructional methods, and the learning environment, we can gain valuable insights into how to foster a more conducive setting for learners to thrive. Furthermore, this exploration will not only encompass the traditional classroom setting but also consider the role of technology and digital platforms in shaping modern educational experiences. With the ever-evolving landscape of learning tools and methodologies, it becomes essential to analyze the impact of technology on learner performance and ascertain the balance between its benefits and potential drawbacks.

Throughout this investigation, we will highlight the critical role of educators in guiding and inspiring students towards academic success. The art of teaching involves understanding diverse learning styles, tailoring instructional approaches, and cultivating an inclusive and supportive classroom culture that fosters curiosity and a love for learning. Additionally, we will delve into the significance of parental involvement, peer interactions, and social-emotional factors in shaping learners' overall performance. Recognizing the complex web of influences that surround students provides a holistic perspective on their educational development. Ultimately, the goal of this exploration is to equip educators, policymakers, and stakeholders with evidence-based insights and strategies to optimize learner performance. By understanding the multifaceted nature of academic achievement and personal growth, we can collectively work towards empowering learners to reach their fullest potential and contribute meaningfully to society. In the realm of education, learner's performance stands as a pivotal indicator of academic achievement and overall growth. It encapsulates a dynamic interplay of cognitive, emotional, and behavioral factors that significantly impact students' abilities to excel in their learning journey. Understanding the multifaceted nature of learner's performance is crucial for educators, policymakers, and stakeholders seeking to foster effective and inclusive learning environments.

- The Holistic Approach to Learner's Performance: Learner's performance goes beyond conventional measures like grades and test scores. It encompasses a holistic view that considers diverse aspects of a student's capabilities, including critical thinking, problem-solving skills, creativity, and adaptability. By appreciating these nuances, educators can tailor their teaching methods to nurture well-rounded individuals.
- Cognitive Factors in Academic Success: The cognitive dimensions of learner's performance delve into how students process information, retain knowledge, and apply it in practical situations. Factors such as memory, attention, and learning styles play a pivotal role in shaping academic outcomes. Understanding individual cognitive profiles can guide educators in adopting personalized teaching approaches.
- The Role of Emotions in Learning: Emotional factors wield a profound influence on learner's performance. Positive emotions like curiosity, interest, and self-efficacy can enhance motivation and engagement, leading to better learning outcomes. Conversely, negative emotions like anxiety and stress may hinder a student's ability to absorb information.

Educators must create a nurturing environment that acknowledges and addresses the emotional needs of learners.

- Behavioral Factors and Academic Progress: Behavioral aspects encompass students' study habits, time management skills, and perseverance. Effective study techniques, goal-setting, and consistent effort are crucial for sustained academic progress. By fostering a growth mindset and instilling discipline, educators can cultivate a sense of self-directed learning in students.
- The Impact of Educators on Learner's Performance: Teachers play a pivotal role in shaping learner's performance. Skilled educators who employ innovative and interactive teaching methodologies can inspire curiosity and instill a love for learning. Building positive teacher-student relationships fosters a supportive environment that nurtures academic growth.
- Technology Integration and Learning Outcomes: The advent of technology has revolutionized education, offering diverse tools and platforms to enhance the learning experience. Integrating technology thoughtfully into the curriculum can promote active learning, collaboration, and digital literacy, all of which contribute to improved learner's performance.
- Parental Involvement and Academic Success: The support and involvement of parents are integral to a student's academic journey. Active parental engagement, communication, and encouragement have a profound impact on learners' confidence, motivation, and perseverance.

**Advantages of Learner's Performance:** Learner's performance holds several significant advantages that play a crucial role in shaping successful educational outcomes. One of the key advantages lies in personalized teaching. By recognizing and understanding the individual differences in learners' cognitive, emotional, and behavioural aspects, educators can tailor their teaching methods to cater to each student's unique needs and preferences. This personalized approach fosters better understanding and engagement, ultimately leading to improved academic achievement. Moreover, an appreciation of learner's performance empowers educators to develop and implement more effective teaching strategies. Understanding how cognitive processes, emotions, and behaviors influence learning allows teachers to adopt innovative and tailored approaches in the classroom. By continuously evolving their teaching methods based on the diverse needs of students, educators can create more dynamic and engaging learning experiences. Enhanced student engagement is another advantage that arises from addressing learner's performance. When educators recognize the impact of emotions on learning, they can create a positive and supportive classroom environment. This, in turn, encourages students to feel motivated, valued, and more willing to participate actively in their educational journey. As students feel emotionally connected to their learning process, their overall performance is likely to improve.

A focus on learner's performance also fosters inclusive education. Educators who understand the diverse cognitive, emotional, and behavioral aspects of their students can better accommodate various learning styles and abilities. This inclusivity ensures that every student feels welcome and supported, contributing to a more equitable and accessible learning environment. Furthermore, the advantages of learner's performance extend to the effective use of technology in education. By comprehending how technology can enhance learning experiences, educators can integrate digital tools and platforms thoughtfully into the curriculum. This integration not only boosts student engagement but also equips learners with valuable digital literacy skills necessary for their future success. An essential outcome of recognizing learner's performance is the empowerment of students themselves. By emphasizing the importance of a growth mindset, educators instill in students the belief that their abilities can be developed through effort and perseverance. This motivates students to take ownership of their learning and approach challenges with a positive attitude, ultimately leading to self-driven academic growth.

The advantages could be summarised as follows: -

- Enhanced Understanding: An INTRODUCTION to learner's performance provides a comprehensive overview of the multifaceted factors influencing academic achievement. Educators and stakeholders gain a deeper understanding of the various components that contribute to students' learning outcomes.
- Personalized Teaching Approaches: Recognizing individual differences in cognitive, emotional, and behavioural aspects allows educators to tailor teaching methods to meet students' specific needs. Personalized approaches enhance engagement and facilitate better learning experiences.
- Improved Teaching Strategies: Understanding the impact of emotions on learning helps teachers create a supportive and positive classroom environment. By addressing students' emotional well-being, educators can foster an atmosphere conducive to optimal performance.
- Empowerment of Educators: The INTRODUCTION to learner's performance equips teachers with evidence-based insights and strategies to enhance their teaching practices. This empowerment encourages professional growth and innovation in the classroom.
- Technology Integration: By recognizing the benefits of technology in education, educators can effectively integrate digital tools and platforms into the curriculum. This integration enhances student engagement and prepares learners for a technology-driven world.
- Parent-Teacher Collaboration: Understanding the role of parental involvement in learners' performance encourages effective collaboration between parents and teachers. This partnership enhances support for students, leading to improved academic outcomes.
- Inclusive Education: Recognizing the holistic nature of learner's performance promotes inclusive education. By addressing cognitive, emotional, and behavioral aspects, educators can cater to diverse learning needs and create an inclusive learning environment.
- Motivation and Growth Mindset: An INTRODUCTION to learner's performance emphasizes the importance of fostering a growth mindset in students. By promoting a belief in their ability to improve, students are motivated to embrace challenges and strive for continuous progress.
- Evidence-Based Decision Making: The INTRODUCTION to learner's performance encourages educators and policymakers to base their decisions on research and data. Evidence-based practices lead to more effective educational policies and strategies.
- Long-Term Impact: A comprehensive understanding of learner's performance sets the foundation for long-term improvements in education. By addressing the various aspects that influence academic achievement, educators can make lasting positive changes in students' lives.

**Features of Learner’s Performance:** There are various features collectively shape a student's learner's performance, making it a multifaceted aspect of education that requires a

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holistic approach to understanding and nurturing students' academic growth and personal development. Features could be summarised as follows: -

- Cognitive Abilities: Learner's performance is influenced by various cognitive factors such as memory, attention, problem-solving skills, and critical thinking. A student's ability to process information and apply knowledge impacts their academic achievement.
- Emotional Factors: Emotions play a significant role in learner's performance. Positive emotions like curiosity and interest can enhance motivation, while negative emotions like anxiety can hinder learning outcomes.
- Behavioural Aspects: Learner's performance is influenced by students' study habits, time management skills, and perseverance. Effective study techniques and disciplined behaviour contribute to academic success.
- Learning Styles: Individual differences in learning styles, such as visual, auditory, kinaesthetic, and reading/writing, affect how students best acquire and retain information.
- Motivation and Engagement: Learner's performance is closely tied to students' level of motivation and engagement with the learning material. Intrinsic motivation leads to a more profound commitment to learning.
- Problem-Solving Abilities: The capacity to analyze and solve complex problems is a crucial feature of learner's performance. Students who can apply their knowledge to practical situations demonstrate higher academic achievement.
- Interpersonal Skills: Learner's performance is influenced by a student's ability to collaborate and communicate effectively with peers and teachers, fostering a positive and collaborative learning environment.
- Metacognition: The ability to monitor one's own learning process, set goals, and regulate learning strategies is a key feature of learner's performance, contributing to a deeper understanding of the material.
- Technology Integration: Learner's performance is influenced by the effective use of technology in education. Digital literacy and the incorporation of technology tools enhance learning experiences.
- Parental Support: The level of parental involvement and support in a student's education can impact their motivation, self-confidence, and overall academic performance.
- Classroom Environment: The learning environment, including the teaching methods, classroom culture, and teacher-student relationships, significantly affects learner's performance.
- Assessment and Feedback: Regular assessments and constructive feedback provide students with insights into their progress and areas for improvement, contributing to their overall performance.
- Personal Growth: Learner's performance is not limited to academic achievement but also includes personal growth and development, nurturing students' abilities and skills beyond the classroom.

- Resilience and Adaptability: Learner's performance can be influenced by a student's ability to adapt to challenges and setbacks, demonstrating resilience in the face of difficulties.
- Inclusivity: A learner's performance is enriched by an inclusive learning environment that accommodates diverse learning needs and ensures equal opportunities for all students.

## CONCLUSION

Understanding the complex interplay of cognitive, emotional, and behavioral factors is essential for comprehending learner's performance in education. As we embrace the diverse needs of students, educators and stakeholders can collaboratively create empowering learning environments that enable everyone to unlock their full potential. By nurturing a growth mindset, promoting emotional well-being, and harnessing the power of technology, we can set learners on a path to academic achievement and success beyond the classroom. In CONCLUSION, the INTRODUCTION to learner's performance offers numerous advantages for educators, policymakers, and stakeholders. It fosters personalized teaching, enhances the integration of technology, promotes collaboration, and empowers educators to create supportive and inclusive learning environments. By considering cognitive, emotional, and behavioral factors, educators can nurture students' academic success and equip them with the skills and mindset needed to thrive in a rapidly evolving world.

## REFERENCES

[1] Veerasamy, Ashok Kumar, Daryl D'Souza, Rolf Lindén, and Mikko-Jussi Laakso. "Relationship between perceived problem-solving skills and academic performance of novice learners in introductory programming courses." Journal of Computer Assisted Learning 35, no. 2 (2019): 246-255.

[2] Khan, Ijaz, Abir Al Sadiri, Abdul Rahim Ahmad, and Nafaa Jabeur. "Tracking student performance in introductory programming by means of machine learning." In 2019 4th mec international conference on big data and smart city (icbdsc), pp. 1-6. IEEE, 2019.

[3] Bergin, Susan, Ronan Reilly, and Desmond Traynor. "Examining the role of self-regulated learning on introductory programming performance." In Proceedings of the first international workshop on Computing education research, pp. 81-86. 2005.

[4] Tan, Lin Mei, and Fawzi Laswad. "Academic performance in introductory accounting: Do learning styles matter?." Accounting Education 24, no. 5 (2015): 383-402.

[5] Aly, Ibrahim. "Performance in an online introductory course in a hybrid classroom setting." Canadian Journal of Higher Education 43, no. 2 (2013): 85-99.

# Chapter: 39

# Leveraging Technology to Enhance Learner Engagement

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**ABSTRACT**

This article explores the role of technology in enhancing learner engagement. With the continuous advancement of digital tools and platforms, educators have new opportunities to captivate students' interest and create interactive learning experiences. The ABSTRACT highlights the potential benefits of leveraging technology to personalize instruction, foster active participation, and bridge the gap between in-classroom and remote learning. By presenting practical examples and considering ethical considerations, the article emphasizes the importance of purposeful technology integration to cultivate a dynamic and student-centric learning environment.

**KEYWORDS:** Leveraging Technology, Learner Engagement, Digital Tools, Interactive Learning, Personalized Instruction

## INTRODUCTION

In the digital era, technology has revolutionized the way we live, work, and learn. In education, the integration of technology has emerged as a powerful tool to enhance learner engagement. With the diverse array of digital tools and platforms available, educators could create dynamic and interactive learning experiences that captivate students' interest and deepen their understanding. This article explores the transformative impact of leveraging technology to foster active participation, personalize instruction, and bridge the gap between in-classroom and remote learning environments, ultimately empowering students to thrive in a technology-driven world.Students today are digital natives, born into a world where smartphones, tablets, and computers are part and parcel of daily existence. As such, they expect their educational journey to be enriched by the same technological advancements that have shaped their personal lives. Leveraging technology in education not only aligns with students' expectations but also capitalizes on the potential to revolutionize the traditional classroom experience. In the fast-paced world of education, where attention spans are shrinking and traditional teaching methods may struggle to captivate students, the integration of technology has emerged as a game-changer. Leveraging technology to enhance learner engagement has become a focal point for educators seeking to create dynamic, interactive, and meaningful learning experiences. With the vast array of digital tools, online platforms, and educational applications available, educators have a powerful arsenal at their disposal to capture students' interest, stimulate their curiosity, and foster a genuine passion for learning.

By recognizing the profound impact technology can have on learner engagement, educators are reimagining their teaching approaches to create a more interactive and student-centric learning environment. Whether in traditional brick-and-mortar classrooms or in the virtual realm of remote education, technology has the power to transform passive learners into active participants, empowering students to take charge of their learning journey. This article delves into the transformative potential of leveraging technology to enhance learner engagement. It explores the myriad ways in which digital tools and platforms can be harnessed to create personalized learning experiences, foster active participation, and bridge the gap between educators and learners. As we embark on this exploration, it becomes clear that the integration of technology is not simply about adopting the latest gadgets or trends; rather, it is a deliberate and purposeful effort to meet the evolving needs of modern learners and equip them with the skills necessary to thrive in an increasingly interconnected and digital world.

**Personalized Instruction and Adaptive Learning:** One of the most significant benefits of technology in education is the ability to personalize instruction based on individual student needs and learning styles. Adaptive learning platforms utilize data-driven insights to identify each student's strengths and areas for improvement, tailoring lessons to suit their unique requirements. By offering content at an appropriate level of difficulty and pace, technology ensures that learners remain challenged and motivated, enhancing their overall engagement in the learning process. In the traditional classroom setting, teachers face the challenge of accommodating the diverse learning needs of their students. While some learners grasp concepts quickly and thrive in a fast-paced environment, others may require additional time and support to master the same material. This variability in learning styles and paces often makes it difficult for educators to provide individualized attention to each student.

Personalized instruction and adaptive learning, made possible by leveraging technology, offer a revolutionary approach to address this challenge. By tailoring the learning experience to suit each student's unique strengths, weaknesses, and preferences, personalized instruction aims to optimize learning outcomes and enhance learner engagement. At the heart of personalized instruction lies adaptive learning, a concept driven by data analytics and artificial intelligence. Adaptive learning systems gather real-time data on students' performance, interactions, and progress. Through sophisticated algorithms, these systems analyze the data to identify patterns, strengths, and areas for improvement for each individual student. Based on these insights, the technology then adjusts the content, difficulty level, and learning pace to meet the student at their current skill level.

For instance, a student who excels in mathematics may be presented with more challenging problems to maintain engagement and stimulate further growth. On the other hand, a student who struggles with certain concepts might receive additional explanations, practice exercises, or alternative learning materials to reinforce understanding. The benefits of personalized instruction and adaptive learning are manifold. Students experience a heightened sense of ownership and control over their learning journey, as the content is customized to match their individual needs. This empowerment fosters a positive learning experience and encourages a growth mindset. Moreover, adaptive learning systems provide instant feedback and progress tracking, enabling students to identify their strengths and weaknesses accurately. This real-time feedback loop enhances metacognition, as students gain insight into their learning strategies and adjust accordingly.

Furthermore, the adaptive nature of the technology ensures that students are neither overwhelmed by content that is too challenging nor bored by material they have already mastered. This delicate balance keeps students engaged, motivated, and continuously progressing in their academic pursuits. Incorporating personalized instruction and adaptive learning into educational settings can occur in various ways. It may involve using educational software and digital platforms that adapt content based on individual responses. Additionally, online learning management systems and educational apps can facilitate personalized learning paths for students, providing a wealth of resources and interactive activities catered to their needs. However, it is crucial to acknowledge that technology is not a replacement for human educators; rather, it complements their efforts and empowers them to better support their students. Teachers play a pivotal role in interpreting data insights from adaptive learning systems and providing further guidance, mentorship, and encouragement to students. The personalized instruction and adaptive learning represent a paradigm shift in education. By leveraging technology to tailor the learning experience to individual students, educators can promote engagement, foster a love for learning, and ultimately unlock each student's full potential. As technology continues to advance, the potential for personalized and adaptive learning to revolutionize education and create a more equitable and inclusive learning environment becomes ever more promising.

**Interactive Learning Experiences:** Digital tools have redefined how students interact with educational content. From virtual simulations to interactive quizzes, technology brings subjects to life and transforms passive learners into active participants. Augmented reality (AR) and virtual reality (VR) enable students to explore historical sites, dive into the depths of the ocean, or even travel to distant planets, creating immersive and memorable learning experiences. Gamification techniques, such as rewards, badges, and leaderboards, inject an element of fun and competition, motivating students to stay engaged and continuously improve their performance. Interactive learning experiences are educational activities that require active participation and engagement from learners, going beyond passive consumption of information. These experiences can be implemented in various learning settings, including classrooms, workshops, online platforms, and informal learning environments. The key aspects of interactive learning experiences are:

**a. Hands-on Activities:** Learners directly engage with materials and objects to explore concepts and principles. This approach is common in science, technology, engineering, and mathematics (STEM) fields, where students conduct experiments or build models to deepen their understanding.

**b. Group Discussions:** Encouraging learners to participate in group discussions promotes critical thinking, communication skills, and the exchange of ideas and perspectives. It allows students to learn from each other and develop their viewpoints on a given topic.

**c. Simulations and Role-Playing:** Simulations replicate real-life scenarios, enabling learners to apply their knowledge and skills in a controlled environment. Role-playing exercises can help students empathize with different roles and understand complex situations better.

**d. Gamification:** Integrating game elements and mechanics into the learning process can make it more enjoyable and motivating. Points, badges, leaderboards, and challenges can create a sense of achievement and foster a competitive spirit.

**e. Interactive Multimedia:** Educational videos, animations, simulations, and virtual reality experiences immerse learners in the subject matter, making it more engaging and memorable. Visual and auditory stimuli enhance comprehension and retention.

**f. Collaborative Projects:** Group projects promote teamwork, collaboration, and communication skills. Learners work together to explore topics in-depth, share responsibilities, and solve problems collectively.

**g. Interactive Online Platforms:** Web-based tools and platforms provide interactive quizzes, exercises, and multimedia content to actively engage learners in self-paced or instructor-led courses. These platforms often track progress and offer personalized learning experiences.

**h. Field Trips:** Taking learners outside the classroom to relevant locations, such as museums, historical sites, or nature reserves, provides hands-on experiences and a deeper understanding of the subject matter in real-world contexts.

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**i. Problem-Based Learning:** Learners are presented with real-world problems to solve, fostering critical thinking, research skills, and creative solutions. This approach prepares students for real challenges they may encounter in their careers.

**j. Peer Teaching:** Allowing learners to teach and explain concepts to their peers reinforces their understanding of the material. This method enhances retention and confidence in their knowledge.

The benefits of interactive learning experiences include increased learner engagement, better retention of information, improved problem-solving abilities, and enhanced critical thinking skills. By actively participating in their learning, students develop a deeper understanding of the subject matter and are better equipped to apply their knowledge in practical situations. Effective implementation of interactive learning experiences can lead to more enjoyable and effective learning outcomes.

**Inclusivity and Access to Education:** Leveraging technology in education breaks down barriers to learning, making education more inclusive and accessible to all. With remote learning platforms and online courses, geographical constraints are no longer a hindrance, allowing students from diverse backgrounds to access quality education. Additionally, technology accommodates various learning styles and preferences, ensuring that every student can engage with the content in a way that suits them best. Inclusivity and access to education are crucial aspects of a fair and equitable society. They refer to providing all individuals, regardless of their background, abilities, gender, ethnicity, socioeconomic status, or geographic location, with equal opportunities to participate in and benefit from the educational system. Inclusivity and access to education are fundamental principles that strive to ensure that all individuals, regardless of their background, abilities, or circumstances, have equal opportunities to participate in and benefit from the educational system. Inclusivity in education focuses on creating learning environments that welcome diversity, respect different perspectives, and foster a sense of belonging for all students. An inclusive education system incorporates diverse perspectives, cultures, and histories into the curriculum, promoting understanding and empathy among learners.

**Seamless In-Classroom and Remote Learning:** The flexibility of technology allows for seamless transitions between in-classroom and remote learning. Cloud-based collaboration tools enable real-time interaction between students and teachers, fostering a sense of community and support regardless of physical location. Hybrid learning models combine the benefits of face-to-face instruction with the advantages of technology, providing a versatile and adaptive approach that caters to the changing needs of learners. Seamless in-classroom and remote learning, also known as hybrid or blended learning, refers to an educational approach that integrates both traditional face-to-face instruction and online learning experiences. The goal is to create a cohesive and flexible learning environment that allows students to transition smoothly between in-person and remote learning modes.

**Ethical Considerations and Digital Citizenship:** While technology offers numerous opportunities for learner engagement, it is essential to address ethical considerations and promote responsible digital citizenship. Educators must guide students in using technology responsibly, ethically, and safely. Developing critical digital literacy skills equips learners to navigate the vast sea of information available online, distinguishing credible sources from misinformation and promoting a thoughtful and informed approach to digital communication.In the digital age, ethical considerations and digital citizenship are essential aspects of responsible and respectful behaviour in online environments. Digital citizenship refers to the responsible use of technology and the internet, while ethical considerations involve the principles and values guiding one's actions in the digital real.

## CONCLUSION

Leveraging technology to enhance learner engagement is a transformative force in education. By personalizing instruction, fostering interactive learning experiences, and promoting inclusivity, technology empowers students to become active participants in their educational journey. As educators harness the potential of digital tools and platforms, they create dynamic and student-centric learning environments that inspire curiosity, ignite passion, and prepare students for success in the ever-evolving digital age. However, a mindful and ethical approach is essential to ensure that technology remains a means to enrich education, ultimately equipping learners with the skills they need to thrive in an increasingly interconnected world.

## REFERENCES

[1] Coates, Hamish. "Leveraging LMSs to enhance campus-based student engagement." Educause Quarterly 28, no. 1 (2005): 66-68.
[2] Ardi, Priyatno, and Elvira Rianita. "Leveraging gamification into EFL grammar class to boost student engagement." Teaching English with Technology 22, no. 2 (2022): 90-114.
[3] Coates, Hamish. "A model of online and general campus-based student engagement." Assessment & Evaluation in Higher Education 32, no. 2 (2007): 121-141.
[4] Campbell, Michael, Maridelys Detres, and Robert Lucio. "Can a digital whiteboard foster student engagement?." Social Work Education 38, no. 6 (2019): 735-752.
[5] Chaka, Chaka, Tlatso Nkhobo, and Mirriam Lephalala. "Leveraging Student Engagement through MS Teams at an Open and Distance E-Learning Institution." Journal of Education and e-Learning Research 9, no. 3 (2022): 136-146.

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# Chapter: 40

# Imperative Role of Various Materials Reflectance Used in Scheffler Dish

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**ABSTRACT**

A Scheffler reflector is a device which converts the Sun's radiation into energy. The receiver is placed at a distance from it to absorb the focused sunlight on it. The way to enhance the performance of a Scheffler reflector is to change the coating material. For a wide range of wavelengths different materials can be used for these coatings, and it is shown that by using different materials the heating output of Scheffler dishes can be enhanced. We have studied the performance analysis of reflectivity of various materials which can be used in Scheffler reflectors like aluminum and glass as well as silver and stainless steel are all great materials with high reflectance. As Scheffler reflector plays a significant part in renewable energy, it can be used in a variety of ways by modifying the material used to cover the reflector dish.

**KEYWORDS:** reflectivity, coating material, Scheffler reflectors

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## INTRODUCTION

The capacity to do work is called Energy. Humans need energy to function the internal and external body parts properly. Energy helps in the interaction of body parts with the external environment. Higher the energy, higher will be the functioning of body. We get energy from the food. So, food is essential for living beings like humans to circulate energy in the body. It is very necessary to take a good amount of food. Food taken for human consumption can be raw or can be cooked. In most of the cases the food should be cooked to increase the taste, nutrition, to prevent from food borne disease, and to proper digest [1]. Fuels used for cooking such as LPG, coal, Kerosene, Ethanol, etc. are all non-renewable substances. They are formed in nature in thousands of years. Also, they are in the category of being extinct and causing a lot of pollution to environment. So, it is necessary to come out with an alternate of these resources. Solar energy is the best alternate to replace these resources as it is present in the unlimited amount in nature and causes no pollution to the environment. As Sun is the best source of energy in the world. Solar radiation from the sun is capable of producing the heating effect [2]. For better utilization of solar energy in order to sustain solar heat we have flexible portable heat generating device known as Scheffler reflector invented by Wolfgang Scheffler. It is one of the setups to produce the renewable energy from sun. Scheffler reflector is a solar concentrator which concentrate the solar radiation from Sun and convert it into the energy which can be further used for various purposes. It consists of a large paraboloid or disk shape reflector which has to be tilted $15^0$ per hour to track rotation of the earth [3]. The receiver is placed at a distance from the reflector to absorb the focused sunrays on it. Scheffler Reflector has found application in cooking, coffee-making, desalination, cremation etc. The shape of scheffler reflector should be like that it reflects the maximum of sunrays. Paraboloid shape reflects the maximum number of sunrays, also have the converging property of light due to which it focuses the light on a single point [4]. Using paraboloid shape for reflector the efficiency will be increased to a certain limit. The continuity of the paper is as: first introductory phase, followed by literature and working of Scheffler reflector, followed by methodology and then conclusion and future scope.

## LITERATURE REVIEW

A large amount of research has been carried out in the study of Scheffler dish for generating various heating temperature which can be used in wide range of applications. Also, many types of material are analyzed the heating impact of Scheffler reflector. Below Table No.1 is showing the Scheffler reflector used in various application under different size of reflector dish (2- 16 square meter) by the research scholars.

### Table No.1: Various application of Scheffler reflectors

| S.no | Authors name | Size of Reflector | Application | Discussion |
|---|---|---|---|---|
| **1.** | Desireddy Reddy et al | 2 $m^2$ | General | Provide a method for reducing design error by using MATLAB [8]. |
| **2.** | José Ruelas et al | 2 $m^2$ | General | Analyzed the behavior of various reflectors to increase the size efficiency [9]. |
| **3.** | Thirunavukkarasu et al. | 16 $m^2$ | Thermal application | Study of the aspect ratio variation on the performance analysis of the scheffler reflectors receiver worked experimentally [10]. |
| **4.** | Kumar et al | 16 $m^2$ | General | Study reflector parameters like heat characteristics, Optical competence etc. in different regions of India [11]. |
| **5.** | Jayasimha et. al | 16 $m^2$ | Process Industry | Scheffler reflectors were used to clean condenser equipment in dry cleaning, industrial laundry and steam generating. [12]. |
| **6.** | Tyrolleret. al | 10 $m^2$ | Steam sterilizer | For rural hospitals, Scheffler reflectors were used in solar steam sterilizers [13]. |
| **7.** | Chandak et al | 16 $m^2$ | Food processing | Scheffler reflectors were industrial used to generate portable water for purification [14]. |
| **8.** | Chandrashekara M. et al. | 2 $m^2$ | Desalination | Exfoliated graphite coating plays important role enhancing the thermal performance of Scheffler receiver [7]. |
| **9.** | Chandrashekara M. et al. | 2 $m^2$ | Desalination | Study of material and its property having great heat retainability were discussed [15]. |
| **10.** | Srivastava and Yadav | 1.54 $m^2$ | Water production | Composite material was show to attain water from atmosphere moisture. [16]. |
| **11.** | Kamboj and Yadav | 1.54 $m^2$ | Coffee making | Coffee maker with latest technology were proposed using Scheffler [17]. |
| **12.** | Anish Malan et al | 1.54 $m^2$ | Desiccant Regeneration | Desiccant materials were used to compute the regeneration time by measuring wind speed, solar intensity, temperature and the receiver of the Scheffler reflector. [18]. |
| **13.** | Nahar N.M. et. al. | 16 $m^2$ | Cooking | A series of experiments were carried out in order to enhance the performance of the solar cooker by 20% using a standard box-type solar cooker working with motor oil for storing heat [19]. |
| **14.** | Ramadan et al | 16 $m^2$ | Cooking | For Luminous day, cooking using sand plays important role in Scheffler for heat retention [20]. |
| **15.** | Schwartzer et al. | 16 $m^2$ | | Vegetable oil as heat absorber for working in non-luminous period [21]. |
| **16.** | Domanski R. et al. | 16 $m^2$ | Cooking | Phase Change Material like Magnesium Nitrate Hexa-hydrate were used in box type solar cooker for storing heat [22]. |
| **17.** | Indora and Kabdpal | 16 $m^2$ | Cooking | Scheffler reflector majorly used in cooking application and found economical in many regions. With different setting of the solar cooking scheffler was reliably used for the institutional kitchen [23]. |

From the past research we got the information that Scheffler is mainly used for cooking and other heating applications. A wide range of work has also been carried out for the heat storage devices and on its materials but very few Scholars have focused on the materials reflectance for the Scheffler dish. The variation of reflectance for the different types of materials is discussed in this article.

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## METHODOLOGY

The sunlight falls on the reflector, the reflector absorbs the sunlight even in the rainy days, when the Sun is not present for a long time (small amount of sunlight will be approaching the earth) [5]. In this condition the reflector of scheffler reflector will absorb enough number of sunrays due to the coating of highly sensible materials like copper or aluminum.

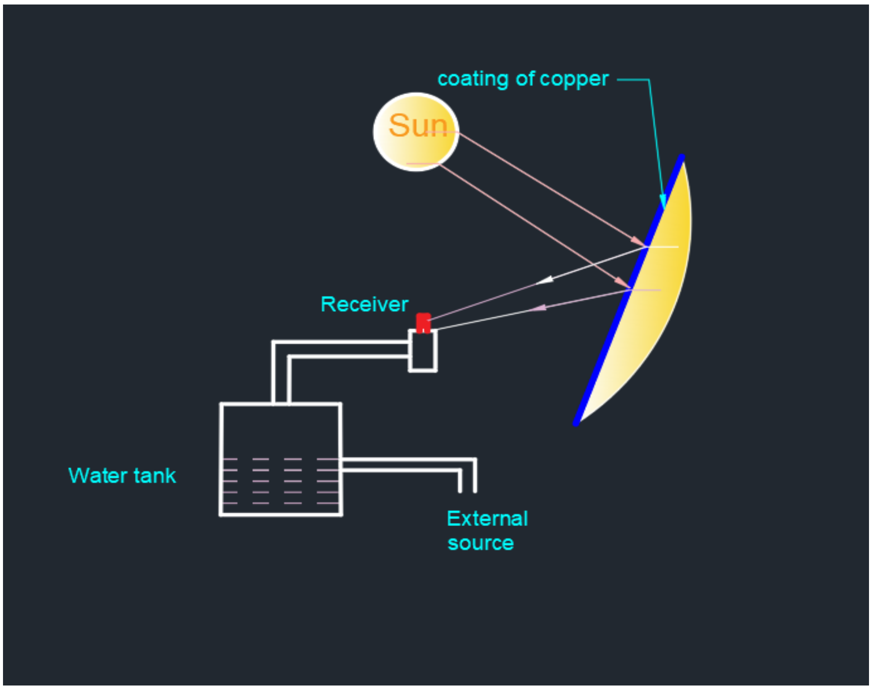


**Fig. 1.: Scheffler working and storage.**

After absorbing the sunrays, the reflector focuses the rays to the receiver (which will also be coated with material for increasing the efficiency). The amount of energy received by receiver can be used for many purposes like cooking, coffee making, etc. according to necessity. The remaining energy which is not utilized by the receiver for any purpose has to be stored now. For this the receiver is connected to a small water tank [6].

The heat will pass from the receiver to the water tank and will get stored in the tank now [7]. The tank is well insulated to prevent the energy losses from the tank. Now we can use this stored energy from the tank by connecting any external source with the tank. By this we can store the energy for future uses.

## METHODS TO INCREASE THE EFFICIENCY OF SCHEFFLER REFLECTOR

Number of attempts by various researchers to increase the efficiency by varying the size and degree of rotation of reflector has been implemented and multiple combination of material has also been studied on Scheffler dish coating to studied variation in temperature that altered the efficiency of a Scheffler Reflector.

Also, efficiency can be increased by using few methods like a suitable metal or substance in the coating of reflector. By storing the absorbed sunlight and using it for forthcoming [24]. Here we will discuss the reflectance of different metal coating on the scheffler reflector. As efficiency is defined, the potential to supply something with a minimum amount of effort.

The same thing we want in the case of Scheffler reflector, as in the rainy season, there is a problem of sunlight as Sun does not appear for a long. So, we have to achieve the best possible outcome even when the Sun is no long present. We can use a suitable metal or substance that absorb the sunrays even when the sunrays are diffuse. In diffuse reflectance the rays are reflected in scattering manner [25].

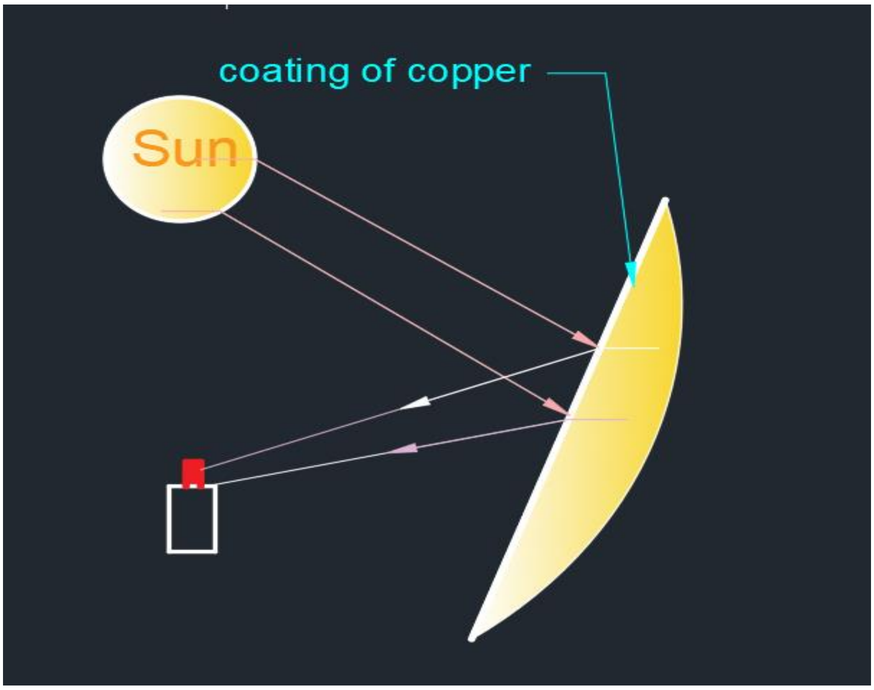


**Fig. 2: Copper coating of Scheffler reflector**

Metals with an atomic structure which donate electrons easily, such as copper and aluminium, have greater thermal conductivity, which means heat flows quickly through metals. Also, copper does not react with water. Several metals, on the other hand, have melting temperatures of above 500 degrees Celsius, making them appropriate for solar applications.

Metal readily captivates and pass heat while enduring high temperatures, which is how many solar setups collect energy. Few Plastics with reflecting coatings have relatively low melting temperatures, still plastic may be useful for solar energy equipment minimal temperature requirement. Shrill coatings of aluminium, silver and other metals serve as operative light reflectors in solar applications that utilise mirrors [26]. Below Table 2 is Showing reflectance of various materials across different wavelength.

It is clear that aluminum and glass have a high reflectance in low wavelength range. Whereas for medium and high wavelength materials like copper and silver are showing high reflectance. We can also see that stainless steel is also showing good reflectance but well below the other mentioned materials.

**Table No. 2:** Reflectance of various materials across different wavelength [26]

| Wavelength | Material | Reflectance (%) |
|---|---|---|
| **300** | Aluminium | 80-87 |
| **400** | Glass | 80-99 |
| **500** | Copper | 70-75 |
| **600** | Silver (highly polished) | 90-92 |
| **700** | Stainless Steel | 55-65 |

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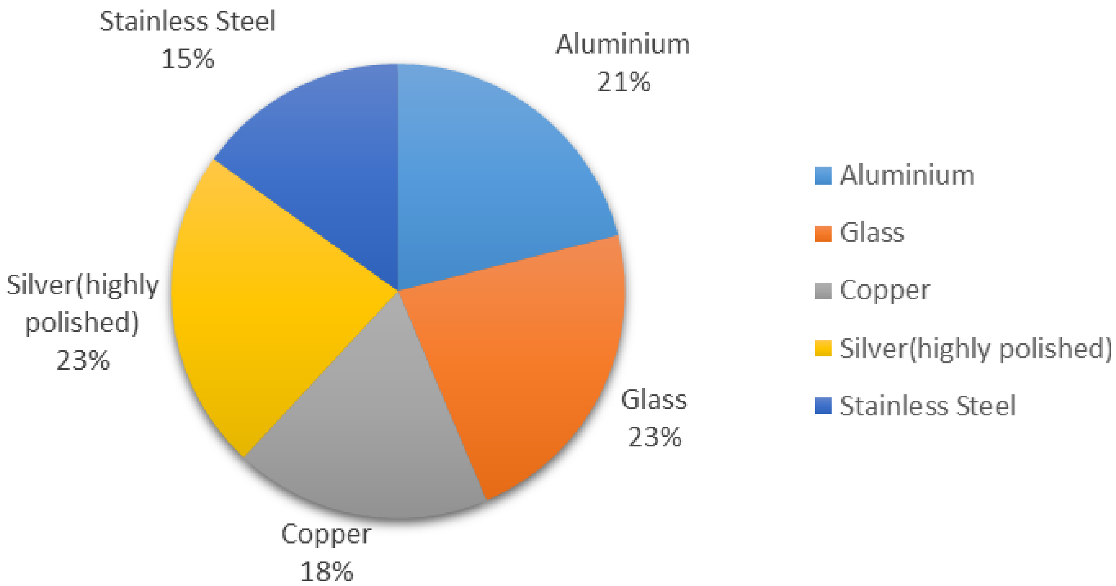


**Fig. 3: Reflectance of various materials**

## CONCLUSION & FUTURE SCOPE

As scheffler reflector is playing important role in renewable energy sector and its usage can be altered in many ways by changing various materials as coating over reflector dish. Number of literatures by research scholars has been studied showing different application area of usage on various size of reflectors. In order to enhance the Scheffler performance various materials can be used for coating on scheffler dish. Materials like aluminum, glass, copper, silver and steel across different wavelengths of sunlight ranging from 300-700 nm projecting different reflectance, indicating the enrichment of heating output of scheffler. For smaller wavelength of 300nm-400nm, aluminum and glass are generating better reflectance and for higher wavelength of around 500nm-700nm silver and copper material coating are projecting high reflectance. Stainless steel is showing satisfactory results at high wavelength. This conclude that material like aluminum and glass can be used for lower wavelength and for higher wavelength materials silver, copper and steel are preferable. For impending improvement other material with better heat storing properties can be replaced to store large amount of heat and for scheffler receiver material can also be applied and tested so that it can absorb large content of heat.

## REFERENCES

[1] Patel, R., & Patel, V. (2020). Scheffler reflector for cooking application: a review. International Journal of Ambient Energy, 1-13

[2] Panchal HN, 2016, “Use of Thermal Energy Storage Materials for Enhancement in Distillate Output of Solar Still: A Review”, Renewable and Sustainable Energy Reviews, 61, 86–96

[3] Scheffler W, Bruecke S, von Werdenbergstr G. Development of a solar crematorium. In: Proceedings of 6th international conference on solar cooker, Granada, Spain; 2006

[4] Islam, Q. U., & Khozaei, F. (2019, September). The Review of Studies on Scheffler Solar Reflectors. In International Conference on Innovation in Modern Science and Technology (pp. 589-595). Springer, Cham.

[5] Sareriya, K. J., Andharia, J. K., Vanzara, P. B., & Maiti, S. (2021). A comprehensive review of design parameters, thermal performance assessment, and medium temperature solar thermal applications of Scheffler concentrator. Cleaner Engineering and Technology, 100366.

[6] Dafle VR, Shinde NN. Design, development and performance evaluation of concentrating monoaxial Scheffler technology for water heating and low temperature industrial steam application. IJERA 2012; 6: 848–852.

ISBN: 978-81-961781-9-2

[7] Chandrashekara, M., & Yadav, A. (2017). An experimental study of the effect of exfoliated graphite solar coating with a sensible heat storage and Scheffler dish for desalination. Applied Thermal Engineering, 123, 111-122.

[8] Reddy, D. S., Khan, M. K., Alam, M. Z., & Rashid, H. (2018). Design charts for Scheffler reflector. Solar Energy, 163, 104-112.

[9] Ruelas, J., Palomares, J., & Pando, G. (2015). Absorber design for a Scheffler-type solar concentrator. Applied Energy, 154, 35-39.

[10] Thirunavukkarasu, V., Sornanathan, M., & Cheralathan, M. (2017). An experimental study on energy and exergy performance of a cavity receiver for solar parabolic dish concentrator. International Journal of Exergy, 23(2), 129-148.

[11] Kumar, A., Prakash, O., & Kaviti, A. K. (2017). A comprehensive review of Scheffler solar collector. Renewable and Sustainable Energy Reviews, 77, 890-898.

[12] Jayasimha, B. K., Akashwani, O., & Hadapsar, P. (2006, July). Application of Scheffler reflectors for process industry. In 6th International Conference on Solar Cocker, Granada, Spain.

[13] Yadav, M. K., Modi, A., & Kedare, S. B. (2021). Solar Autoclave for Rural Hospitals Using Aerogel as Transparent Insulation Material. In Proceedings of the 7th International Conference on Advances in Energy Research (pp. 1667-1677). Springer, Singapore.

[14] Chandak, A.J., Somani, S.M. Industrial oven powered with a pair of Scheffler solar concentrators. Proceedings of International conference on Solar cooking and food processing, Indore, India. 14-16 Jan 2016.

[15] Chandrashekara, M., & Yadav, A. (2017). Experimental study of exfoliated graphite solar thermal coating on a receiver with a Scheffler dish and latent heat storage for desalination. Solar Energy, 151, 129-145

[16] Srivastava, S., & Yadav, A. (2019). Economic analysis of water production from atmospheric air using Scheffler reflector. Applied Water Science, 9(1), 1-10.

[17] Kamboj, V., Agrawal, H., Malan, A., & Yadav, A. (2021). Thermal performance of the steam boiler based on Scheffler solar concentrator for domestic application: Experimental investigation. Australian Journal of Mechanical Engineering, 19(5), 521-531.

[18] Malan, A., Kamboj, V., Sharma, A. K., & Yadav, A. (2020). The regeneration of various saturated solid and novel composite desiccant using Scheffler solar concentrator: an experimental investigation. International Journal of Ambient Energy, 41(2), 224-236.

[19] Pande, P. C., Nahar, N. M., Chaurasia, P. B. L., Mishra, D., Tiwari, J. C., & Kushwaha, H. L. (2009). Renewable energy spectrum in arid region. Trends in arid zone research in India, 210-237.

[20] El Hage, H., Herez, A., Ramadan, M., Bazzi, H., & Khaled, M. (2018). An investigation on solar drying: A review with economic and environmental assessment. Energy, 157, 815-829.

[21] Schwarzer, K., & Da Silva, M. E. V. (2003). Solar cooking system with or without heat storage for families and institutions. Solar Energy, 75(1), 35-41.

[22] El-Sebaii, A. A., Domański, R., & Jaworski, M. (1994). Experimental and theoretical investigation of a box-type solar cooker with multi-step inner reflectors. Energy, 19(10), 1011-1021.

[23] Indora, S., & Kandpal, T. C. (2018). Institutional cooking with solar energy: A review. Renewable and Sustainable Energy Reviews, 84, 131-154.

[24] Senthil Ramalingam., Gupta Mukund. & Rath Chinmaya. (2017). Parametric analysis of a concentrated solar receiver with Scheffler reflector. International Journal of Mechanical and Production Engineering Research and Development, 7(5), 261-268.

[25] Panchal, H., Patel, J., Parmar, K., & Patel, M. (2020). Different applications of Scheffler reflector for renewable energy: a comprehensive review. International Journal of Ambient Energy, 41(6), 716-728.

[26] Mark S. Rea, ed., The IESNA Lighting Handbook: REFERENCE and Application, Ninth Edition. (New York: Illuminating Engineering Society of North America, 2000), 1-22.

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# Chapter: 41

# Deep Learning for Medical Image Processing: Overview, Challenges and the Future

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**ABSTRACT**

The health care sector is totally different from any other industry. It is a high priority sector and consumers expect the highest level of care and services regardless of cost. The health care sector has not achieved society’s expectations, even though the sector consumes a huge percentage of national budgets. Mostly, the interpretations of medical data are analyzed by medical experts. In terms of a medical expert interpreting images, this is quite limited due to its subjectivity and the complexity of the images; extensive variations exist between experts and fatigue sets in due to their heavy workload. Following the success of deep learning in other real-world applications, it is seen as also providing exciting and accurate solutions for medical imaging, and is seen as a key method for future applications in the health care sector.

**KEYWORDS—**Deep Learning, Medical Image Analysis, Image Analysis

## INTRODUCTION

Gone are the days when health care databases were small. Due to the tremendous advancement in image acquisition devices, the increase in throughput and the installation of bio-medical data collection devices have led to an unprecedented amount of data. This data is high dimension (CT, MRI, etc.), rich in variables and collected from many (often incompatible) data platforms. It makes medical data challenging and of great interest for analysis, especially images. This rapid growth in medical images requires extensive and tedious effort from medical experts—work that is subjective, prone to human error and that may have large variations from expert to expert. An alternative solution is to use machine learning techniques to automate the process of diagnosis; however, traditional machine learning methods are not sufficient to deal with such complex problems. A happy marriage of high-performance computing with machine learning promises the capacity to access big medical image data for accurate and efficient diagnosis.

## LITERATURE SURVEY

Deep learning has made significant advancements in various domains, including medical image processing. It has revolutionized the field by providing automated and accurate solutions for tasks such as disease detection, segmentation, classification, and image enhancement. Here is a brief literature survey highlighting some key research papers in the field of deep learning in medical image processing. Deep Learning in Medical Image Analysis" by Litjens et al. (2017). This comprehensive survey paper discusses the application of deep learning techniques, such as convolution neural networks (CNNs) and recurrent neural networks (RNNs), in medical image analysis tasks, including tumor detection, organ segmentation, and disease diagnosis. "Deep Learning for Medical Image Analysis: A Review" by Shen et al. (2017).This review paper provides an overview of deep learning methods, architectures, and applications in medical image analysis. It covers a wide range of topics, including image segmentation, registration, detection, and classification, with a focus on CNN-based approaches. Deep Learning in Medical Imaging: Overview and Future Promise of an Exciting New Technique" by Greenspan et al. (2016). This paper presents an overview of deep learning techniques applied to medical imaging, including computer-aided diagnosis, lesion detection, and image reconstruction. It discusses the challenges, benefits, and potential future developments in the field. Deep Learning for Medical Image Segmentation: A Survey" by Litjens et al. (2017).This survey paper focuses specifically on deep learning methods for medical image segmentation. It provides an in-depth analysis of different segmentation techniques and architectures used for specific medical imaging modalities, such as magnetic resonance imaging (MRI) and computed tomography (CT). Deep Learning in Healthcare: A Review" by Miotto et al. (2018).Although not focused solely on medical image processing, this paper offers a comprehensive review of deep learning applications in healthcare, including medical imaging. It covers topics such as disease diagnosis, prognosis, treatment planning, and genomics, providing insights into the impact of deep learning in the broader healthcare domain. Deep Learning in Medical Image Analysis: Challenges and Applications" by Zhu et al. (2018).This paper presents an overview of challenges and applications of deep learning in medical image analysis. It discusses issues related to limited labeled data, interpretability of deep models, and provides insights into different deep learning architectures used for medical image processing tasks.

## DEEP LEARNING IN MEDICAL IMAGING

Deep learning has shown tremendous potential in medical imaging, revolutionizing the field by providing automated and accurate solutions for various tasks. Here are some key applications of deep learning in medical imaging. Disease Detection and Diagnosis. Deep learning models, particularly convolutional neural networks (CNNs), have been used for automated detection and diagnosis of diseases in medical images. Examples include the detection of lung cancer in chest X-rays or CT scans, identification of diabetic retinopathy in retinal images, and classification of breast lesions in mammograms. Image Segmentation. Deep learning models have been applied to segment and identify specific structures or regions within medical images. This includes segmenting tumors, organs, blood vessels, and other anatomical structures. Deep learning techniques such as U-Net and Mask R-CNN have shown great success in medical image segmentation tasks.Image Reconstruction and Enhancement. Deep learning has been utilized to reconstruct and enhance medical images, improving image quality, resolution, and reducing noise. Generative adversarial networks (GANs) and variational autoencoders (VAEs) have been employed for image synthesis and super-resolution tasks, enabling sharper and more detailed medical images.Radiomics and Predictive Modeling.

Deep learning models have been used to extract high-dimensional features from medical images, which are then integrated with clinical data to develop predictive models for prognosis, treatment response, and disease outcomes. This field of study, known as radiomics, leverages deep learning to extract valuable information from medical images beyond what can be observed by the human eye.Image Registration and Fusion. Deep learning approaches have been employed for image registration and fusion, aligning and combining multiple medical images from different modalities or timepoints. These techniques enable accurate comparison and analysis of images for treatment planning, monitoring disease progression, and image-guided interventions. Image Reconstruction from Limited Data. Deep learning methods, such as deep neural networks and compressed sensing techniques, have been used to reconstruct medical images from limited or incomplete data. This has the potential to reduce radiation dose in CT scans, acquisition time in MRI, and improve image quality in other imaging modalities.

Deep learning techniques continue to evolve, and ongoing research aims to address challenges related to interpretability, generalizability, and ethical considerations. The application of deep learning in medical imaging holds great promise for improving diagnostic accuracy, treatment planning, and patient outcomes in various medical specialties.

## OPEN RESEARCH ISSUES AND FUTURE DIRECTIONS

While deep learning has made significant progress in medical image processing, several open research issues and future directions remain. Addressing these challenges can further advance the field and improve the application of deep learning in healthcare. Here are some key open research issues and future directions. Deep learning models often lack interpretability, making it challenging to understand the reasoning behind their decisions. Developing methods to interpret and explain the predictions made by deep learning models in medical image analysis is crucial for gaining trust from healthcare professionals and ensuring the models' transparency. Annotated medical imaging datasets are often limited in size due to the need for expert radiologists to label the data. Developing methods for effective utilization of limited labeled data, such as transfer learning, semi-supervised learning, and active learning, can enable training deep learning models with improved performance.

Deep learning models may struggle to generalize well to new data or handle variations in imaging protocols, equipment, and patient populations. Developing techniques to improve the generalization and robustness of deep learning models across different medical imaging modalities, acquisition parameters, and patient demographics is essential. Deep learning models typically provide point estimates, but in medical imaging, uncertainty estimation is crucial for decision-making. Developing techniques to estimate and quantify uncertainties in deep learning predictions can enhance their clinical applicability and provide clinicians with more confidence in the model's outputs. Medical imaging datasets contain sensitive patient information, necessitating robust privacy and security measures. Research is needed to develop privacy-preserving deep learning techniques, such as federated learning, differential privacy, and secure multi-party computation, to ensure patient data protection while enabling collaborative research and model sharing. Integration with Clinical Workflow: Integrating deep learning models seamlessly into clinical workflows is crucial for real-world adoption.

Developing methods for integrating deep learning models with electronic health records (EHRs) and picture archiving and communication systems (PACS) can facilitate efficient utilization of the models in clinical practice. Deep learning in medical imaging raises ethical concerns, such as algorithmic bias, fairness, and accountability. Addressing these issues requires developing guidelines, policies, and frameworks to ensure equitable and responsible deployment of deep learning models in healthcare. Combining information from multiple imaging modalities and scales can enhance the performance and clinical utility of deep learning models. Research on developing techniques for effective fusion of multimodal and multiscale medical imaging data can improve disease detection, characterization, and treatment planning. Deep learning models often have high computational requirements, limiting their deployment in real-time or resource-constrained settings. Developing techniques for efficient model architectures, model compression, and hardware acceleration can enable real-time inference on edge devices, facilitating point-of-care applications. Rigorous clinical validation studies are essential to assess the performance and clinical impact of deep learning models in medical imaging. Conducting large-scale multi-center studies, evaluating the models' effectiveness across diverse patient populations, and addressing regulatory challenges are critical for the widespread adoption of deep learning in clinical practice. Addressing these open research issues and future directions will contribute to the advancement and responsible deployment of deep learning in medical image processing, enabling improved patient care, accurate diagnoses, and personalized treatment strategies in healthcare.

## APPLICATIONS

Deep learning has found numerous applications in medical image processing, enabling more accurate and efficient analysis of medical images. Some key applications include like Disease Detection and Diagnosis where Deep learning models have been employed to automatically detect and diagnose diseases in medical images. For example, deep learning algorithms have been developed to detect and classify lung nodules in chest X-rays or CT scans, identify tumors in MRI scans, and diagnose diabetic retinopathy in retinal images. Deep learning techniques are used for precise segmentation of anatomical structures and lesions in medical images. Convolution neural networks (CNNs) and U-Net architectures, for instance, have been applied to segment organs, tumors, blood vessels, and other structures in various imaging modalities, aiding treatment planning and disease monitoring. Deep learning models have been used for classification tasks, enabling the identification of specific image patterns or features. This includes the classification of different types of cancers, Alzheimer's disease stages, or tissue types in histopathology images.

CNNs are commonly employed for image classification in medical imaging. Deep learning algorithms have been utilized for image reconstruction and enhancement, improving the quality and resolution of medical images. Generative adversarial networks (GANs) and deep super-resolution networks help reconstruct high-quality images from low-resolution or noisy inputs, enhancing image details and reducing artifacts. Deep learning models are applied to extract high-dimensional features from medical images, which are then integrated with clinical data for predictive modeling. These models can provide insights into disease prognosis, treatment response, and patient outcomes. Deep learning also plays a crucial role in image registration and fusion, aligning images from different modalities or time points and facilitating accurate comparisons and interventions. Moreover, deep learning techniques have been utilized for data augmentation, synthesis, and quality assessment, addressing data scarcity and ensuring reliable and robust medical image analysis. However, challenges and research directions remain. Interpretability and explainability of deep learning models in medical image processing need to be further explored to gain the trust of healthcare professionals and ensure transparency. Limited labeled data, generalization across different imaging modalities, patient populations, and integration into clinical workflows are areas that require continued research and development. Ethical considerations, data privacy, and security are also important factors in the deployment of deep learning in medical imaging.

Radiomics approaches leverage deep learning to extract valuable information from medical images beyond human visual analysis. Deep learning techniques enable accurate image registration and fusion of multiple medical images, aligning images from different modalities or timepoints. This aids in treatment planning, tracking disease progression, and image-guided interventions. Deep learning algorithms have been employed for deformable image registration and multimodal image fusion. Deep learning can generate synthetic medical images or augment existing datasets, addressing the challenge of limited annotated data.

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Generative models like GANs and variational autoencoders (VAEs) can create realistic medical images, aiding in training robust deep learning models and overcoming data scarcity. Deep learning algorithms have been developed to assess the quality and reliability of medical images, enabling automatic identification of artifacts, noise, and other image quality issues. This assists radiologists in identifying image quality problems and ensuring accurate diagnosis. These applications highlight the significant impact of deep learning in medical image processing, empowering healthcare professionals with advanced tools for diagnosis, treatment planning, and patient care. Continued research and advancements in deep learning techniques hold immense potential for further improving the accuracy, efficiency, and clinical utility of medical image analysis.

## CONCLUSION

Deep learning has brought about remarkable advancements in the field of medical image processing. The application of deep learning techniques to medical images has revolutionized disease detection, diagnosis, segmentation, classification, and image enhancement. By leveraging convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative models, deep learning has significantly improved the accuracy, efficiency, and automation of medical image analysis.

Deep learning algorithms have demonstrated their effectiveness in detecting and diagnosing diseases, such as lung cancer, diabetic retinopathy, and various tumors, in medical images. The segmentation of organs, lesions, and anatomical structures has become more precise and reliable with the use of deep learning techniques, aiding in treatment planning and disease monitoring. Additionally, deep learning has contributed to image reconstruction and enhancement, generating high-resolution images from low-quality inputs and reducing noise artifacts. The extraction of high-dimensional features from medical images has enabled the development of predictive models for disease prognosis, treatment response, and patient outcomes.

Collaboration between researchers, clinicians, and regulatory bodies is crucial to validate the clinical efficacy and safety of deep learning models and ensure responsible adoption in healthcare settings. Overall, deep learning has emerged as a powerful tool in medical image processing, with the potential to enhance diagnostic accuracy, improve treatment planning, and advance patient care. Continued advancements and interdisciplinary collaborations will drive further innovation and contribute to the transformation of healthcare through deep learning in medical imaging.

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## REFERENCES

[1] Litjens, G., Kooi, T., Bejnordi, B. E., Setio, A. A. A., Ciompi, F., Ghafoorian, M., ... & Sánchez, C. I. (2017). A survey on deep learning in medical image analysis. Medical image analysis, 42, 60-88.

[2] Shen, D., Wu, G., & Suk, H. I. (2017). Deep learning in medical image analysis. Annual review of biomedical engineering, 19, 221-248.

[3] Greenspan, H., Van Ginneken, B., & Summers, R. M. (2016). Deep learning in medical imaging: overview and future promise of an exciting new technique. IEEE transactions on medical imaging, 35(5), 1153-1159.

[4] Litjens, G., Ciompi, F., & Sánchez, C. I. (2017). Deep learning for medical image segmentation: A review. Deep learning for medical image analysis, 3-26.

[5] Miotto, R., Wang, F., Wang, S., Jiang, X., & Dudley, J. T. (2018). Deep learning for healthcare: review, opportunities and challenges. Briefings in bioinformatics, 19(6), 1236-1246.
[6] Zhu, W., Lou, Q., Vos, P. M., & Zhang, J. (2018). Deep learning in medical image analysis: challenges and applications. Medical physics, 45(7), e793-e800.
[7] Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., & Thrun, S. (2017). Dermatologist-level classification of skin cancer with deep neural networks. Nature, 542(7639), 115-118.
[8] Ronneberger, O., Fischer, P., & Brox, T. (2015). U-net: Convolutional networks for biomedical image segmentation. In International Conference on Medical image computing and computer-assisted intervention (pp. 234-241). Springer.
[9] Huang, G., Liu, Z., Van Der Maaten, L., & Weinberger, K. Q. (2017). Densely connected convolutional networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 4700-4708).
[10] Litjens, G., Sánchez, C. I., Timofeeva, N., Hermsen, M., Nagtegaal, I., Kovacs, I., ... & Van Der Laak, J. (2016). Deep learning as a tool for increased accuracy and efficiency of histopathological diagnosis. Scientific reports, 6(1), 1-11.

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# Chapter: 42

## Knowledge Graphs for Recommender System

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**ABSTRACT**

To solve the information explosion problem and enhance user experience in various online applications, recommender systems have been developed to model users preferences. Although numerous efforts have been made toward more personalized recommendations, recommender systems still suffer from several challenges, such as data sparsity and cold start. In recent years, generating recommendations with the knowledge graph as side information has attracted considerable interest. Such an approach can not only alleviate the abovementioned issues for a more accurate recommendation, but also provide explanations for recommended items. In this paper, we conduct a systematical survey of knowledge graph-based recommender systems. Knowledge graphs for recommender systems refer to the representation and utilization of structured knowledge in the form of graphs to enhance the recommendation process. Knowledge graphs provide a means to organize and link various entities and their relationships, enabling the system to have a comprehensive understanding of user preferences, item characteristics, and domain-specific knowledge.

**KEYWORDS:** Knowledge Graph, Recommender System, Explainable Recommendation.

## INTRODUCTION

Entity Representation: In a knowledge graph, entities such as users, items, attributes, and relationships are represented as nodes, while the connections between these nodes are represented as edges. Each node and edge may have additional properties and attributes associated with them, providing a rich representation of the underlying information. User Modeling. Knowledge graphs can capture user preferences, behaviour, and contextual information.[1] By incorporating user-specific data into the graph, such as their interactions, demographics, and social connections, the recommender system gains a holistic understanding of each user's interests and preferences.[2] This information can be leveraged to make personalized recommendations. Item Representation: Items in a recommender system, such as products, movies, or articles, can be represented as nodes in the knowledge graph. Each item node can include attributes such as genre, author, release date, or product features. By capturing detailed item information, the recommender system can better understand item characteristics and similarities, enabling more accurate recommendations.

Knowledge Integration i.e., knowledge graphs can integrate external domain-specific knowledge, such as semantic relationships, taxonomies, or ontologies, into the recommendation process.[3][4] This additional knowledge enriches the graph by establishing connections between related entities or providing hierarchical information. For example, a knowledge graph for movie recommendations could include relationships like "directed by," "starring," or "belongs to genre." Recommendation Generation: With the ABSTRACT knowledge graph in place, recommender systems can employ various algorithms and techniques to generate recommendations. Graph-based algorithms can utilize graph traversal, node similarity, or path-based reasoning to identify relevant items based on user preferences, item characteristics, and the underlying knowledge graph structure. Contextual Recommendations: Abstract knowledge graphs can incorporate contextual information, such as time, location, or user context, into the recommendation process. By leveraging the graph's contextual relationships and attributes, the recommender system can generate context-aware recommendations that are more relevant and timelier. Overall, ABSTRACT knowledge graphs

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provide a flexible and powerful framework for recommender systems by incorporating structured knowledge, user preferences, and item characteristics. By leveraging graph-based algorithms and reasoning techniques, recommender systems can make more accurate and personalized recommendations, enhancing the user experience.

## LITERATURE SURVEY

"A Survey of Knowledge Graphs: Representation, Acquisition, and Applications" by Niket Tandon, Gerard de Melo, and Gerhard Weikum. This survey provides an overview of knowledge graph representation, acquisition methods, and applications. It covers topics such as ontology-based knowledge graphs, construction techniques, and use cases in areas like search engines, question answering, and recommendation systems. “Knowledge Graphs" by Maximilian Nickel, Kevin Murphy, Volker Tresp, and Evgeniy Gabrilovich. This survey focuses on the construction and applications of knowledge graphs. It discusses approaches for knowledge extraction, representation learning, and reasoning in knowledge graphs. It also covers applications in natural language processing, information retrieval, and recommendation systems."A Survey on Knowledge Graphs: Representation, Acquisition and Querying" by Shirui Pan, et al. This survey provides an in-depth analysis of knowledge graph representation, acquisition methods, and querying techniques. It discusses various graph-based representation models, entity and relation extraction techniques, and query languages for knowledge graphs. It also highlights challenges and future directions in the field.

"Knowledge Graphs: Techniques, Applications and Challenges" by Fajar J. Ekaputra, et al. This survey explores knowledge graph techniques, applications, and challenges. It covers topics such as knowledge graph construction, completion, reasoning, and quality assessment. It also discusses applications in areas like semantic search, recommendation systems, and social network analysis.” Graph Data Management: Techniques and Applications" by Ioana Manolescu, et al. This book provides an extensive overview of graph data management techniques, including knowledge graphs. It covers topics such as graph querying, indexing, storage, and visualization.[5] It also discusses applications in various domains, including recommendation systems, social networks, and bioinformatics. “Knowledge Graph Embedding: A Survey of Approaches and Applications" by Xin Luna Dong, et al. This survey focuses on knowledge graph embedding techniques. It discusses various embedding models such as TransE, DistMult, and ComplEx, and their applications in link prediction, entity classification, and recommendation systems. It also provides a comparative analysis of different embedding approaches.

## OVERVIEW

**Recommender System:** A recommender system is an information filtering technology that suggests items or content to users based on their preferences, interests, or past behaviour. The goal of a recommender system is to provide personalized recommendations that enhance user experiences, facilitate decision-making, and increase user engagement. Types of Recommender Systems: a. Collaborative Filtering: This approach recommends items based on the preferences and behaviour of similar users. It utilizes user-item interaction data to identify patterns and make recommendations.[3] Collaborative filtering can be further categorized into memory-based (based on user-item ratings) and model-based (using machine learning algorithms) methods. Content-Based Filtering: This approach recommends items based on the characteristics or features of the items themselves. It analyses the content or attributes of items that a user has liked or interacted with and suggests similar items based on those attributes. Content-based filtering can be used when user-item interaction data is scarce.[7][8] Hybrid Recommender Systems: Hybrid systems combine multiple recommendation techniques, such as collaborative filtering and content-based filtering, to provide more accurate and diverse recommendations. They leverage the strengths of different approaches to overcome limitations and improve recommendation quality. Knowledge-Based Recommender Systems: These systems incorporate domain-specific knowledge, such as ontologies or knowledge graphs, into the recommendation process. They utilize explicit knowledge about users, items, and their relationships to generate recommendations that align with user preferences and domain-specific constraints. [10] Recommendation Techniques: a. Item-Based Filtering: This technique calculates item similarities based on user-item ratings or item attributes and recommends items similar to the ones a user has interacted with or liked. User-Based Filtering: This technique identifies similar users based on their past behaviour or preferences and recommends items that these similar users have liked or interacted with. Matrix Factorization: Matrix factorization techniques, such as Singular Value Decomposition (SVD) or Matrix Factorization with Alternating Least Squares (ALS), decompose the user-item interaction matrix into low-rank matrices to capture latent factors and generate recommendations.[8] Deep learning techniques, such as neural networks, can learn complex patterns and representations from user-item data to make personalized recommendations. Approaches like neural collaborative filtering and deep matrix factorization have shown promising results.

Evaluation Metrics: Recommender systems are evaluated using various metrics, including accuracy, coverage, diversity, serendipity, and novelty. Common evaluation metrics include precision, recall, Mean Average Precision (MAP), Normalized Discounted Cumulative Gain (NDCG), and Hit Rate. Application Areas: Recommender systems have been widely used in various domains, including e-commerce, media and entertainment, social media, music streaming, news recommendation, and personalized advertising. [9] They help users discover relevant products, movies, music, news articles, and more. Challenges: Building effective recommender systems comes with challenges such as data sparsity, cold-start problem (for new users or items), scalability, privacy concerns, and ensuring fairness and diversity in recommendations. Recommender systems play a crucial role in delivering personalized experiences, improving user satisfaction, and driving user engagement in today's information-rich and personalized digital landscape**.**

**Knowledge Graphs:** Knowledge graphs are a structured representation of knowledge that captures entities, their attributes, and relationships between them. They provide a way to organize and connect various pieces of information, enabling powerful reasoning and analysis capabilities.A knowledge graph is a graph-based knowledge representation model that consists of nodes representing entities (such as concepts, objects, or events) and edges representing relationships between these entities. Each node and edge can have additional attributes and properties associated with them. Entity Representation: Entities in a knowledge graph represent real-world objects or concepts. They can be people, places, products, or ABSTRACT concepts. Entities are typically represented as nodes in the graph, and they can have various attributes that describe their characteristics. Relationship Representation: Relationships in a knowledge graph capture the connections or associations between entities. [5][7] Relationships are represented as edges connecting nodes in the graph. They provide valuable contextual information and semantics about how entities are related to each other.

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Attributes and Properties: Nodes and edges in a knowledge graph can have attributes or properties associated with them. Attributes provide additional information about the entities and relationships, such as names, descriptions, timestamps, or numerical values. These attributes enrich the knowledge graph and enable more detailed analysis.[3] Knowledge Acquisition: Knowledge graphs can be constructed using various techniques. They can be manually curated by domain experts, extracted from structured or unstructured data sources using natural language processing and information extraction techniques, or automatically populated from existing knowledge bases or ontologies.

Semantic Representation: Knowledge graphs often incorporate semantic technologies such as ontologies or vocabularies to provide a formal representation of the domain knowledge. Semantic annotations and standard vocabularies enable interoperability, integration, and reasoning across different knowledge graphs and systems. Reasoning and Inference: Knowledge graphs enable reasoning and inference capabilities by leveraging the rich structure and semantic relationships within the graph. Inferences can be made by traversing the graph, applying logical rules, or using machine learning algorithms to derive new knowledge or make predictions based on existing knowledge. Applications: Knowledge graphs have numerous applications across various domains.[7] They are used in search engines to enhance search results and provide contextual information. They power recommendation systems by capturing user preferences and item characteristics. They are also utilized in question answering systems, knowledge-based chatbots, semantic web applications, and data integration scenarios. Standards and Technologies: Several standards and technologies support the development and utilization of knowledge graphs. These include RDF (Resource Description Framework), OWL (Web Ontology Language), SPARQL (SPARQL Protocol and RDF Query Language), and graph database systems. Knowledge graphs provide a powerful framework for representing, organizing, and reasoning over knowledge. By capturing the relationships between entities and incorporating domain-specific semantics, knowledge graphs enable advanced analysis, discovery, and decision-making capabilities.

## OPEN RESEARCH ISSUES AND FUTURE DIRECTIONS

Knowledge Graph Construction: Developing efficient and scalable methods for constructing and updating knowledge graphs is an ongoing research area. This includes exploring techniques for automated knowledge extraction from various data sources, integration of heterogeneous knowledge, and continuous knowledge graph maintenance.[9] Knowledge Graph Representation Learning: Enhancing representation learning techniques for knowledge graphs can improve recommendation accuracy. Research can focus on developing novel embedding models, graph neural networks, or deep learning architectures that effectively capture entity and relationship semantics in knowledge graphs. Incorporating Contextual Knowledge: Integrating contextual information into knowledge graphs can enable more precise and context-aware recommendations. Research can investigate methods to model and utilize temporal, spatial, or user-specific context in knowledge graphs for personalized recommendations. Cross-Domain Recommendations: Extending knowledge graphs to support cross-domain recommendations is a promising direction. This involves leveraging connections between different knowledge graphs to provide recommendations that span multiple domains and offer diverse item suggestions to users. [6] Enhancing the interpretability and transparency of recommender systems is an important research area. This involves developing methods to explain recommendations based on the underlying knowledge graph, enabling users to understand and trust the recommendation process. Privacy and Ethical Considerations: Addressing privacy concerns and ensuring ethical usage of knowledge graphs in recommender systems is crucial. Research can focus on developing privacy-preserving techniques, fairness-aware recommendation algorithms, and methods to mitigate biases present in the knowledge graph data.

Active Learning and User Feedback: Investigating techniques for active learning and leveraging user feedback to improve knowledge graph-based recommendations is an open research area. This involves exploring methods to actively solicit user preferences, incorporate explicit user feedback, and adapt the knowledge graph in real-time based on user interactions. [5] Developing comprehensive evaluation metrics and benchmarks for knowledge graph-based recommender systems is essential for fair and comparative assessment. Research can focus on designing standardized evaluation frameworks and metrics that consider various aspects, such as recommendation accuracy, diversity, novelty, and user satisfaction. Interoperability and Integration: Enhancing interoperability and integration of knowledge graphs with other recommendation techniques and systems is a future direction. Research can explore methods to combine knowledge graph-based recommendations with collaborative filtering, content-based filtering, or hybrid approaches to leverage their complementary strengths. Real-world Deployments and Case Studies: Conducting more extensive real-world deployments and case studies of knowledge graph-based recommender systems is necessary to understand their practical challenges and benefits. Research can focus on collecting user feedback, assessing system scalability, and evaluating the impact of knowledge graphs on user engagement and business outcomes.

## APPLICATIONS OF KNOWLEDGE GRAPHS

Semantic Search and Information Retrieval: Knowledge graphs enable semantic search capabilities by capturing relationships between entities and providing contextual understanding.[2] They enhance search engines by delivering more accurate and relevant search results and supporting advanced search features such as entity recognition, query expansion, and disambiguation. Knowledge graphs play a crucial role in recommendation systems by capturing user preferences, item characteristics, and semantic relationships. They enable personalized recommendations by leveraging user-item interactions, collaborative filtering, content-based filtering, and contextual information to suggest relevant items or content to users.

Question Answering and Chatbots: Knowledge graphs enhance question answering systems and chatbots by providing a structured representation of knowledge and enabling efficient retrieval of relevant information. They support natural language understanding, entity recognition, and reasoning capabilities, allowing users to ask complex questions and receive precise answers. Data Integration and Linked Data: Knowledge graphs facilitate data integration by connecting disparate data sources and representing them in a unified structure. They enable interoperability and seamless integration of data from different domains, providing a comprehensive view of interconnected information. Knowledge graphs also contribute to the Linked Data initiative by linking data on the web and enabling data interlinking and discovery.

Expert Systems and Decision Support: Knowledge graphs serve as a foundation for expert systems and decision support systems. They capture domain-specific knowledge, rules, and constraints, enabling intelligent reasoning and decision-making capabilities. Knowledge graphs enhance expert systems by providing a rich representation of expertise, facilitating knowledge sharing, and supporting complex decision processes. Biomedical and Life Sciences: Knowledge graphs find extensive applications in biomedical research and life sciences.[3][4] They facilitate the integration and analysis of diverse biomedical data, including clinical data, genomics, proteomics, drug interactions, and disease ontologies. Knowledge graphs enable researchers to discover new insights, identify potential drug targets, and support personalized medicine approaches. Internet of Things (IoT): Knowledge graphs are valuable in the IoT domain by enabling the integration and analysis of data from connected devices. They facilitate the representation and understanding of relationships between IoT devices, sensor data, and contextual information. Knowledge graphs enhance IoT systems by enabling intelligent decision-making, anomaly detection, and context-aware applications. Business Intelligence and Knowledge Management: Knowledge graphs support business intelligence applications by organizing and connecting business-related data, including customer profiles, sales data, product information, and market trends.[6] They facilitate knowledge discovery, trend analysis, and decision support for business processes, such as customer segmentation, product recommendations, and market analysis.

## CONCLUSION

Knowledge graphs play a significant role in advancing recommender systems by leveraging structured knowledge representation and semantic relationships. They provide a comprehensive understanding of user preferences, item characteristics, and domain-specific knowledge, enabling personalized and context-aware recommendations. By incorporating user-specific data, such as interactions and demographics, into the knowledge graph, recommender systems gain insights into individual preferences, leading to more accurate recommendations. Additionally, the integration of external domain-specific knowledge enhances the recommender system's understanding of item attributes, relationships, and contextual information. Knowledge graphs enable sophisticated recommendation generation through graph-based algorithms, leveraging traversal, similarity, and path-based reasoning. These algorithms traverse the graph to identify relevant items and discover hidden patterns or connections, resulting in highly tailored recommendations. The incorporation of contextual information, such as time, location, or user context, into the knowledge graph enhances the recommender system's ability to provide timely and contextually relevant recommendations. This contextualization improves the user experience and drives engagement.

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## REFERENCES

[1] "Knowledge Graphs: Techniques, Applications and Challenges" by Fajar J. Ekaputra, et al. (2021). Knowledge Engineering Review.

[2] "A Survey of Knowledge Graphs: Representation, Acquisition, and Applications" by Niket Tandon, Gerard de Melo, and Gerhard Weikum. (2020). The VLDB Journal.

[3] "Knowledge Graphs" by Maximilian Nickel, Kevin Murphy, Volker Tresp, and Evgeniy Gabrilovich. (2016). Proceedings of the IEEE.

[4] "A Survey on Knowledge-Based Recommender Systems" by Adomavicius, G., & Tuzhilin, A. (2005). IEEE Transactions on Knowledge and Data Engineering

[5] "Deep Learning for Recommender Systems: A Survey and New Perspectives" by Zhang, S., Yao, L., & Sun, A. (2019). ACM Transactions on Intelligent Systems and Technology.

[6] "Collaborative Filtering for Recommender Systems" by Koren, Y. (2010). Encyclopedia of Machine Learning and Data Mining.
[7] "Matrix Factorization Techniques for Recommender Systems" by Koren, Y., Bell, R., & Volinsky, C. (2009). IEEE Computer.
[8] "Hybrid Recommender Systems: A Systematic Literature Review" by Burke, R. (2002). ACM Computing Surveys.
[9] "Evaluation Measures for Recommender Systems" by Jannach, D., et al. (2010). Recommender Systems Handbook.
[10] "Novelty and Diversity in Recommender Systems" by Zhou, T., et al. (2010). ACM Transactions on Intelligent Systems and Technology.

# Chapter: 43

# An Analysis of Effect of Social-Media on Students

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**ABSTRACT**

During last decade, social media sites continue to grow in popularity, technology has become is a vital part in today's student success equation. This descriptive, exploratory research study drew a random sample (N=82) of males (n=50) and females (n=32) who were administered a student perception questionnaire on how social media affects college students. Thirty-five percent of the participants were undergraduates and 65% were graduate students, studying at Uttar Pradesh Technical University. Thirty-one percent of participants have full-time jobs, 30% have part-time jobs and 39% do not have jobs. The results of the survey questionnaire indicate that 45% of the sample admitted that they spent 6-8 hours per day checking social media sites, while 23% spent more than 8 hours; 20% spent 2-4 hours and only 12% spent less than 2 hours on this task. Results indicate while most college students use social media and spend many hours checking social media sites, there was a negative aspect to college students' use of social media.

**KEYWORDS**—social media, Social Networking, Facebook, YouTube, Blogs, Twitter, MySpace, LinkedIn.

## INTRODUCTION

The social media can be defined as "the relationships that exist between network of people [1]. During last decade, the online world has changed dramatically. With the help of the social media websites [2] states that the social media sites encourage negative behaviors for teen students such as procrastination (catching up with friends), and they are more likely to drink and drug. However, every day, many students are spending countless hours immersed in social media, such as Facebook, Twitter, MySpace, World of Warcraft, or Sim City. At first glance this may seem like a waste of time; however, it also helps students to develop important knowledge and social skills and be active citizens who create and share content. At present, whether social media is favorable or unfavorable, many students utilize these sites on a daily basis. As social media sites continue to grow in popularity it is our belief that technology is a vital part of today's student success equation [2]. Many researchers have different opinions into a considerable amount of research on how social media influences student retention and progress at colleges. Many parents and teachers are worried that their college students are spending too much time on Facebook and other social media sites and not enough time studying. Therefore, our research as certain the relationship between the social media and students' study efficiency [3].

## STATEMENT OF PROBLEM

To analyze the issue of the effectiveness of using social networking, the first question raised in this study is:

For what purpose is the student utilizing social networking? Research on this topic will start to reveal social networking sites are simply part of how students interact with each other with no apparent impact on grades. Thus, the objective of this research is to explore the advantages and disadvantages of students' use of social networking for study [3].

The main purpose of this research is to expand on previous research, explore the relationship between the effects of social networking and students' study efficiency, and to determine if social media interfering with students' academic lives.

## RESEARCH QUESTIONS

- Which is the most popular social media site for students?
- What is the amount of time students spend utilizing social media in various academic processes?

## REVIEWOFTHELITERATURE

College students have great interest in social media. For the purpose of this survey, social media was defined as Facebook, YouTube, Blogs, Twitter, MySpace or LinkedIn (Martin, 2008).[4] Although, providing a detailed perspective on social media use among university students and underscoring that such use can produce both positive and negative consequences, according to the India Today-Nielsen Media Research study, in June 2016, almost25 percent of students' time on the Internet is now spent on social networking websites [5]. Facebook is the most used social network by college students, followed by YouTube and Twitter. Moreover, Facebook alone reports that it now has 500 active million users, 50% of whom log on every day. In addition, according to a study by Online PhD, students spend roughly 150 minutes per day on Facebook [6]. In 2014, the number of students who used Facebook was already enormous: 92 percent of college students had an account. By 2016, 99 percent of students had an account on Facebook. That is quite a large amount considering the service was only opened in 2006 to everyone. On one hand, the positive aspect of online communities is that youths can utilize them for academic assistance and support etc [8]. Due to the capability of social media to enhance connections by making them easily accessible, social media has also yield many benefits for the young, including providing a virtual space for them to explore their interests or problems with similar individuals, academic support, while strengthening online communication skills and knowledge. Students who may be reluctant to speak up in class are participating in book discussion blogs and writing for real audiences. There are new Web tools emerging all the time that are enhancing learning [8].

On the other hand, "Our findings indicate that electronic media use is negatively associated with grades. We also find that about two-thirds of the students reported using electronic media while in class, studying, or doing homework [6]. This multitasking likely increases distraction, something prior research has shown to be detrimental to student performance. As social media websites, such as Facebook, YouTube and Twitter gain popularity, they are also becoming increasingly dangerous as they create modes to procrastinate while trying to complete homework. Hence, in a survey of 102 students, 57% stated that social media has made them less productive. As to the relationship between social media and grades, a study reveals that college students who utilize Facebook spend less time on studying and have lower grades than students who do not use the popular social networking sites [8]. Moreover, according to a new study by doctoral candidate, college students who use the 500-million-member social network have significantly lower grade-point averages (GPAs) than those who do not. Nevertheless, another study found no correlation between heavy social media usage and grades. There was no significant difference in grades between those considered to be heavy users of social media and those considered to be light users. Additionally, there was no correlation between grades and the social media platform used. For example, almost the same number of heavy and light users of both Facebook and YouTube received the same percentage high and low grades.

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Regarding the relationship between using social media with the grades of college students, concurrent with past studies that find that online communication is linked to time spent in offline relationships, “our findings indicate that Social Networking Site (SNS) use and cellular-phone communication facilitates offline social interaction, rather than replace it [11]. Students commonly commented that connect should be invaluable for making friends and supporting each other, especially within the first few weeks after arriving at the University [8] Furthermore, “The relationship between Facebook and well-being appears to become positive over the college years, possibly because upper-class students use Facebook to connect socially with their peers and participate in college life [7]. Therefore, “we need to keep in mind that the benefits of this interactive technology far outweigh the risks, says Leri. “When it’s used in a positive way, it can be an extraordinary tool [8].

## METHOD

The purpose of collecting data was to perform group research on how social media affects college students. In this research, an anonymous questionnaire was administered to collect data which was the standard survey collection method. The total number of questionnaires administered were 90, however the usable questionnaires were(N=82). According to the respondents, males(n=50) and females(n=32) were involved in this survey. Thirty-five percent of participants were undergraduates and 65%were graduate students currently studying in Uttrar Pradesh Technical University. Thirty-one percent of participants have full-time jobs, 30% have part-time jobs and 39% do not have jobs. The number of females who have jobs is higher than that of males. This was one part of our anonymous questionnaire. In the following, other relevant questions were developed to carry out the research. Other questions focused on the lives of students and the feeling of students-when they were using different social media. For example, how many hours a day do you check your social media site?” and “Do you post or respond while completing homework?” Also, at the end of the questionnaire, we asked two open questions about the biggest advantage or disadvantage when college students used social media in studying and looking back to the last time that they used social media. The participants were randomly selected regardless of gender or educational level. These questions related to their lives. There were three different perspectives present in the research which included advantage, disadvantage or not sure. However, other independent variables were tried to decrease the impact on the results.

## RESULTS

Sixty percent of participants are in favor of Facebook, 22% like Skype, 10% prefer Twitter and 8% like My Space. Sixty-eight percent of the sample reported that they primarily used a laptop to check social media sites; while 20% use a cell phone; and only12% preferred to use a desktop computer. Forty-five percent of the sample admitted that they spent 6-8 hours per day to check a social media site, 23% spent more than 8hours, 20% spent 2-4 hours and only 12% spent less than 2 hours. The ratio of participants who posted or responded during school hours was 64%; 15% rarely used social media during school hours; 21% were not sure whether they would like to use it. Eighty percent of the sample reported that they posted or responded while completing homework; 8% would never use social media while doing homework; and 2% were not sure. In terms of the benefit of social media, 20% agreed that social media helps with school assignments; 25% agreed that social media helps to make new friends; and 55% just used social media for fun.

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## DISCUSSION

According to the data we collected from the anonymous questionnaire, most college students would prefer to use social media and therefore spent vast hours checking social media sites. Facebook is very popular among college students, even though students would use it when they had classes. Ninety percent of students spent their time on entertainment; there were not too many college students who preferred using social media to deal with their homework. Eighty percent of the sample admitted that they posted or responded while completing homework. It has definitely affected their efficiencies and their grades. Considering the data collected, there was a negative attitude towards social media when college students used them. For instance, imagining one student spent over six hours checking social media site and responded while completing their homework; it would be likely increasing distraction of the students which can be detrimental to student performance.

## CONCLUSION

Our research has revealed that college students were likely to be affected by social media. Social media is attractive; it not only provides college students another world to make friends, also provides a good way to release pressure. To some degree, it absolutely affects the lives of college students including the grades. This research also indicates that an approach is needed to better balance the relationship between social media and academic study. Therefore, college students should think more about the balancing equation of social media and academics.

## LIMITATIONS AND COMMENDATIONS

This study was limited in several aspects. First, the timeframe to collect data was too short. Three to four weeks for the study was not sufficient. Second, a total of 90 questionnaires were administered, however usable questionnaires were 82, so the result may not reflect the real situation for the whole population. With this sample size, the estimated sample error is14.4%, so an increase in sample size might yield different results. And of course, these results might be affected by this very large sample error. Third, this research did not consider student’s psychological state; perhaps influences and motivations for social networking use our research indicated that most college students would prefer to use social media and spend many hours checking social media sites.

Social networking is definitely affecting students’ efficiencies as well as their grades. Hence, educators need to be concerned about these problems and try to find better ways to solve these problems. Although, framed within an academic context, the concepts outlined here can be utilized to investigate the use of communication technology not only at school, however also at home, workplace, and various other settings, and for a variety of different audiences such as teenagers, young adults, the elderly, or families. For future research, it may be more helpful to measure the social presence besides motivation and pressure, examining how a student’s psychological state influences motivations for social media use. Also, do social media sites have a positive influence on study and academics and are students leveraging them as cited sources indiscipline research.

## REFERENCES

[1] Baldwin,T. T., Bedell, M. D., & Johnson, J. L. (1997). The social fabric of a team-Based M.B.A. Program: Network effects on student satisfaction and performance. Academy Of Management Journal, 40(6),1369-1397.doi:10.2307/257037

[2] Brydolf, C. (2007). Minding MySpace: Balancing the benefits and risks of students' online social networks. Education Digest,73(2),

[3] Domine,V.(2009).Asocialhistoryofmedia,technologyandschooling.Journal of Media Literacy Education, 1(1), 42-52.

[4] Gerlich, R., Browning, L., &Westermann, L. (2010). The social media affinity scale: implications for education. Contemporary Issues in EducationResearch,3(11),35-41.

[5] Jacobsen, W. C., &Forste, R. (2011). The Wired Generation: Academic and Social Outcomes of Electronic Media Use Among University Students.

[6] Junco, R., Merson, D., & Salter, D. W. (2010). The Effect of Gender, Ethnicity, and Income on College Students' Use of Communication.

[7] Kalpidou, M., Costin, D., & Morris, J. (2011). The relationship between Facebook and the well-being of undergraduate college students. Cyberpsychology, Behavior & Social Networking,14(4),183-189.

[8] Lusk, B. (2010). Digital natives and social media behaviors: An overview. Prevention Researcher,173-6.

[9] Margaryan,A.,Littlejohn,A.,&Vojt,G.(2011).Are digital natives a myth or reality? University students' use of digital technologies. Computers & Education, 56(2), 429-440.Oberst, L. (2010).

[10]The 6S Social Network. Retrieved from: Rosen, L., Lim,A., Carrier, L., & Cheever, N. (2011).

[11]An empirical examination of the educational impact of text message-induced task switching in the classroom: educational implications and strategies to enhance learning.(2011).Psicologia Educativa 17(2), 163-177.

[12]Schill, R. (2011). Social Networking Teens More Likely to Drink, Use Drugs, Study Finds.

[13]Y.Yorozu,M.Hirano,K.Oka ,and Y.Tagawa,“Electron spectros copy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn.Jpn.,vol. 2, pp. 740-741, August 1987[Dig.9th Annual Conf. Magn. Jpn.,p. 301, 1982].

# Chapter: 44

# Review of BLDC Motor - Advanced Control Methods, and Applications

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**ABSTRACT**

The majority of dynamic applications, such those in the automotive, pumping, and rolling industries, favour brushless direct current (BLDC) motors. According to predictions, It is predicted that BLDC motors will displace conventional induction motors as the standard form of power transmission in businesses by 2030. Although BLDC motors are becoming more popular in industrial and commercial applications, there are a number of serious difficulties and unresolved research issues that must be addressed. BLDC motor fails to produce increased fault tolerance, decreased electromagnetic interference, decreased acoustic noise, decreased flux ripple, and decreased torque ripple. Closed-loop vector control is a viable approach for BLDC motors to address these problems. Only a small number of surveys on BLDC motor controllers and designing were done in the literature review over the previous five years. Additionally, a thorough analysis of numerous advanced controls for BLDC motors is discussed in detail, including fault tolerance control, electromagnetic interference reduction, field orientation control, direct torque control, current shaping, input voltage control, intelligent control, drive-inverter topology, and its basic workings in reducing torque ripples.

**KEYWORDS-** BLDC motor, torque ripple, current shaping techniques, controlling input voltage, direct torque control, drive-inverter topology, field orientation control, motor design, fault tolerance control, electromagnetic interference reduction.

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## INTRODUCTION

Before 50 years, T. G. Wilson and P. H. Trickey carried out a number of experiments to operate Direct Current (DC) motors with solid-state commutation, which laid the foundation for the philosophy of constructing BLDC motors, which are based on Lorentz's force law. A good responsiveness is provided by BLDC motors. They must be properly engineered to have strong magnetic coupling in order to be employed for a variety of tasks, including lifting, cutting, and bracing.

BLDC motors are anticipated to perform better than conventional motors in terms of efficiency, torque to weight ratio, and operational noise. Between the rotor and stator of these machines is stationary flux, which primes the motor to operate with a unity power factor. Drives with electronic commutation are used to power BLDC motors. A closed-loop controller is used to drive each phase of the motor. A closed-loop controller's primary function is to deliver a current pulse to the motor windings so that the speed and torque, which are complementary phenomenon in a motor, may be controlled.

In the last few decades, BLDC motors have been the subject of intense study to help electric vehicles gain traction in the automotive sector. BLDC motors are employed in a variety of industries, including the automotive, pumping, and rolling industries, due to their maneuverability, small design, and light weight. Fewer circuits, known as sensor-less controllers, detect the back electromotive force within the non-driven coils to gather the position of the rotor instead of using Hall Effect sensors to directly measure the rotor's location.

Three dual-directional outputs on a fixed BLDC general hall sensor motor are managed by a digital logic-based circuit. Other sensor-less controllers are designed to estimate characteristics such back electromotive force (EMF) and flux by detecting the winding current flow that is induced by the magnets' direction to determine the rotor's location.

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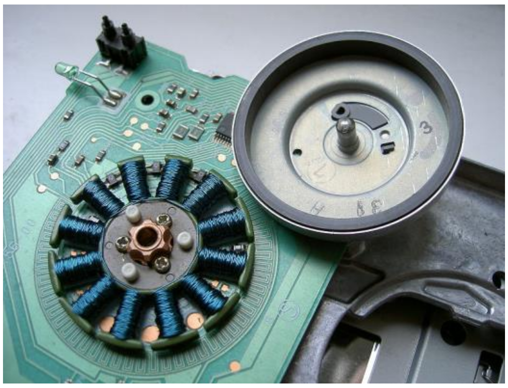

**Fig. 1- fig shows the BLDC motor used in floppy disc drive in computer.**

## TYPES OF BLDC MOTOR

The stator and rotor make up the two main components of a BLDC motor. Fig. 4 depicts the classification of BLDC motor types. The motor can be built in a variety of ways, including with an inner and an outer rotor. A BLDC motor with an outside rotor is discussed. The stator windings are kept stationary inside, while the rotor permanent magnet is embedded at the exterior surface. Electric vehicles, drones, variable drive industries, water pumping, and home electronics are the principal applications for the outer rotor BLDC motor. The air-gap radius between the stator and the rotor is minimized in the design of the outer rotor BLDC motor. Designing for BLDC motors with an inner rotor is covered. The ferrite bonded magnet utilized in BLDC motor is examined using finite element analysis. It was discovered through experiments that the inner rotor motor also has good power characteristics under dynamic conditions. A high-speed ferrite-based BLDC motor's preliminary algorithm is discussed. By modifying the mechanical restrictions, magnetic flux components are improvised. In BLDC, the stator can be categorized depending on the number of phases, types of laminated core, and back EMF. BLDC stators can be categorized according to how many phases they operate in. For static application single-phase and three-phase motors are used. Motors with three, five, or seven phases are preferable for dynamic applications like electric automobiles.

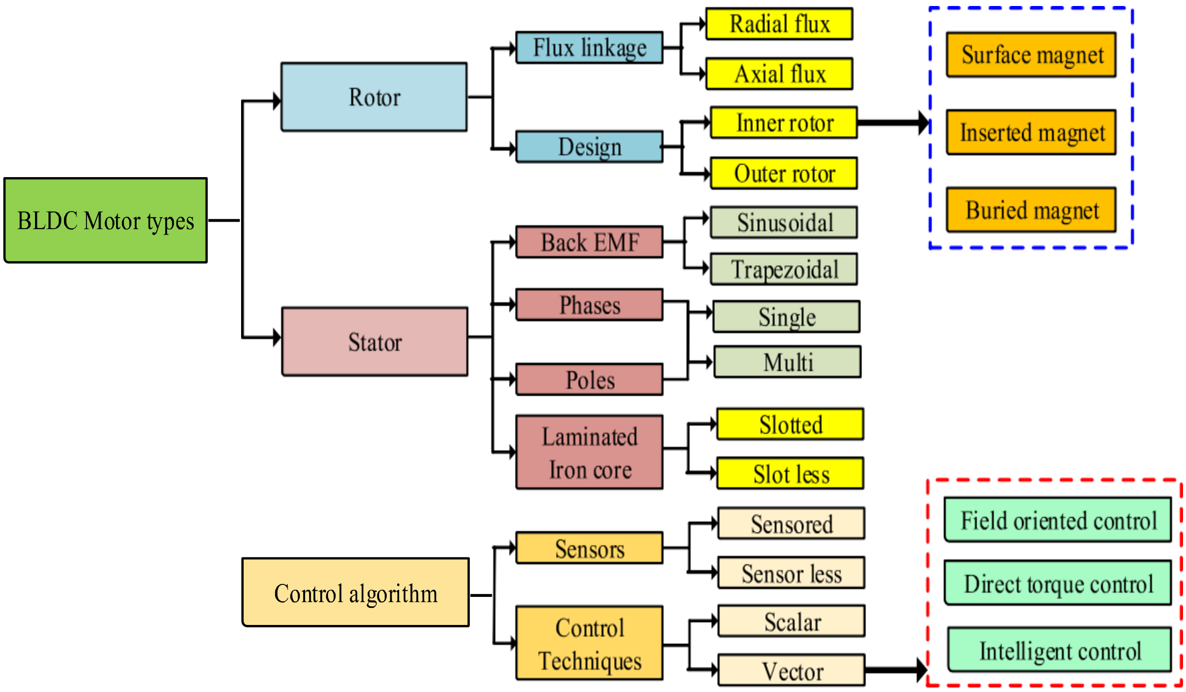


**Fig. 2 – Types of BLDC Motors**

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## CHALLENGES AND ADVANTAGES OF BLDC MOTOR

**A. REDUCED MASS:** The designed motor should have less weight. The designed motor may be used for various applications such as traction, pumping, household, etc. Depending on the purpose, the designed motor weight may vary but a motor with less weight can be used for various applications. Reduced mass is much related to reducing volume. For applications such as hand tools, the motor used requires high power and reduced volume. Hence, the designed motor should be of small size.

**B. HIGH EFFICIENCY:** The main purpose of bldc motor in place of induction motor is to improve efficiency and power output of the system. This is achieved by designing a motor with less torque ripple, improved flux linkage, and thermal stability of the system.

**C. LOW COST:** Usually BLDC motors run with motor drives. These drives may be integrated or kept separately. Motors and motor drives are usually very high in cost. Keeping a drive separately may increase the installation cost using wiring cables, individual wiring, etc., Cost reduction in motor design is done using various component materials while manufacturing.

**D. IMPROVED FAULT TOLERANCE:** While designing a BLDC motor, it is very much necessary to detect the rotor position for providing the commutation in power switches. These rotor position detectors are hall sensors, speed sensors, stator flux coils, etc. In heavy applications such as electrical vehicle tractions, it is very difficult to continue the operation if there is any fault in the rotor position sensors. Hence, it is very necessary to improve the fault tolerance of the motor.

## CONCLUSION

The number of electric and hybrid automobiles is growing. BLDC motors are becoming more popular in EV applications because they are easy to use, reliable, and efficient. In addition to discussing the creation of a design platform for BLDC motors, this paper analyses numerous BLDC motor types, their standards, applications, torque ripple reduction approaches, and BLDC motor control techniques. At the moment, Hub motors and other BLDC motors with an exterior surface rotor are frequently employed in commercial applications. Techniques for electromagnetic interference management, acoustic noise control, and fault-tolerant control are all addressed along with the BLDC motor control drive. Due to their minimal cogging torque, which results in a high loading effect, high power, and higher efficiency, outer surface rotor-type motors are increasingly widely used. Due to their exposure to ambient air conditioning from the outside environment, these motors require less cooling for the rotor.

## REFERENCES

[1] H.-W. Kim, K.-T. Kim, Y.-S. Jo, and J. Hur, ''Optimization methods of torque density for developing the neodymium free SPOKE-type BLDC motor,'' IEEE Trans. Magn., vol. 49, no. 5, pp. 2173–2176, May 2013,

[2] J. Shao, ''An improved microcontroller-based sensor less brushless DC (BLDC) motor drive for automotive applications,'' IEEE Trans. Ind. Appl., vol. 42, no. 5, pp. 1216–1221, Sep. 2006.

[3] J. Shao, ''An improved microcontroller-based sensorless brushless DC (BLDC) motor drive for automotive applications,'' in Proc. 40th IAS Annu. Meeting. Conf. Rec. Ind. Appl. Conf., Oct. 2005, pp. 2512–2517.

[4] C. L. Xia, Permanent Magnet Brushless DC Motor Drives and Controls. Singapore: Wiley, 2012

[5] K. P. Kumar, ''Modeling of a commercial BLDC motor and control using GA- controller for a BLDC propulsion application for hybrid electric vehicle,'' Int. J. Psychosocial Rehabil., vol. 23, no. 4, pp. 1604–1613, Dec. 2019.

[6] A. Senthilnathan and P. Palanivel, ''Fuzzy logic controller based zeta converter for BLDC motor,'' J. Adv. Res. Dyn. Control Syst., vol. 12, no. 7, pp. 125–133, Jul. 2020.

[7] H.-J. Kim, ''BLDC motors for robot vacuum cleaners,'' Trans. Korean Inst. Electr. Eng., vol. 60, no. 4, pp. 172–174, Dec. 2011.

ISBN: 978-81-961781-9-2

[8] J. W. K. K. Jayasundara and R. Munasinghe, ‘‘Software design tool for optimum axial flux BLDC motors,’’ in Proc. Int. Conf. Ind. Inf. Syst. (ICIIS), Dec. 2009, pp. 526–531.

[9] J. Shao, ‘‘An improved microcontroller-based sensor less brushless DC (BLDC) motor drive for automotive applications,’’ IEEE Trans. Ind. Appl., vol. 42, no. 5, pp. 1216–1221, Sep./Oct. 2006.

[10] S.-T. Jo, H.-S. Shin, Y.-G. Lee, J.-H. Lee, and J.-Y. Choi, ‘‘Optimal design of a BLDC motor considering three-dimensional structures using the response surface methodology,’’ Energies, vol. 15, no. 2, p. 461, Jan. 2022.

[11] T.-Y. Lee, M.-K. Seo, Y.-J. Kim, and S.-Y. Jung, ‘‘Motor design and characteristics comparison of outer-rotor-type BLDC motor and BLAC motor based on numerical analysis,’’ IEEE Trans. Appl. Supercond., vol. 26, no. 4, pp. 1–6, Jun. 2016, doi: 10.1109/TASC.2016.2548079.

[12] R. K. Behera, R. Kumar, S. M. Bellala, and P. Raviteja, ‘‘Analysis of electric vehicle stability effectiveness on wheel force with BLDC motor drive,’’ in Proc. IEEE Int. Conf. Ind. Electron. Sustain. Energy Syst. (IESES), Jan. 2018, pp. 195–200, doi: 10.1109/IESES.2018.8349873.

[13] S. Sashidhar and B. G. Fernandes, ‘‘A low-cost semi-modular dual-stack PM BLDC motor for a PV based bore-well submersible pump,’’ in Proc. Int. Conf. Electr. Mach. (ICEM), Sep. 2014, pp. 24–30.

[14] S. Sashidhar and B. G. Fernandes, ‘‘A novel ferrite SMDS spoke-type BLDC motor for PV bore-well submersible water pumps,’’ IEEE Trans. Ind. Electron., vol. 64, no. 1, pp. 104–114, Jan. 2017.

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# Chapter: 45

# Monitoring of Electric Buses within an Urban Smart City Environment

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**ABSTRACT**

A real-world example of tracking the data produced by electric buses is provided, with a focus on the batteries' charge, status, and energy use. The task is completed The H2020 Smart City Lighthouse STARDUST project established a global smart city strategy that is out in the open. This work has made clear the vital significance that data collecting and transmission from electric buses play, thus the chosen solutions are detailed in detail. Numerous important elements for the effective deployment of the required communication infrastructure and the monitoring system architecture are also covered.

**Key words-** smart city, smart grid; electric bus; monitoring; LoRa; business intelligence.

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## INTRODUCTION

A smart city's infrastructure is built on sensors, which collect data and deliver it to the cloud. Sensors are used in smart cities to measure a wide range of factors related to to energy use, traffic flow, the quality of the air and water, etc. These sensors are placed all over the city and offer useful data to decision-makers, governmental agencies, or directly to citizens in real time, enabling the city and its residents to be connected in an atmosphere of an urban smart and rational city. The European Commission is dedicated to providing assistance. projects that demonstrate a development in its cities' sustainability. This work presents some of the findings from the Seven towns are working closely together as part of the Smart towns and Communities Lighthouse STARDUST project [2] to test and validate technology solutions and cutting-edge commercial models and to produce blueprints for replication across Europe and beyond The STARDUST project's goal is to pave the urban solutions and new business models, integrating the areas of buildings, mobility, and intelligence will lead to low-carbon, highly effective, intelligent, and citizen-oriented cities. Information and communication technology (ICT) for effective energy. To enhance, among other things, air quality and noise pollution in cities, public transport must transition to more environmentally friendly vehicles. In this regard, electrified and intelligent buses clearly offer advantages. Electric buses are typically linked to increased user comfort and information, in addition to helping to reduce atmospheric and auditory pollutants [3]. The following structure was chosen for this effort in order to contribute to that goal. The work done on one of the bus lines in one of the cities taking part in the STARDUST project is described in Section II, along with the benefits of electric buses. To optimise the charging infrastructure and finally integrate the information obtained in the municipal platform for the benefit of the citizens, communications and monitoring of the data collected are crucial duties. The solutions used for communication and data monitoring are described in Sections III and IV, respectively. In Section V, CONCLUSIONs are reached.

**Electric Buses and Smart Grid:** In a world where nations like Norway, Germany, the Netherlands, the United Kingdom, and France are planning to outlaw internal combustion engines within the next several years, The technical advancements in electric vehicles as well as the falling cost and rising energy density of batteries have all contributed to the rapid development of electrical mobility in recent years [4]. The electrification of transport is a crucial component of smart and sustainable cities. Improved air quality, reduced noise pollution, decreased energy usage, and, if the electricity is generated from renewable sources, energy independence are all benefits of driving an electric vehicle. Electric buses have the greatest potential to contribute to the realisation of these benefits in the future because of their longer operating hours and increased passenger capacity per vehicle. Smart urban areas [5]. Furthermore, because of their predictable routes and timetables, it is easy to build specialised infrastructure for both the vehicles themselves and the charging stations. First, in order to extend the life and performance of the bus batteries, optimised energy management algorithms can be developed. Second, depending on the anticipated energy demand and the features of the local electric distribution network, the necessary charging infrastructure can be placed properly throughout the city [6]. Advanced monitoring and communication systems are necessary in both situations for the global electric bus networks to operate at their best. In the north of Spain, the city of Pamplona has been For many years, hybrid buses and integrated biogas have been promoted as forms of sustainable public transportation. Route 9 is completely closed as of March 2019. a ground-breaking project in Spain, run by electric buses. Particularly, six electric buses run every 12 minutes between the two terminals, one at the Arrosadia Campus of the Public University of Navarra (UPNA) and the other at the Train Station, to cover the 12.3 km distance of the outbound and incoming trips. The batteries in the buses contain a 44.3 kWh lithium titanate (LTO) battery with a weight of 550 kg and a rated voltage of 650 V. A fast charging station, which is commonly utilised in a kind of public transport where the buses must be swiftly charged between stops. Around 10 kWh of energy are used for each journey, and the bus's battery can be fully recharged in 3.5 minutes. When the pantograph is attached to the bus, the charging station at UPNA is depicted in Fig. 1


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**Fig. 1. Bus charging station at UPNA Fuvex aircraft Marvin5**

Despite the benefits that electric buses bring to the community, obtaining their electricity is not an easy task. The charging stations' need for peak electric power could jeopardise the voltage drops and other disruptions are caused by the quality of the electric distribution network. While the average power used can be less than 70 kW, the charging peaks of the electric buses examined in this research can reach values of over 250 kW. A typical day's worth of electric power usage is depicted in Fig. 2. Because some charges are missed when the stop time is insufficient, there are gaps in the profile. Additionally, charging times can change based on the battery's current State of Charge (SOC).

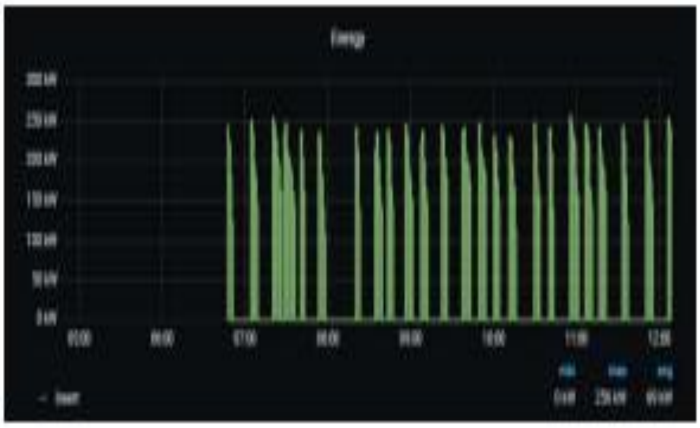

**Fig.2. Typical bus charging profile**

A stationary support battery is intended to be incorporated into the UPNA bus charging station in order to prevent the distribution network from having to handle high electric peak loads [7]. Such a battery would be in charge of giving the buses the peak power during the charging period and would charge continuously from the distribution network for the remaining time. The communication system must convey in real-time the demands of the following bus to be charged in terms of necessary energy, anticipated stop time, and bus battery performance in order to establish optimised energy management methods for this stationary support battery.

**Communication System:** Low power Wide-Area Network (LPWAN)-based wireless communications have been used to enable data transmission between electric buses and infrastructure nodes. Low transmission rates (below 50 Kbps) and moderate delay values (in the range of 2–5 seconds) are compatible quality of service measures in terms of system-level criteria. Furthermore, in order to optimise node number, design, and location, long distance communication range is essential. It is important to note that the suggested communication method is similar to vehicle-to-infrastructure linkages, where mobile nodes located inside of urban buses communicate with infrastructure nodes dispersed throughout the layout of the city. Due to their great range and low power consumption, LoRa/LoRaWAN communications have been taken into consideration with these settings. And simplicity of integrating gateway nodes into infrastructures that use the cloud. The network topology that is supported is a star topology, in which nodes found inside of urban buses directly connect to equivalent gateways found inside of urban infrastructure, like lampposts or government structures. As a result, non-line of sight situations, which are typically present in vehicle to vehicle links, are minimised in wireless communication links with a relative height difference. Functionalities like mesh networking can be avoided in this approach, which lowers MAC level complexity and energy usage [8]. Radio channel characterization has been done at an operational frequency of 868 MHz to confirm the viability of using LoRa/LoRaWAN for our application. Analysis has been done TTN Gateways are used as the infrastructure, with LoRa Dragino, LoRa 3 Click, MWR WAN 1310, and I-NUCLEOLRWAN1 employed as on-board nodes. nodes. Urban settings have been studied using empirical/statistical propagation models [9], with a height setting of 2.5 m for the mobile node and 10 m for the infrastructure node. Different wireless link conditions have been taken into consideration based on the geometrical placement of the infrastructure node and mobile node in terms of grazing angle, ranging from 35o (Case 1), 55o (Case 2), and 75o (Case 3). Figure 3 shows the coverage/capacity relations for different scenarios using LoRa@868MHz.

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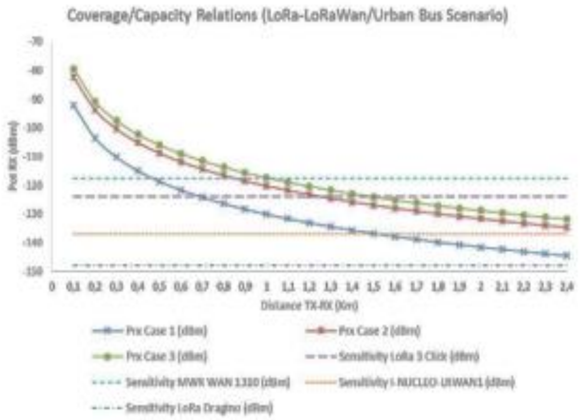


Fig. 3. Coverage/capacity estimations for infrastructure to vehicle links employing LoRa/LoRaWAN at 868MHz, for different transceivers and link conditions

As can be shown, in the worst possible circumstances, communication links can be established that are up to 400 metres away, but under less adverse circumstances and when using transceivers with lower sensitivity communication links longer than 2 km. With this in mind and taking into account the operating service area's 25.1 km2 size within the city of Pamplona, service can be offered with three infrastructural gateways providing overlapping coverage. As shown in Figure 4, for the three distinct geometrical link configurations, bit error rate (BER) values as a function of infrastructure to vehicle distance can also be used to analyse quality of service measures. As indicated from Figure 3, larger grazing angles result in better BER at close ranges.

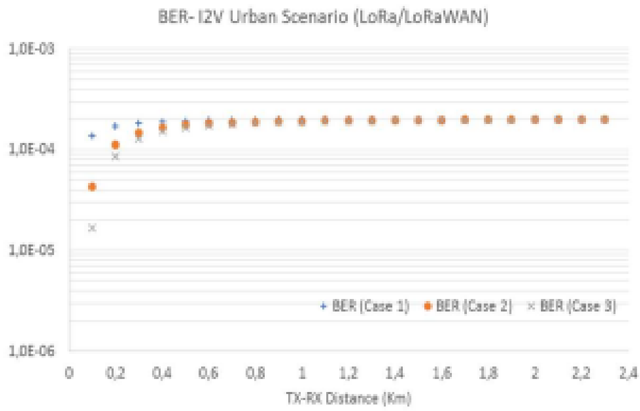


Fig. 4. BER estimation for infrastructure to vehicle links employing LoRa/LoRaWAN at 868MHz, for different transceivers and link conditions

**Monitoring Approach:** Monitoring systems that use the cloud typically includes the daily operations of municipal buses are specifically improved by both vehicle tracking and operation monitoring. Buses contain a communication gateway that notifies the management system of operations and locations periodically or as needed. Location data is used to provide bus monitoring so that users will be informed when the vehicle is likely to arrive at each bus stop. It is also used to investigate overall traffic patterns to improve city traffic and guarantee the effectiveness of urban transportation. The estimated is part of the data operation the number of people using the bus, the number of people boarding or alighting at each bus stop, the temperature and humidity of the a number of factors, including the vehicle, the incidents the driver wants to record, notifications of traffic accidents or of the vehicle itself. In our instance, we also provide extra details on the battery monitoring. The goal is to keep track of the vehicle's autonomy in order to optimise battery charge cycles, achieve efficient battery usage, and perform the fewest number of recharges necessary to extend the battery life. The monitoring will make it possible to determine how the battery ageing impacts the autonomy and functionality of the system. The monitoring system set up uses a number of Ubuntu 18 machines that have been VMware virtualized. Fig. 5 shows the monitorization system, which comprises four layers. Two Apache components known as NiFi and Kafka are part of the data acquisition layer and are in charge of collecting copious amounts of data from buses (through LoRa, as mentioned in the previous section). Data is transformed by NiFi [10] so that it can be properly stored in a MySQL [11] database. Following the subscription-publication model on messaging queues, Apache Kafka [12] enables offering the acquired (published) data at the MySQL database's disposal. The Apache Spark Streaming [13] (ML-Lib) component of the machine learning layer enables data analytics and machine learning processing pipelines. Our My SQL relational database is used to store data, and the Visualization Layer also includes a web application for analytics visualization called Grafana [14], a tool for map visualization based on the Leaflet JavaScript library [15], and Swagger [16] to offer a Restful web service for data publishing. Machine Learning (ML) models created in batches are used to analyse the data, along with historical and persistent data that can be accessed from Spark Streaming in real-time. To implement customized algorithms, statistics, time series analysis, and classification and clustering methods, Apache Spark Streaming offers APIs in Java, R, and Python.

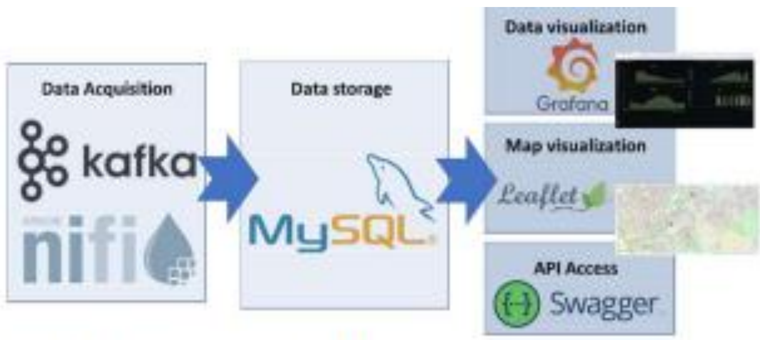


Fig. 5. Monitorization system architecture.

Fig. 6 shows one of the built monitoring dashboards as an example. It contains data about the temperature, relative humidity, insolation, and energy charge. The resulting charge profiles can be used, in particular, as Section II describes.

Fig. 6. Monitorization dashboard (Grafana)

## CONCLUSION

This work demonstrates various accomplishments linked to the integration of sensor data provided by electric buses into the city platform, including the monitoring of the battery

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condition, under the European Stardust project. These facts are important for extending battery life and for being able to operate charging stations and bus charging cycles in the city as efficiently as possible. We anticipate that this experience will benefit other communities and help to create and effectively incorporate electric buses into smart cities.

## REFERENCES

[1] R. Morello, S. C. Mukhopadhyay, Z. Liu, D. Slomovitz and S. R. Samantaray, "Advances on Sensing Technologies for Smart Cities and Power Grids: A Review," in IEEE Sensors Journal, vol. 17, no. 23, pp. 7596-7610, 1 Dec.1, 2017.

[2] STARDUST project, https://stardustproject.eu/ (accessed June 27, 2020).

[3] A. Ghosh, P. Pramanik, K. D. Banerjee, A. Roy, S. Nandi and S. Saha, "Analyzing Correlation Between Air and Noise Pollution with Influence on Air Quality Prediction," 2018 IEEE International Conference on Data Mining Workshops (ICDMW), Singapore, Singapore, 2018, pp. 913-918,

[4] BloombergNEF, “Electric Vehicle Outlook 2020”, https://about.bnef.com/electric-vehicle-outlook

[5] A. Nightingale, “Forget Tesla, It’s China’s E-Buses That Are Denting Oil Demand”, Bloomberg, 2019.

[6] https://www.bloomberg.com/news/articles/2019-03-19/forget-tesla-it-schina-s-e-buses-that-are-denting-Oil-demand (accessed June 27, 2020).

[7] A. M. Othman, H. A. Gabbar, F. Pino, M. Repetto, “Optimal electrical fast charging stations by enhanced Descent gradient and Voronoi diagram”, Comput. Electr. Eng., vol. 83, p. 106574, 2020.

[8] Ojer, A. Berrueta, J. Pascual, P. Sanchis, A. Ursúa, “Development of energy management strategies for the sizing of a fast charging station for electric buses”, Proc. of 20th IEEE Int. Conf. on Environment and Electrical Engineering, Jun 2020.

[9] D. Zorbas, K. Abdelfadeel, P. Kotzanikolaou, D. Pesch, “TS-LoRa: Timeslotted LoRaWAN for the Industrial Internet of Things”, Computer Communications 153 (2020) 1–10.

[10] X. Yin, X. Cheng. “Propagation Channel Characterization, Parameter Estimation and Modelling for Wireless Communications.” Ed. John Wiley & Sons, Singapore, 2016.

[11] Apache Nifi, https://nifi.apache.org/ (accessed June 27, 2020)

[12] My SQL, https://www.mysql.com/ (accessed June 27, 2020).

[13] Apache Kafka, https://kafka.apache.org/ (accessed June 27, 2020).

[14] Apache Spark, https://spark.apache.org/docs/latest/index.html (accessed June 27, 2020).

[15] Grafana, https://grafana.com/ (accessed June 27, 2020).

[16] Leaflet - a JavaScript library for interactive maps https://leafletjs.com/ (accessed June 27, 2020).

# Chapter: 46

# Quality Control Methods for Product Reliability and Safety

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**ABSTRACT**

Advanced technology requires to use products in a range of conditions what may lead to their unintended performance in practical situations. In order to achieve reliability and safety different sources of uncertainties and variations in design, manufacturing and operation of products should be considered. Moreover, in the paper concepts of novel approaches to quality control of products robust against to uncertainties are proposed which enable to increase product reliability and safety operations.

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## INTRODUCTION

Customer satisfaction determines the success of a new product and only products at high value meet needs of clients who expect them to perform correctly in their whole life cycle. In order to fulfill such requirements the minimum of variation of parameters should be assured within the manufacturing processes and the product itself. From an elementary part to compound parts, they must be designed and manufactured on high quality level and be reliable and safe in use. In the literature the notions: quality, reliability and safety are often used interchangeably. However, they do not have the same meaning as quality is conformance to specifications, whereas reliability concerns functioning under defined conditioned for a specified time. So, it can be said that reliability is the extension of the term *quality* over time and can be defined as “the time period over which a product meets the standards of quality for the period of expected use. In the paper some considerations of quality, reliability and safety are shared as a number of problems and challenges must be faced in manufacturing and operation of products which are becoming more and more complex. Different approaches to quality control of products are presented and widely discussed. Their pros and cons are shown in order to indicate the direction of further research in this scope.

## VARIATIONS AND UNCERTAINTIES AS THE SOURCES OF PRODUCT FAILURES

In order to tackle the development of advanced technologies, the reliability of products has become a significant matter of concern. It regards with respect to failure avoidance rather than probability of failure. Product failure occurs when the product is not able to perform its objective functions and does not meet its requirements. Thus, reliability is a product capability to fulfill intended tasks for a specified performance period. Performance period can be a function of cycles, distance or time. Its rapid growth results from the INTRODUCTION of the idea of safety and risk as nowadays it is expected to produce and sell high reliability products and purchase and operate them safely without any risk. Failures are usually attributable to one or a group of failure modes which can result from a chain of causes and effects such as: a symptom, trouble or operational complaint. They can be categorized into different types and sources. Considering all product failures two types can emerge: random (or physical) and systematic (or functional). Random failures result in casual lack of achieving its objectives what may lead to one or more degradation mechanisms in the hardware, whereas if the product does not perform its intended tasks but no components have already failed is the example of systematic failure. Failures can be categorized due to intrinsic and extrinsic causes which result from weakness and/or wear-out or errors, misuse or mishandling. Among them the following can be distinguished: design faults, material defects, processing and manufacturing deficiencies, lack or improper quality control, inadequate testing, human errors, improper assembly or

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installation, off-design or unintended service conditions, improper operation, lack of protection against over stress and maintenance deficiencies. Failures lead to losses in repair cost, warranty claims, customer disappointment, product recalls, loss of sale, and finally loss of life. To reduce them, variations can be decreased, or a product can be designed robust against these variations. Moreover, other uncertainties such as incomplete information regarding the phenomena, data, model errors, human mistakes and parameter uncertainties have to be taken into account. Uncertainty encompasses the occurrence of events which are beyond human management capabilities.

Any uncertain variable has a random characteristic which yields a level of error. In the literature there are various classifications of uncertainties, however, they are generally categorized as either aleatory or epistemic uncertainties. The first one concerns the underlying, inherent uncertainties such as randomness of a phenomenon, scattered in life and the load variation within a population when the modeler is not able to foresee the possibility of their reduction. The latter one refers to the uncertainties due to lack of knowledge, which can be decreased by the application of additional data or information, better modeling, and parameter estimation methods.

It should be emphasized that in the reliability modeling, it is possible to divide the second kind of uncertainty into statistical uncertainty and model uncertainty, whereas the first type of uncertainty is called random variation (or physical uncertainty, noise factor). Statistical uncertainty refers to estimation of model parameters based on the available data where the observations of the variable may not represent the real situation perfectly, and thus, the recorded data may be biased. Additionally, different sample data sets usually provide diverse statistical estimates.

Model uncertainty results from the use of one (or more) simplified relationship which is supposed to represent the “real” relationship or phenomenon of interest. Such an approach results from lack of knowledge or increased availability of data. Another important kind of uncertainty is related to the uncertainties due to human factors. Such uncertainties result from human errors and interventions undertaken in the design, manufacturing and operation. For example, they can be caused by misuse, gross errors and human mistakes. They can be considered by creating robustness through product changes or using extra safety, however, in practice they are primarily subjects to quality management.

## PRODUCT RELIABILITY

The behaviour of the product depicted in Fig 1. can be described by the following relation:

$\mathbf{Y_k = F(\ P, U_K) + E_K}$ where $U_K$ and $Y_k$ are product inputs and outputs, respectively. **p** are parameters representing physical features of a manufactured product such as dimension or physical characteristics of product components. All these values, manufactured in the production process, are influenced by control factors **s.**

Moreover, the relation between inputs, output and parameters describing the behaviour or properties of the product and $\mathbf{E_K}$ represents the noise.

The problem of product reliability and safety h as to be considered during product design, its manufacturing and operation stages (c.f. Figs. 2-4). In order to ensure the product’s reliability it is necessary to ensure its robustness against different sources of uncertainty.

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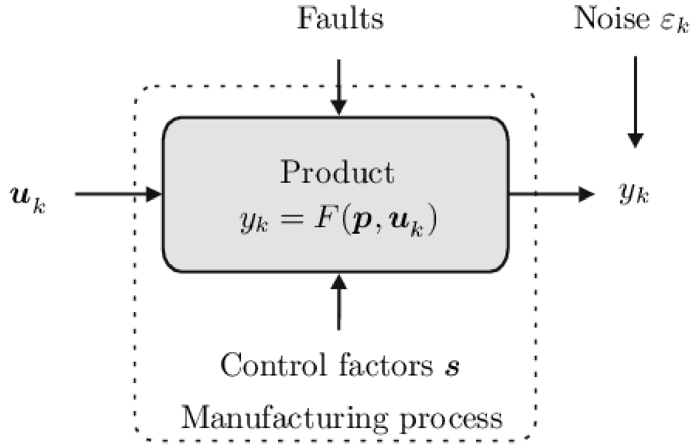


**Fig. 1. The general scheme of the product.**

Robustness is defined in Taguchi et al. as ‘the state where the technology, product, or process performance is minimally sensitive to factors causing variability (either in manufacturing or user’s environment) and aging at the lowest manufacturing cost’. Thus, its aim is not to eliminate noise but to create insensitivity to it. The general scheme of the reliable product design is depicted in Fig. 2.

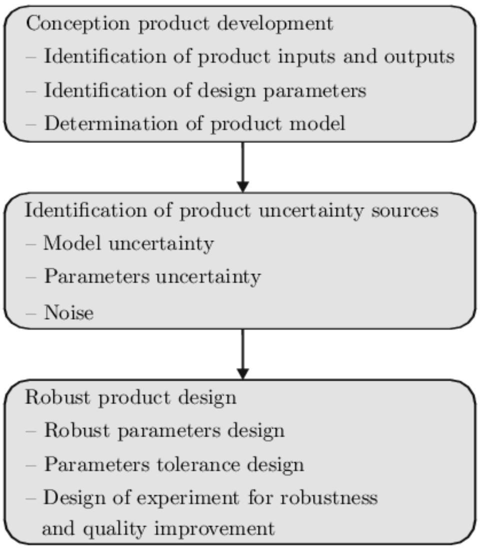


**Fig. 2. Reliable product design.**

As it can be seen it includes conception design, identification of product uncertainty sources and robust product design. The most important tasks concern product parameters and its tolerance design. In the literature several method to solve them can be found (i.e. QFD, Taguchi, Worst Case, Six Sigma, Monte Carlo, optimization-based methods) . The optimization-based methods seem to be especially attractive as they are based on the choice of parametric structure of the model during conception product development stage and parameter estimation with the application of optimization techniques . This mathematical model can be used to elaborate a control method of product quality in the manufacturing process and operation. Moreover, such an approach allows to choose the optimal values of parameters of the model which accurately reflect clients’ expectations. To improve the model, design of experiments, which is based on fractional factorial designs or orthogonal arrays, can be applied. Control factors, which include the design parameters in product or process design, are set at fixed levels, whereas the settings of noise factors (variables), which have a potential influence on the product outputs, are varied systematically to show their changeability in normal conditions. The appropriate choice of the setting of control factors allows to make them less sensitive to noise variations what reduces the performance variation of the product.

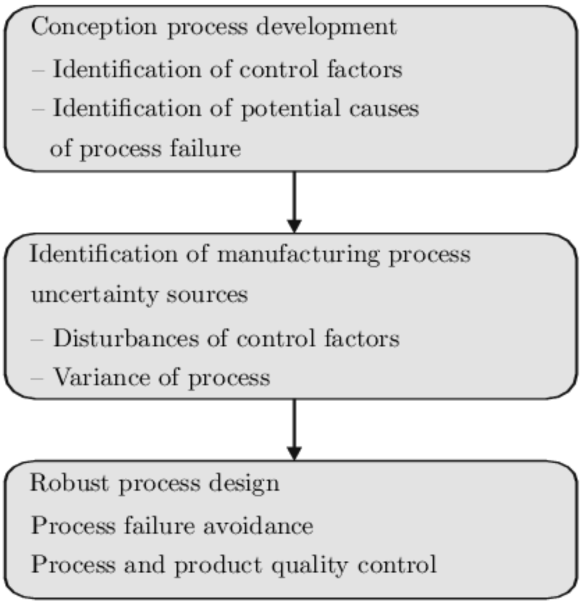


**Fig. 3. Reliable process design**

Reliable product operation is usually ensured by the application of different failure avoidance techniques. They are generally effective when whole potential operation uncertainty sources are known but it is often impossible. The product quality control (supervision of quality), which takes place during product operation, is directed to detection of deterioration of product quality (or its parameters). In this case it is vital to detect it early enough not to accept the situation where a damaged component can make a breakdown of other product elements.

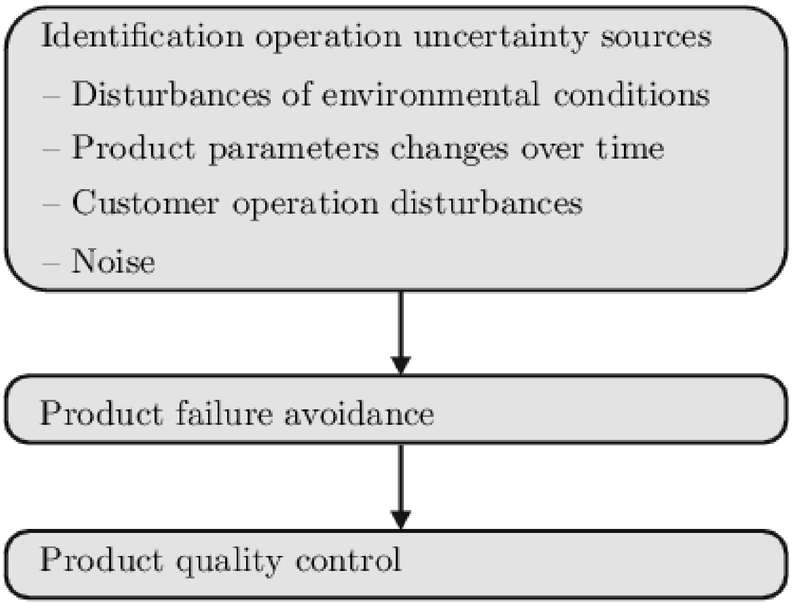


**Fig. 4. Reliable product operation.**

## CONCLUSIONS

In the engineering approach to new product design, manufacturing and operation it must be ensured that all variations and uncertainties affecting its performance are considered as far as practicably possible. In order to achieve it, it is advisable to apply robust design methods. These methods allow for further development of quality control of products in the manufacturing and operation. Quality control methods based on the parameter's estimation

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can be applied for simple products in which the linear relation between parameters and outputs can be found. In the case of more complex nonlinear products the above approach cannot be applied, and the application of output adaptive threshold technique presented in the paper seems to be a promising solution.

## REFERENCES

[1] M.A. Levin, T.T. Kalal, Improving Product Reliability: Strategies and Implementation, John Wiley & Sons Ltd, Chichester, 2003.
[2] E. Zio, Reliability engineering: Old problems and new challenges, Reliability Engineering and System Safety 94 (2009) 125–141.
[3] S.M. Thampi, B. Bhargava, P.K. Atrey, Managing Trust in Cyberspace, CRC Press Taylor & Franicis Group, Boca Raton, 2014.
[4] A.K. Verma, S. Ajit, D.R. Karanki, Reliability and Safety Engineering, Springer-Verlag, London, 2010.
[5] B. Forouraghi, Worst-Case Tolerance Design and Quality Assurance via Genetic Algorithms, Journal of Optimization Theory and
Applications 113 (2002) 251–268.
[6] W.H. Greenwood, K.W. Chase, Worst-Case Tolerance Analysis with Nonlinear Problems, John Wiley, New York, 1992.
[7] T.P. Ryan, Statistical methods for quality improvement, 3rd ed., John Wiley & Sons, Inc., Hoboken, 2011.
[8] W. Seidel, An open optimization problem in statistical quality control, Journal of Global Optimization 1 (1991) 295–303.
[9] D.C. Montgomery, INTRODUCTION to statistical quality control, 3rd ed., John Wiley & Sons, Inc., Hoboken, NJ, 2009.
[10] P. Johannesson, B. Bergman, T. Svensson, M. Arvidsson, Å. Lönnqvist, S. Barone, J.d. Maré, A Robustness Approach to Reliability, Qual.
Reliab. Engng. Int. 29 (2013) 17–32.
[11] A. Myers, Complex System Reliability: Multichannel Systems with Imperfect Fault Coverage, Springer-Verlag, London, 2010.
[12] A. Górny, Minimum safety requirements for the use of work equipment (for example of control devices). Occupational Safety and Hygiene -
Sho2013 (2013) 227–229.
[13] A. Górny, Occupational Risk In Improving The Quality Of Working Conditions, in: P. Vink (Ed.), 5th International Conference on Applied
Human Factors and Ergonomics, 19-23 July, 2014, AHFE Conference, Cracow.
[14] T. Nakagawa, Advanced Reliability Models and Maintenance Policies, Springer-Verlag, London, 2008.
[15] H.P. Bloch, F.K. Geitner, Machinery Failure Analysis and Troubleshooting: Practical Machinery, 4th ed., Elsevier Inc., Oxford, 2012.

# Chapter: 47

# Research and Design of Smart Grid Monitoring System Based on Cloud Computing

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**ABSTRACT**

Real-time data of power system is an important data for power system equipment measurement and acquisition. These data are important basis for analyzing power system stability, predicting grid load and power equipment failure and aging, andare the data that must be monitored for grid operation. Aiming at the problem of massive monitoring data access and processing in smart grid monitoring system, this paper proposes a smart grid monitoring system based on cloud computing framework by comprehensively utilizing geographic information technology, network communicationtechnology and distributed database technology. The system's workflow is more efficient and reliable for information processing than traditional database models and existing methods.

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## INTRODUCTION

Numerous power equipment and monitoring instruments in the power grid form real-time status data that requires the power information system to continuously receive and process. The amount of data inthese status data is huge, and high reliability and real-time requirements are imposed on the monitoring system. However, in the face of massive state data, the traditional system shows that the storage capacity and processing capacity are seriously insufficient, which restricts the working efficiency of the power grid monitoring system to a large extent. Therefore, storing information data and processing these datahas become the key to restricting smart grid monitoring. Hadoop is a decomposition/aggregation cloud computing framework for large dataset object analysis processing. Through the coordinated management of the distributed file system HDFS and the parallel programming model Map/Reduce, thesystem can effectively segment and reasonably schedule massive data, thus achieving efficient parallelprocessing for big data. At present, China is accelerating the construction of smart grids, and adopting cloud computing technology for reliable storage and parallel processing of state monitoring data will inevitably play a huge role in promoting the establishment of smart grids in the future. Based on this, based on the research of the combination of geographic information system and smart grid, this paper develops intelligent grid monitoring system based on cloud computing to realize efficient parallel storage and processing of largedataset grid monitoring information, and it is difficult to solve real-time monitoring of grid operation. The problem of slowness and improvement of the monitoring of the operation of the power grid to improve the overall emergency support capability of the power grid.

## GRID MONITORING TECHNOLOGY

Grid monitoring refers to the process of providing the basis for equipment fault diagnosis by detecting,transforming, analyzing, processing and displaying the characteristic signals under a certain operating state, and outputting the information collected by the diagnosis. Through the combination of advanced automatic control, communication technology, computer technology, information technology, etc., telemetry, remote signaling, remote control, remote adjustment operation, and secondary equipment andauxiliary equipment for power operation equipment facilities monitored in a physical area of the systemRealize remote control, realize

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monitoring, measurement, control, recording and alarm of all primary equipment, realize optimal operation, optimization control and optimization management of power grid, thereby improving grid operation status, safety level and forecast level of accident disaster prediction.

The data to be faced and processed by the smart grid monitoring system mainly includes three types: basic geographic information data, grid equipment facility spatial data and other data with spatial attribute characteristics. The basic geographic information data includes national grid map data, provincial network map data, and key city grid map data of various scales. Grid equipment facility spatial data is grid data with spatial location information, including power plants, substations, overhead lines, towers, cable lines, and so on. Other data with spatial attribute characteristics are grid environment information, including meteorological information, disaster information, geological monitoring (earthquake), natural disasters (typhoons, ice disasters, etc.), and sources of danger. These will have an impact on the grid, which is the focus of the monitoring system. The smart grid monitoring system belongs to a complex adaptive system and requires comprehensive support of geographic information technology, network communication technology and database technology. While the monitoring system displays and monitors the power parameters, in order to perform statistics, analysis and processing on the data in the future, and realize the dynamic display of the data curve, it is also required to provide a database storage function for the system. Since the power information has many kinds of data, large amount of data, inconsistent format, one-time writing, multiple readings, etc., the power monitoring equipment needs to continuously write real-time monitoring data into the database. In order to meet the requirements of reliability and real-time, the traditional relational database is not used, and the distributed data management mode based on column storage is adopted to support the efficient management of large data sets. Although the distributed database spreads the data records on each physical node, it still logically belongs to the same system. This data is shared by the method of data distribution. A global database is responsible for the management of the entire system, and some databases are undertaken by the local database of each node. In this way, the data is dispersed to maximize the local application, and the mutual interference between the computing nodes is also minimized. Tasks are shared among nodes, thus avoiding load bottlenecks and improving work efficiency.

## SYSTEM DESIGN

The smart grid monitoring geographic information system designed in this paper is divided into three levels, namely the on-site monitoring layer, the network communication layer and the management application layer. The on-site monitoring layer is also called the sensing layer. It consists of various sensors and sensor network tubes, including temperature sensors, humidity sensors, two-dimensional code labels, RFID tags, readers, cameras and other sensing terminals. It mainly monitors the operating parameters of all links in the power grid. Real-time monitoring including transmission line monitoring, substation station monitoring, substation monitoring, etc., including geographic attribute information with geographic coordinates, network communication network operation status and grid environment information. The network communication layer mainly realizes the transmission and control of information. The various operating parameters of the power grid obtained from the on-site monitoring layer and the grid environment information are transmitted to the management application layer through the network communication layer. On the other hand, instructions issued from the management application layer need to be forwarded to the monitor of the

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power running device on the field monitoring layer through the network communication layer. The network communication layer undertakes a two-way, massive grid data transmission task. The system uses a variety of communication technologies such as power private network and public wireless network to complete the data transmission of the network communication layer. According to the characteristics of smart grid equipment monitoring, this paper uses distributed redundant storage system and column storage-based data management mode to store and manage data to ensure the reliability and efficient management of smart grid massive state data. The operating condition data of the power equipment facility acquired by the sensor network, the power private network, and the like are generated and stored in the database through the Map Reduce-based grid monitoring data parallel processing platform. Other information databases with spatial attribute features include remote sensing information, road information, and weather information. For meteorological information, relevant meteorological geographic information data such as grid dispatching meteorological warning and forecasting service data are obtained from the meteorological department through a dedicated cable or the Internet. This article uses Hive and HBase database to store data. As a distributed database, HBase has high query efficiency. Install HBase on the already configured Hadoopsmart grid monitoring platform, edit and modify the hive-site.xml in the conf directory. The modificationis shown in Figure 1.

```
<property>
<name> hive.aux.jars.path</name>
<value>file:///home/hadoop/hive-0.10.0/lib/hive-hbase-0.10.0.jar ,file:///home/hadoop/hive-0.
10.0/lib/hbase-0.94.4.jar ,file:///home/hadoop/hive-0.10.0/zookeeper-3.4.5.jar</value>
</property >
```

**Figure 1. Edit and modify the file in the conf directory.**

Through the system read and write test, no matter which end of the data is written, the data can be read at the other end, indicating that the Hive database can be used for large data storage and processing, and HBase can quickly display data, indicating that the two technologies are obtained. Effective integration.

## PARALLEL PROCESSING BASED ON MAP REDUCE

When processing the monitoring data set, Map Reduce first divides it into hundreds or thousands ofsmall data sets, and then each node in the cluster processes one or several divided small data sets and produces intermediate results, and finally passes merging a large number of nodes translates these intermediate results into final results. The whole work process is divided into two stages: Map and Reduce.

```
hadoop@ubuntu1:~/hadoop-0.20.2$ bin/hadoop fsck /home/hadoop/hive-0.8.1/datastore/test1106/test100.xls -files -blocks -locatio
ns
/home/hadoop/hive-0.8.1/datastore/test1106/test100.xls 106988874 bytes, 2 block(s):  OK
0. blk_8440866167082317220_1010 len=67108864 repl=2 [172.16.11.154:50010, 172.16.11.205:50010]
1. blk_2393521136500549826_1010 len=39880010 repl=2 [172.16.11.154:50010, 172.16.11.205:50010]

Status: HEALTHY
 Total size:    106988874 B
 Total dirs:    0
 Total files:   1
 Total blocks (validated):      2 (avg. block size 53494437 B)
 Minimally replicated blocks:   2 (100.0 %)
 Over-replicated blocks:        0 (0.0 %)
 Under-replicated blocks:       0 (0.0 %)
 Mis-replicated blocks:         0 (0.0 %)
 Default replication factor:    2
 Average block replication:     2.0
 Corrupt blocks:                0
 Missing replicas:              0 (0.0 %)
 Number of data-nodes:          4
 Number of racks:               1
```

**Figure 2. Parallel processing operation**

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Usually, there are many duplicate keys in the intermediate results processed by the Map operation. In order to alleviate the burden of Reduce operation and network transmission, the system is optimized, that is, a custom Combiner method is used to locally integrate and stipulate the intermediate results. The Combiner operation runs on each node that performs the Map operation, usually using the same process as the Reduce operation. The only difference is that the result of the Reduce operation is written to the final output file, and the result of the Combiner operation is sent to the Reduce operation as an intermediate file. The specific steps of the improved Map Reduce execution process are as follows:

- First, the monitoring data set of the cloud computing platform that is imported into the running user program is preprocessed, and data noise reduction and the like are processed.
- The Map Reduce function library in the user program divides the imported monitoring data file into 16 to 64 megabytes of M blocks (which can be adjusted by parameters), and then executes a copy of the program on different machines in the cluster. It should be pointed out that the split does not need to understand the internal logical structure of the file. The specific split mode can be specified by itself or by several simple partitions that Hadoop has defined.
- In all running processes, the master program master is responsible for the allocation of the remaining execution tasks. The master program in the execution program assigns Map and Reduce tasks according to the idle status of the worker.
- The working node assigned the Map task reads and processes the input data block, and the Map function finally outputs the intermediate result pair. In addition, in order to further shorten the processing time, when performing the Combine operation, the merged key pairs are first indexed, then merged into several large new data pairs, and after being transferred to the Reduce process, the decomposition is performed, and the index is utilized.
- The system packs the key/value pair data and sends the index information to the Master, and then transmits it to Reduce through the Master.
- The Reducer Worker calls the user-defined Reduce function to analyze and sort the set of intermediate results.
- After executing all the Map Reduce tasks, the Master is responsible for controlling the corresponding monitoring data to be stored in the library and generating a corresponding copy file for transmission.

## CONCLUSION

Based on the research of the combination of geographic information system and smart grid, this paper designs a smart grid monitoring system based on cloud computing for the problem of large data set storage in the traditional mode of power grid monitoring system. The method stores and processes massive amounts of monitoring data. Through the development of cloud computing-based smart grid monitoring system, the efficient parallel storage and processing of large dataset grid monitoring information is realized, the problem of difficult and slow real-time monitoring of power grid operation is solved, and the monitoring of grid operation is improved to the overall emergency of the grid.

## REFERENCES

[1] REN Jianfeng, DING Yawei, FU Lei, et al. An improved strategy for out-of-step separation basedon phase angle principle for 1 000 kV ultra-high voltage AC power grids [J]. Automation of Electric Power Systems,

2011, 35 (10): 104 - 107.

[2] Li Chenghua, Zhang Xinyi, Jin Hai, Xiang Wen. MapReduce: A New Distributed Parallel Computing Programming Model [J]. Computer Engineering and Science, 2011, 33 (3): 129 - 135.

[3] Luo Junzhou, Jin Jiahui, Song Aibo, et al. Cloud computing: architecture and key technologies [J]. Journal of Communications, 2011, 32 (7): 3 - 21.

[4] Lu Wei, Zhang Tianbing, Li Guozhi. Design and key technology of power grid emergency command information management system [C]. Proceedings of China Communications Society 2011 Optical Cable and Cable Academic Annual Conference, 2011: 45 - 50.

[5] Shu Qiang. Information Network Support Platform for Smart Grid [J]. Equipment ManufacturingTechnology, 2011 (3): 118 - 121.

[6] Li Xiangzhen, Liu Jianming. IoT technology for smart grid and its application [J]. Telecom Network Technology, 2010, 8: 41 - 45.

[7] Wang Dewen, Song Yaqi, Zhu Yongli. Smart grid information platform based on cloud computing [J]. Power System Automation, 2010, 34 (22): 7 - 12.

[8] Meteorological industry standards of the People's Republic of China. Power grid dispatching meteorological warning and forecasting service products (draft for comments) [S]. Beijing: China Meteorological Administration, 2011.

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# Chapter: 48

# Green Marketing in India

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**ABSTRACT**

Environmental issues have gained importance in business as well as in public life throughout the world. It is not like that a few leaders of different countries or few big renowned business houses are concerned about the day-to-day deterioration of oxygen level in our atmosphere, but every common citizen of our country and the world is concerned about this common threat of global warming. So, in this scenario of global concern, corporate houses has taken green-marketing as a part of their strategy to promote products by employing environmental claims either about their attributes or about the systems, policies and processes of the firms that manufacture or sell them. Clearly green marketing is part and parcel of overall corporate strategy; along with manipulating the traditional marketing mix (product, price, promotion and place), it requires an understanding of public policy process. Smart business houses have accepted green marketing as a part of their strategy. This paper will attempt to introduce – the terms and concept of green-marketing; about the importance of green marketing; examine some reasons that make the organizations interested to adopt green marketing philosophy; it also highlights some problems that organization may face to implement green marketing.

**KEYWORDS**: Environmental issue, green marketing, Ecological Marketing.

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## INTRODUCTION

The term Green Marketing came into prominence in the late 1980s and early 1990s.The American Marketing Association (AMA) held the first workshop on "Ecological Marketing" in 1975.The proceedings of this workshop resulted in one of the first books on green marketing entitled "Ecological Marketing". The first wave of Green Marketing occurred in the 1980s. Two tangible milestones for wave 1 of green marketing came in the form of published books, both of which were called Green Marketing. They were by Ken Pattie (1992) in the United Kingdom and by Jacquelyn Ottoman(1993) in the United States of America

**Meaning of Green Marketing:** "Green Marketing is the marketing of products that are presumed to be environmentally safe. Thus, green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Yet defining green marketing is not a simple task where several meanings intersect and contradict each other, an example of this will be the existence of varying social, environmental, and retail definitions attached to this term. Other similar terms used are Environmental Marketing and Ecological Marketing. Different authors have given different definitions of green marketing. Some of the commonly used definitions are:

According to the American Marketing Association,

A3 Ways definition (Retail definition): The marketing of products that are presumed to be environmentally safe.

(Socially marketing definition): The development and marketing of products designed to minimize negative effects on the physical environment or to improve its quality.

(Environment definition): The effort by an organization to produce, promote, package and reclaim products in a manner that is sensitive or responsive to ecological concerns.

Green marketing emphasizes environmental stewardship. Alma T. Mintu and Hector R. Lozada define green marketing as "the application of marketing tools to facilitate exchanges that satisfy

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organizational and individual goals in such a way that the preservation, protection and conservation of the physical environment is upheld." Walter Coddington defines *environmental marketing* as "marketing activities that recognize environmental stewardship as a business development responsibility and business growth responsibility." Others have focused more on strategic dimensions in defining green marketing; for example, Martin Charter defines it as "a holistic and responsible strategic management process that identifies, anticipates, satisfies and fulfills stakeholder needs for a reasonable reward, that does not adversely affect human or natural environmental well-being." Finally, Robert D. Mackoy, Roger Calantone, and Cornelia Dr6ge differentiate among three aspects of green marketing, which they identify as *demarketing* (managing demand to maintain optimal long-term profitability), *green marketing* (addressing the needs and wants of a segment of consumers expressing environmental concerns), and *social marketing* (adapting marketing tactics and strategies to the development and promotion of social goals). Green or environmental marketing may be defined as any marketing activity that recognizes environmental stewardship as a fundamental business development responsibility and business growth responsibility. Environmentally responsible or "green" marketing is a business practice that takes into account consumer concerns about promoting preservation and conservation of the natural environment. Green marketing campaigns highlight the superior environmental protection characteristics of a company's products and services. The sorts of characteristics usually highlighted include such things as reduced waste in packaging, increased energy efficiency of the product in use, reduced use of chemicals in farming, or decreased release of toxic emissions and other pollutants in production.

Why Are Firms Using Green Marketing?

When looking through the literature, there are several suggested reasons for firms increased use of Green Marketing. Five possible reasons cited are:

1. Organizations perceive environmental marketing to be an opportunity that can be used to achieve its objectives.
2. Organizations believe they have a moral obligation to be more socially responsible.
3. Governmental bodies are forcing firms to become more responsible.
4. Competitors' environmental activities pressure firms to change their environmental marketing activities.
5. Cost factors associated with waste disposal, or reductions in material usage forces firms to modify their behavior.

**(A) Opportunities:** It appears that all types of consumers, both individual and industrial are becoming more concerned and aware about the natural environment. Nowadays, firms marketing goods with environmental characteristics have realized a competitive advantage over firms marketing non-environmentally responsible alternatives. There are numerous example of firms who have strived to become more environmentally responsible, in an attempt to better satisfy their consumer needs.

- McDonald's replaced its clam shell packaging with waxed paper because of increased consumer concern relating to polystyrene production and Ozone depletion.
- Tuna manufacturers modified their fishing techniques because of the increased concern over driftnet fishing, and the resulting death of dolphins.
- Xerox introduced a "high quality" recycled photocopier paper in an attempt to satisfy the demands of firms for less environmentally harmful products.

This does not mean that all firms who have undertaken environmental marketing activities actually improve their behavior. In some cases, firms have misled consumers in an attempt to gain market share. In many other cases firms have jumped on the green bandwagon without considering the accuracy of their behavior, their claims, or the effectiveness of their products. This lack of consideration of the true "greenness" of activities may result in firms making false or misleading green marketing claims.

**(B) Social Responsibility:** Many firms are beginning to realize that they are members of the wider community and therefore must behave in an environmentally responsible fashion. This translates into firms that believe they must achieve environmental objectives as well as profit related objectives. This results in environmental issues being integrated into the firm's corporate culture. Firms in this situation can take two perspectives: 1) they can use the fact that they are environmentally responsible as a marketing tool; or 2) they can become responsible without promoting this fact.

There are examples of firms adopting both strategies. Organizations like the Body Shop heavily promote the fact that they are environmentally responsible. While this behavior is a competitive advantage, the firm was established specifically to offer consumers environmentally responsible alternatives to conventional cosmetic products. This philosophy directly ties itself to the overall corporate culture, rather than simply being a competitive tool. An example of a firm that does not promote its environmental initiatives is Coca-Cola. They have invested large sums of money in various recycling activities, as well as having modified their packaging to minimize its environmental impact. While being concerned about the environment, Coke has not used this concern as a marketing tool. Thus, many consumers may not realize that Coke is a very environmentally committed organization. Another firm who is very environmentally responsible but does not promote this fact, at least outside the organization, is Walt Disney World (WDW). WDW has an extensive waste management program and infrastructure in place, yet these facilities are not highlighted in their general tourist promotional activities.

**(C) Governmental Pressure:** Governmental regulations relating to environmental marketing are designed to protect consumers in several ways: 1) reduce production of harmful goods or by-products; 2) modify consumer and industry's use and/or consumption of harmful goods; or 3) ensure that all types of consumers have the ability to evaluate the environmental composition of goods. These governmental regulations are designed to control the amount of hazardous wastes produced by firms. Many by-products of production are controlled through the issuing of various environmental licenses, thus modifying organizational behavior. In some cases, governments try to "induce" final consumers to become more responsible. For example, some governments have introduced voluntary curbside recycling programs, making it easier for consumers to act responsibly. In other cases, governments tax individuals who act in an irresponsible fashion. For example, in Australia there is a higher gas tax associated with leaded petrol.

One of the recent publicized environmental regulations undertaken by governments has been the establishment of guidelines designed to "control" green marketing claims. These regulations include the Australian Trade Practices Commission's (TPC) "Environmental Claims in Marketing - A Guideline, the US Federal Trade Commission's (FTC) "Guides for the Use of Environmental Marketing Claims" and the regulations suggested by the National Association of Attorneys-General. All these regulations were designed to ensure appropriate information to consumers so that they could evaluate firm's environmental claims. Thus, governmental attempts to protect consumers from false or misleading claims theoretically provide consumers with the ability to make more informed decisions.

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**(D) Competitive Pressure:** Another major force in the environmental marketing area has been a firm's desire to maintain its competitive position. In many cases, firms observe competitors promoting their environmental behaviors and attempt to emulate this behavior. It is only in some instances that this competitive pressure causes an entire industry to modify and thus reduce its detrimental environmental behavior. For example, it could be argued that Xerox's "Revive 100% Recycled paper" was introduced a few years ago in an attempt to address the INTRODUCTION of recycled photocopier paper by other manufacturers. In another example when one tuna manufacture stopped using driftnets, the others followed suit.

**(E) Cost / Profit Issues:** Certain firms use green marketing to address cost/profit related issues. Disposing of environmentally harmful by-products, such as polychlorinated biphenyl (PCB) contaminated oil are becoming increasingly costly and, in some cases, difficult. Therefore, when attempting to minimize waste, firms are often forced to re-examine their production processes. In these cases, they often develop more effective production processes that not only reduce waste but reduce the need for some raw materials. This serves as a double cost savings, since both waste and raw material are reduced. In many other cases, it has been found that firms find end-of-pipe solutions, instead of minimizing waste. In these situations, firms try to find markets or uses for their waste materials, where one firm's waste becomes another firm's input of production.

## DARK SIDE OF GREEN MARKETING

The Green Movement is still in its infancy and is just starting to build trust among people now concerned about the environment. These are people who, in many cases, are now willing to pay more for a green product. Should that product not be green or live up to its promises, many new green consumers will lose faith in the movement as a whole. It's easy for companies to tout their own horn on how green they are. When possible, consumers should look for product certifications from governments and standard setting bodies such as EcoLogo and Green Seal. However, not all small and medium size companies can afford the fees required for testing by these agencies. Companies in this category, and those in the service industry, should review their own company practices, set a plan for their own green initiatives, and strive for professional third-party recognition of their efforts. With all that is at stake, no company can afford to be on the "dark side" and lose the confidence of the new green consumer. However, green marketing poses huge dangers for marketers if they get it wrong:

- Most customers choose to satisfy their personal needs before caring for the environment.
- Overemphasizing greenness rather than customer needs can prove devastating for a product.
- Many customers keep away from products labeled "green" because they see such labeling as a marketing gimmick, and they may lose trust in an organization that suddenly claims to be green.

Green marketers need to find out the value their customers place on green benefits. It is important that they position the product on the basis of the functional need it caters to and then talk about the additional benefits of greenness. Marketers need to find out whether, by adopting green marketing, their organizations will be perceived as more socially responsible. They need to know whether their customers understand the benefits of green products and value them enough. If they do not, then the marketers may also need to invest in customer education in order to make their marketing efforts successful.

## CONCLUSIONS

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Green marketing is based on the premise that businesses have a responsibility to satisfy human needs and desires while preserving the integrity of the natural environment. Indeed, there are significant indications that environmental issues will grow in importance over the coming years and will require imaginative and innovative redesign and reengineering of existing marketing efforts on the part of many businesses.clever marketer is one who not only convinces the consumer, but also involves the consumer in marketing his product. Green marketing should not be considered as just one more approach to marketing, but has to be pursued with much greater vigor, as it has an environmental and social dimension to it. With the threat of global warming looming large, it is extremely important that green marketing becomes the norm rather than an exception or just a fad. Recycling of paper, metals, plastics, etc., in a safe and environmentally harmless manner should become much more systematized and universal. It has to become the general norm to use energy-efficient lamps and other electrical goods. Marketers also have the responsibility to make the consumers understand the need for and benefits of green products as compared to non-green ones. In green marketing, consumers are willing to pay more to maintain a cleaner and greener environment. Finally, consumers, industrial buyers and suppliers need to pressurize effects on minimize the negative effects on the environment-friendly. Green marketing assumes even more importance and relevance in developing countries like India.

## REFERENCES

[1] Chopra, S. Lakshmi (2007), "Turning Over a New Leaf", Indian Management, Vol-64, April-2007
[2] Ottman, J A(Jan2004) “empower to the people”In b usi ness.
[3] Prakash, A. (May2002) “ Green Marketing, public policy and managerial strategy”
[4] Business Strategy and The Environment, Bus.Strat.Env.II, pg 285-297.
[5] Ottman, J.A. et al, "Avoiding Green Marketing Myopia", Environment, Vol-48, June-2006
[6] www.greenmarketing.net/stratergic.html
[7]www.epa.qld.gov.au/sustainable_industries
[8]www.wmin.ac.uk/marketing research/ marketing/greenmix.html

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# Chapter: 49

# Artificial Intelligence in Gaming

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**ABSTRACT**

Artificial intelligence (AI) is the intelligence exhibited by an artificial entity, generally assumed to be a computer. It has been involved with gaming since day one. It is progressively being widely used in the gaming industry. AI in games is commonly used for creating player's opponents. It is the foundation of all video games. Games like Nim, checkers, or chess took advantage of smart algorithms to beat human players. AI-based games are based on a finite set of actions or reactions whose sequence can be easily predicted by expert players. This paper provides an INTRODUCTION on the applications of AI in different games.

**KEYWORDS:** games, artificial intelligence, computer games, artificial intelligence in gaming, game AI, gamification of AI

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## INTRODUCTION

Game developers have been programming software both to pretend like it is a human. The origin of the application of artificial intelligence in gaming can be found in the chess games between the computer IBM AI known as Deep Blue and the Russian master Gary Kasparov in 1996. In 2016, a Google AI system AlphaGo defeated top ranked player Lee Sedol in a game match of the Chinese board game Go. These examples suggest that AI systems can be dominant in just about any kind of game we humans can think of. Gaming and AI have been bedfellows for nearly 70 years. The games industry is one of the most lucrative industries due to the billion dollar sales of digital games. The motivations for playing digital games are varied and different for different age groups. People play digital games for several reasons, from entertainment to professional training [1]. Game developers have been employing AI in unique and interesting ways for decades. They become especially adept at using traditional techniques to achieve the illusion of intelligence. They have used AI to create art for games and push automated game design to new heights [2]. Their intent has not been to try and achieve some unprecedented level of human-like intelligence, but to create an experience that stimulates players in ways only the real world used to be capable of. The goal is to make the AI more human or at least appear to be.

## OVERVIEW ON ARTIFICIAL INTELLIGENCE

The term "artificial intelligence" (AI) was first used at a Dartmouth College conference in 1956. AI is now one of the most important global issues of the 21st century. AI is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence, e.g. visual perception, speech recognition, decision-making, and language translation. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being. Without being taught by humans, machines use their own experience to solve a problem. AI is stand-alone independent electronic entity that functions much like human expert. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc. AI is not a single technology but a range of computational models and algorithms. Some forms of AI that are most commonly used in different applications include the following:

**Expert systems:** They solve problems with an inference engine that draws from a knowledge base equipped with information about a specialized domain, mainly in the form of if-then rules. Expert systems are the earliest, most extensive, the most active, and most fruitful area.

**Fuzzy logic:** This makes it possible to create rules for how machines respond to inputs that account for a continuum of possible conditions, rather than straightforward binary.

**Neural networks**: These are specific types of machine learning systems that consist of artificial synapses designed to imitate the structure and function of brains. They are similar to the human brain. They are made up of artificial neurons, take in multiple inputs, and produce a single output. The network observes and learns as the synapses transmit data to one another, processing information as it passes through multiple layers.

**Machine learning:** This includes a broad range of algorithms and statistical models that make it possible for systems to find patterns, draw inferences, and learn to perform tasks without specific instructions. Machine learning is a process that involves the application of AI to automatically perform a specific task without explicitly programming it. ML techniques may result in data insights that increase production efficiency. Today, artificial intelligence is narrow and mainly based on machine learning.

**Deep learning:** This is a form of machine learning based on artificial neural networks. Deep learning architectures are able to process hierarchies of increasingly ABSTRACT features, making them especially useful for purposes like speech and image recognition and natural language processing. Deep learning networks can deal with complex non-linear problems.

**Natural Language Processors:** For AI to be useful to us humans, it needs to be able to communicate with us in our language. Human language is complex, but AI can be trained to slowly pick up the language. Computer programs can translate or interpret language as it is spoken by normal people.

**Robots:** These are computer-based programmable machines that have physical manipulators and sensors. Sensors can monitor temperature, humidity, pressure, time, record data, and make critical decisions in some cases. Robots have moved from science fiction to your local hospital. In jobs with repetitive and monotonous functions they might even completely replace humans. Robotics and autonomous systems are regarded as the fourth industrial revolution.

**AI in Gaming:** In a game can simply act as the player. The player learns to think either strategically, tactically, or reactively. The player can give his squad two kinds of orders: explicit and implicit. Most games support only explicit orders: move, attack, guard, build, etc. Unlike explicit orders, implicit orders transmit information from the player to the units and assists them in making better autonomous decisions. To influence the player to perceive the creatures as intelligent, he has to be provided more insight on their actions, intentions, thoughts, and emotions (such as joy, fear, are trust, surprise, fear, disgust, and anticipation), which are simple to model. Autonomous behavior is hard to program manually, but it can be taught by providing examples. Game playing has been an active research area in AI from the beginning. Artificial intelligence can be used in games in various ways. AI tools are used in a wide variety of fields inside a game. AI can mimic, imitate, learn, forget, teach, and collaborate. It could be a testing tool to make your code or design more robust. It may be the unseen hand directing the whole affair. AI creates entirely new elements for the game — new levels, new rules, new environments. AI techniques can help generate intelligent, responsive behavior that molds on your reactions as a player. AI makes the game more interactive by boosting player's experience. They can adjust parameters such as speed and time. While you are playing the game, the game is also playing you. AI is more geared towards automation. In order to give the player non-human opponents, AI is needed in almost all games. AI-based games make you feel like you are playing against another person. You will not need other human interactions when you play some of the multiplayer video games.

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## APPLICATIONS OF AI IN GAMING

Modern games have advanced in multiple ways over the past decades. AI technologies such as machine learning, deep learning, neural networks, and natural language processing can produce high-quality video game and make modern games look amazing.

**Video Games:** Artificial intelligence has been an integral part of video games since the 1950s. If you have played a video game, you have interacted with AI. Various video games, whether they are racing games, shooting games, or strategy games, have numerous features that are affected by AI. In video games, AI is used to generate responsive, behaviors in non-player characters similar to human-like intelligence. Video game AI has revolutionized the way humans interact with all forms of technology. As far as video games are concerned, AI may be regarded as the set of techniques used to design the behavior of the "Non-Playable Characters" (NPC). In most video games, NPCs' behavior patterns are programmed and cannot learn anything from players. The main component of AI techniques that is widely used in video games is machine learning or more specifically, reinforcement learning. Game inventors dream of building video games and provide machine learning with a flexible environment for quick changes and easy customization. The most widely used AI technique in games is cheating. In AI-based video games, cheating refers to the programmer giving agents actions and access to information that would be unavailable to the player in the same situation. Instead of learning how best to beat human players, AI in video games tends to enhance human players' gaming experience.

**VR Games:** Virtual reality (VR) is the simulation of a real environment using visual, auditory, and other stimuli. It involves using computer technology to create a simulated environment. The common method of participating in VR is through a headset. Virtual reality game is a niche category when compared to the rest of the gaming industry. Machine learning is used in the video game industry, especially in virtual reality. VR is the future of gaming. VR games (or even just regular console games) will become more immersive and dynamic. Figure 4 illustrates an example of virtual reality game that brings people together. Big tech companies like Facebook, Google, Microsoft, and Sony have greatly invested in developing VR hardware and games. These companies are busy making VR more consumer-friendly.

**AR Games**: AR is a variation of VR. It plays a supplemental role rather than a replacement of reality. Typical augmented reality (AR) devices include mobile phones and specially made glasses. The AR technology powered Pokémon Go. It took a well-established brand (Pokémon) to get consumers to give it a try. AR is taking off faster than VR because people have an appetite for games that interact with reality, not remove them from it.

**Mobile Games:** Companies are already rolling out 5G for mobile devices, which make data available quickly, enable you to pull up an AR game, look through your screen, and get data on the world around you.

## BENEFITS

Gaming is the future of entertainment. In essence, games are learning devices. Human enjoyment of games is derived from enjoying progress, mastery, proficiency, experimentation, and learning. AI is initiating a new era of smart video games. AI essentially consists of algorithms which you can tame whichever you want. AI has a rich history and has been the backbone for countless aspects of computing, gaming, and more. AI in games takes the role of a never bored and never boring opponent. AI serves to improve the game-player experience. AI can also be used to enhance existing games. "Video games offer the best test of intelligence we have. Combining AI with virtual or augmented reality opens the gates to add reality factor to video games.

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## CHALLENGES

AI is not yet capable of creating entire high-quality games from scratch. Games can be addictive to the player. Elon Musk has recently warned the world that the fast development of AI with learning capability by Google and Facebook would put humanity in danger. The gaming industry is pretty conservative, and publishers or game makers need to take risks. There is the temptation of preferring to keep doing that same thing. Perhaps the only barrier to fully utilizing AI technology in gaming is the eventual limit of money and time. A related challenge is the cost incurred in the maintenance and repair. The idea of machines replacing human beings sounds threating. If robots begin to replace humans in every field, it will eventually lead to unemployment. It is difficult to create thoroughly robust AI because its development is constrained to the scope of an individual game project.

## THE FUTURE OF AI IN GAMING

The future of the application of AI technology lies in the development of video games and the ability of the technology to increase the human connection, i.e., AI that is human-like, emotional, and responsive. AI is clearly the future of gaming and the future of AI in video games would naturally point to automation. In the future, AI will become a kind of collaborator with humans, helping designers and developers create art assets, design levels, and even build entire games from the ground up. Big tech companies such as Sony, Nintendo, Microsoft, Apple, Google, and Amazon are seizing the moment and developing gaming products.

## CONCLUSION

Games have been regarded as the perfect testbed for artificial intelligence (AI) techniques. Modern computer games often feature realistic environments by employing 3D animated graphics to give the impression of reality. State-of the-art games can recreate real-life environments with a surprising level of detail. The demands of the gaming community and the games themselves keep evolving.

## REFERENCE

[1] M. N. O. Sadiku, S. M. Musa, and R. Nelatury, “Digital games,” International Journal of Research and Allied Sciences, vol. 1, no. 10, Dec. 2016, pp. 1,2.

[2] G. N. Yannakakis and J. Togelius, Artificial Intelligence and Games. Springer, 2018.

[3] I. Millington and J. Funge, Artificial Intelligence for Games. Boca Raton, FL: CRC Presss, 2nd edition, 2009.

[4] J. Togelius, Playing Smart: On Games, Intelligence, and Artificial Intelligence. Cambridge, MA: The MIT Press, 2019.

[5] D. Charles et al., Biologically Inspired Artificial Intelligence for Computer Games. London, UK: IGI Global, 2007.

[6] G. Seemann and D. M Bourg, AI for Game Developers. O'Reilly Media, 2004, chapter 1

[7] S. Ghosh, “ AI games – Video games with artificial intelligence,” https://www.minditsystems.com/aigames-video-games-with-artificial-intelligence/

[8] “Artificial intelligence in games,” September 2018, https://medium.com/aifrontiers/an-overview-of-artificial-intelligence-for-video-games-f491229c0e7d

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# Chapter: 50

# Introduction to Smart Meters in the Smart Grid: A Review

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**ABSTRACT**

One of the most crucial components of the smart grid (SG) is the smart metre. The smart metre is a sophisticated energy metre that gathers data from end users' load devices, monitors end users' energy usage, and then gives additional data to the utility provider and/or system operator. A smart metre uses a number of sensors and control devices, all backed by specialised communication infrastructure This essay describes a few smart metre features and capabilities. Additionally, it presents the two fundamental communication technologies used in smart metre systems, Power Line Carrier (PLC) and Radio Frequency (RF), as well as current developments in these two technologies. This essay also discusses various policies, the state of the world now, as well as upcoming initiatives and goals for the growth of SG in various nations. Finally, the article examines a few key features of recent smart metre systems from various firms.

**KEYWORDS:** Power Line Carrier (PLC), Radio Frequency (RF), smart meter, Value Proposition

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## INTRODUCTION

One of the most crucial components of the smart grid (SG) is the smart metre. The term "grid" refers to the whole electrical system, which includes electricity production, transmission, distribution, and consumption. In conventional power grids, electricity is delivered from a small number of central generators to a sizable number of load centres that house consumers of electricity . A smart grid (SG) is a brand-new category of electrical infrastructure that is currently under construction. It enables unusual power flow as well as two-way information flow to build a sophisticated automated and distributed energy delivery network. A basic comparison between the current grid and the smart grid (SG) is shown in Table I. The smart metre is a sophisticated energy metre that collects data from end users' load devices, evaluates end users' energy usage, and then gives additional data to the utility company and/or system operator for improved monitoring and invoicing. Smart metres monitor electrical data like voltage and frequency and record real-time data on energy use. Smart metres provide two-way communication between the central system and the metre. The smart metre may also be used to monitor and regulate the users' appliances and gadgets in order to manage demands and loads within the "smart-buildings" in the future. It also has the built-in capability to remotely disconnect and reconnect some loads. A smart metre uses a number of sensors and control devices, all backed by specialised communication infrastructure. The data from smart metres combines the specific metre identity, the data timestamp, the numbers for power usage, and other information. In order to optimise the customer's bill and power consumption, smart metres can gather diagnostic data and information about the distribution grid and household appliances, measure electricity consumption from them to identify parameters, transfer the data to utilities, and send back the command signals. A smart metre may occasionally be able to interact with other smart metres.

From the standpoint of the user, smart metres have a variety of potential advantages. For instance, consumers may regulate their energy consumption by estimating costs based on the data obtained. From the utility's standpoint, real-time data may be realised using the information gathered from smart metres. Pricing is a tool used by businesses to control the maximum amount of power that may be consumed while also attempting to persuade customers to lower their demands during times of high load. With the correct mechanism, a system operator can remotely cut off or reconnect energy to any customer in order to optimise power flows in accordance with data received from demand sides. Figure I contrast a traditional energy metre with a smart metre. The remainder of the essay is structured as follows. Section

III introduces two types of typical technologies for smart metre communication and related research; Section IV goes into great detail about the current state of affairs in several countries and the governments' long-term policy goals; Section II lists various smart metre functions and their advantages; Section V analyses a few key features of the most recent smart metre models from various manufacturers.

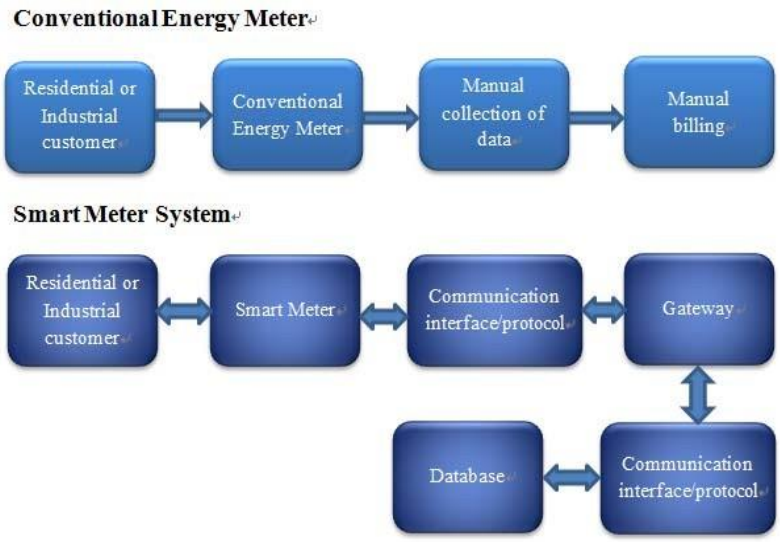


**Fig. 1 the metering architectures of a conventional energy meter and a smart meter.**

**METHOLOGY**

**SMART METER FUNCTIONS AND BENEFITS**

**The typical function of smart meter:**

Commonly, smart meter is expected to have the following functions:

- The two-way communication function
- The data collection function
- The data recording function
- The data storing function
- The load control function
- The programming function
- The security function
- The display function
- The billing function

**Smart metering system benefits:**

The benefits for installing smart meters are numerous for many different stakeholders in different aspects of the smart grid system.

**Smart Metering Value Proposition for the utilities:**

- It saves a lot of money by improving the remote area reading and billing system.
- It gives utility the ability to better manage during peak load times.
- It makes more efficient use of energy and grid resources.
- It offers new tariff model in the electricity market.
- It improves the transformer load management for the transmission line.

Smart Metering Value Proposition to Consumers:

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- It shows customer data about their electricity usage habit.
- It gives customer more accurate and timely electrical billing.
- It helps customer to better use the electrical equipment during the expensive hours.
- It facilitates customer to switch/delay their electrical equipment with significant consumption to less expensive hours.

Smart Metering Value Proposition for Governments:

- It stimulates the economy by investing in smart metering networks.
- It improves the environmental condition by reducing $CO_2$ emission.
- It leads to reduction of consumption by increasing the awareness of consumption pattern.
- It helps better load forecasting for power grid and prevent large-scale black out.
- It gives data for improving efficiency and reliability of service.

**SMART METER TECHNOLOGIES**

Smart Meter Systems are varied in technology and design but operate through a simple overall process [4]. Smart Meters collect data from the end consumers and transmit this data information through the Local Area Network (LAN) to the data collector. This transmission process can be executed every 15 minutes or as infrequently as once a day based on the requirement of the data demand. After that the collector retrieves the data and then transmits it. The utility central collection points further processes the data by using the Wide Area Network (WAN). Since the communications path is two-way, signals or commands can be sent directly to the meters, customer premise or distribution device [4]. Figure III shows the basic architecture of Smart Meter System operations.

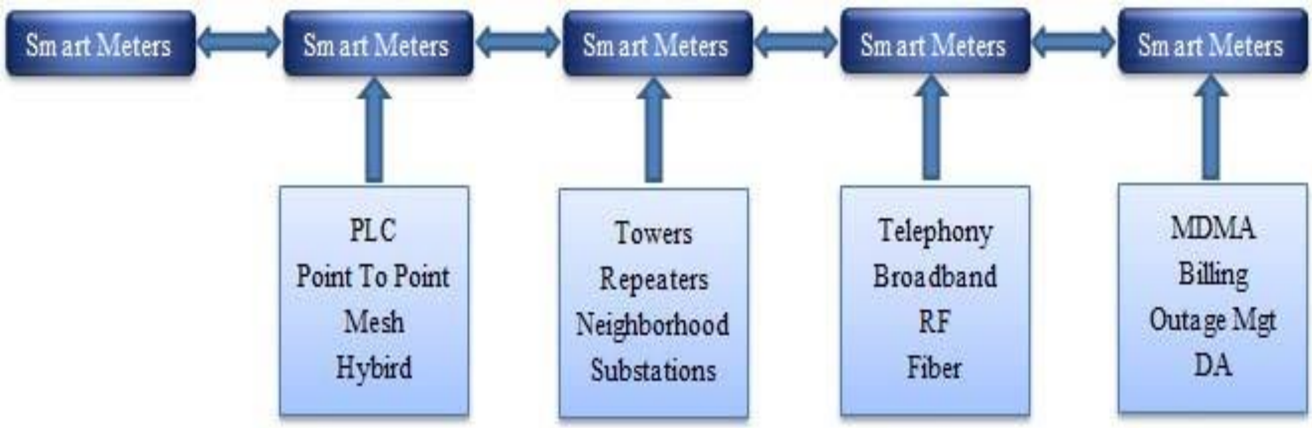


**Fig. 3 the basic architecture of Smart Meter System operations [4]**

There are two basic types of smart meter system communication technologies: Radio Frequency (RF) and Power Line Carrier (PLC). In smart grid applications, there are different advantages and disadvantages associated with them. The utilities choose the best technology based on their business profits. Making the right decision to choose which technology requires a thorough evaluation and analysis of the existing needs and the future benefits of business. There are factors that impact the selection of the technology, such as [4]:

- Evaluation of existing infrastructure;
- Impact on legacy equipment, functionality, technical requirements as well as the economic impact to the utility's customers.

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**Radio Frequency – RF:** Smart meter collects the measurement data from the end consumers and then transmit the data by the wireless radio from the meter to a data collector. Then, the data is processed and delivered by several methods to the utility data systems at a central collection location. The utility billing, outage management, and other systems use these data for operational and business purposes. There are two different types of RF technologies:

**Mesh Technology:** The smart meters talk to each other to form a LAN cloud at the collection point. The collector transmits the data using various WAN methods to the utility central location [4].

- The mesh RF technology has some advantages, such as the large bandwidth, the acceptable latency and the typical operation frequency is at 915 MHz.
- The mesh RF technology also has some disadvantages, such as the proprietary communications, the topography and long distance issues for the remote areas.

Some research has been conducted in the mesh RF area. Parag Kulkarni et al. [5] propose a mesh-radio based solution which is an enhanced version of the RPL (Routing Protocol for Low-Power and Lossy Networks (LLN)) protocol and exhibits self-organizing characteristics. Parag Kulkarni et al. [6] also propose a mesh radio based solution with self- organizing characteristics, which has the ability to enhance the RPL protocol, a connectivity enabling mechanism for low power and lossy networks currently being standardized by the IETF ROLL working group.

Daniel Geelen et al. [7] present and evaluate a real-life implementation of a new routing protocol for use in smart-metering mesh-network grids which is designed with both technological constraints and legislative requirements. Hamid Gharavi et al. [8] present a multi-gate mesh network architecture that has been developed to ensure high performance and reliability under emergency conditions when a system expects to receive power outage notifications and exchanges. They take into account both the hop-count and the queue length of each mesh node to introduce a back-pressure based scheduling algorithm. Bill Lichtensteiger et al. [9] describe the system architecture and the performance evaluation of a Radio Frequency (RF) mesh based system for smart energy management applications in the Neighborhood Area Network (NAN).

Arjun P. Athreya et al. [10] propose the resilient and survivable hierarchical communication architecture for the smart grid that mirrors the hierarchy of the existing power grid. Also analytical models are proposed to study the performance of the flattened architecture as a function of outage area, smart-meter density and smart-meter’s neighborhood size. approach which can be used for both type of automatic meter reading (AMR) and advanced metering infrastructure (AMI) by using combination of PLC and WiFi protocols. Liang Dong et al. [17] present the noise characteristic and transmission characteristic of the power line channel at first, then establish the basic power line channel model according to measured data. Many companies have produced smart meters on the basis of market demand. According to the different purposes, these meters are categorized into two applications: residential smart meters and commercial & industrial smart meters. In some major smartNmeters are descried

**General Electric (GE) Company:** The GE has been offering two standards smart meters, which are the ANSI standard (American National Standard Institute) and the IEC standard (International Electrotechnical Commission). For each standard, it has some series products designed for residential and commercial or industrial purposes.

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**For the ANSI standard smart meter:**

**The I-210 series residential meters:** The GE's I-210 series is the single phase electronic meters which includes 3 models: I-210+c, I-210+, I-210. This series cover almost all the metering needs from the basic electronic energy-only meters to the highly-flexible smart meters. The GE I-210 series have some key benefits, re-stated here from GE official website [21]:

1. Reliable and accurate cash register for utilities.
2. AMR/AMI Plug-n-Play functionality.
3. Multiple communication technologies tied to AMI systems to provide reliable data in a timely manner.
4. Smart Grid metering functions such as Time of Use demand metering and service switch capabilities.
5. Demand side management through pre-payment and demand limiting features.

| Product Characteristics | I-210+c | I-210+ | I-210 |
|---|---|---|---|
| Rating Voltage | 120 V-240 V | 120 V-240 V | 120 V-240 V |
| Rating Frequency | 50 Hz or 60 Hz | 50 Hz or 60 Hz | 50 Hz or 60 Hz |
| Typical Starting Voltage | 5.0 V | 5.0 V | 5.0 V |
| Typical Voltage Losses | 0.7 V | 0.7 V | 0.7 V |
| Typical Accuracy | Within +/-0.2% | Within +/-0.2% | Within +/-0.2% |
| Operating Voltage Range | +/-20% | +/-20% | +/-20% |
| Operating Temperature Range | -40$^{o}$C to +85$^{o}$C | -40$^{o}$C to +85$^{o}$C | -40$^{o}$C to +85$^{o}$C |
| Communication Type | AMR RF Mesh PLC Cellular | AMR RF Mesh LC | AMR |

**Table III Main parameters for GE I-210 series meters**

**The KV2c series commercial and industrial meters:** The kV2c has the function of five demand measures, real-time pricing, and real time data monitoring, which offers easy and powerful functional upgrades to meet the metering needs. There are 2 models (KV2c and KV2c+) in the GE kV2c product family which provides more choices for applications including a polyphase option for a voltage of 600V. The GE KV2c series have some key benefits, re-stated here from GE official website [21]:

1. AMR/AMI Plug and Play designed to accommodate: RF, PLC, Cellular (GPRS/CDMA), Ethernet.
2. Complete range of S-base and A-base forms.
3. 4-quadrant industrial or substation measures.
4. Powerful functional upgrades provide 4-channel 64 kb, 20-channel 192 kB, or 20-channel 384 kB recording for voltage, current, energy, apparent power, reactive power, distortion

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power, power factor, THD, TDD, DPF.

5. Per phase AC instrumentation (amps, volts, and frequency).

The GE kV2c+ offers the following benefits in addition to those offered with the kV2c [21]:

1. Enhanced power supply to support a variety of AMI technology.
2. 57-120V auto-ranging power supply for low voltage applications.
3. Ability to serve 600V applications.
4. Revenue Guard option preserves billing integrity when a phase voltage is lost.
5. Available in Switchboard form (Z base).

| Product Characteristics | KV2c | KV2c+ |
|---|---|---|
| Rating voltage | 120 V-480 V | 57 V-120 V, 600 V |
| Rating frequency | 50 Hz or 60 Hz | 50 Hz or 60 Hz |
| Typical accuracy | Within +/-0.2% | Within +/-0.2% |
| Operating voltage range | +10% to -20% | +10% to -20% |
| Operating temperature Range | -40°C to +85°C | -40°C to +85°C |
| Communication type | AMR RF Mesh PLC Cellular | AMR RF Mesh PLC Cellular |

**Table IV Main parameters for GE KV2c series meters**

For the IEC standard smart meter:

**The SGM3000 series smart meter**: The GE's SGM3000 series is the most popular meter series comprise of advanced capabilities. It contains eight meters in the series for both residential and commercial demand, including single phase, polyphase, dual-element and CT metering. The GE SGM3000 series have some key benefits [21]:

1. Improved energy efficiency from the utility to the house.
2. Advanced co-generation applications using configurable, full quadrant measurements.
3. Modular communications with field replaceable options.
4. Extensive relay and multi-element configurations for application flexibility.
5. Scalable, future-proof metering with ample embedded resources.

The SGM1100 smart meter: The GE's SGM1100 meter is the single-phase smart meter which was designed for residential and small commercial energy customer. In this meter, PLC AMI communications based on the Powerline Intelligent Metering Evolution (PRIME) standard and DLMS/ COSEM protocol [21] are available. The GE SGM1100 has some key benefits, re-stated here from GE official website [21]:

1. Dual pole relay for old residential infrastructure resulting in a more secured and safe service disconnection.
2. Remote upgradable firmware and meter configuration via PLC communications to reduce on-site visits for service and maintenance.
3. Designed to facilitate quick and easy installations in difficult environments.
4. Integrated PRIME PLC modem; providing reliable and interoperable communications with PRIME compliant data concentrators.
5. Local communications via an optical port, enabling local configuration, firmware updates, and diagnostics as needed. Table V shows the main parameters of the GE

SGM3000 series and the SGM1100 meters.

Itron Company: Itron's smart residential meters deliver the two-way communications due to customers need to build their advanced metering infrastructure. Itron's smart meters are built upon industry standards and provide unprecedented interval data storage, remote upgradeability and configuration changes, and the gateway to consumer smart devices.

The Itron CENTRON OpenWay meter: The Itron's OpenWay smart meter system provieds an enhanced security and a reliable approach to data collection and communications between the smart meter and the network system. In the Itron advanced smart meter the usage data can be calculated within the meter instead of insert a network communication card into a standard meter. This designed smart meter can allow utilities to leverage time-base rates, demand response, home networking and many other smart grid applications. OpenWay smart meter is unique and offers the following distinguishing features [22]:

**Time-of-use and critical peak pricing data.**

- A two-way, unlicensed RF module and adaptive-tree radio frequency local area network architecture.
- ZigBee radio for interfacing with home area networking and load control devices.
- A remote service switch with load limiting capabilities to support many new services, such as prepaid metering.
- Tamper detection including meter inversion, meter removal and reverse energy flow.

**CENTRON Bridge Meter:** The CENTRON Bridge smart meter is the first meter available with compatibility between the Itron's CENTRON OpenWay network and the Itron's ChoiceConnect mobile environment. It is the bridge between Itron communication architectures that enable AMI and smart grid functionality the meter's adaptability allows it to be incorporated along with the existing Itron smart meters with a mobile collection system, delivering advanced metering benefits associated with interval data, remote service switch and demand reset. This revolutionary capability is perfect for customers that require advanced metering functionality in a mobile environment today,

**Sensus Company**: Sensus's iCON smart meter make consumers (residential, commercial and industrial) deliver the accurate and reliable results between customers and energy companies. Combined with the FlexNet advanced meter infrastructure, electricity supplies can install and upgrade the iCON meter's electricity management platform for significant efficiency.

**iCON A residential meter:** The Sensus iCON A smart meter with the SmartPoint integrated display is one of the most reliable and efficient Advanced Metering Infrastructure (AMI) smart meters available. An optional remote disconnect switch allows operators to disconnect or reconnect services by using the Regional Network Interface (RNI) software. The FlexNet communications network is approved by FCC for operation on an unshared primary-use licensed spectrum. It offers a reliable, simple, and an economical way for meter deployments, strategic deployments, and rural applications. The iCON A has some key benefits [23]:

- Integrated FlexNet™ AMI on display board
- Power Quality reporting
- Time-of-Use
- Remote configuration and meter firmware downloads
- Accuracy exceeds ANSI C12.20 (Class 0.2)

**iCON APX commercial and industrial meter:** Although the traditional iCONAPX Commercial

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and Industrial meter provides stability in the fluid landscape of the developing smart grid, it lags behind contemporary social requirement of a smart metering device with the flexibility to balance a wide variety of ever changing factors and service quality demands. Combined with the FlexNet advanced meter infrastructure, electricity supplies can install and upgrade the iCONAPX meter's electricity management platform for significant efficiency. The iCON APX has some key benefits:

- Accuracy exceeding ANSI C12.20 (Class 0.2)
- Reliable, unbreakable one-piece cover
- Complete DC immunity
- Inversion-proof
- Advanced user-friendly configuration software-iCONFig Table VII shows the main parameters of the Sensus

| Product Characteristics | iCON A | iCON APX |
|---|---|---|
| Voltage Rating | 120 V, 208 V, 240 V | 120 V to 480 V |
| Frequency Rating | 60 Hz | 50 Hz, 60 Hz |
| Starting Voltage | 5 V | 5 V |
| Operating voltage range | +10% to -20% | +10% to -20% |
| Typical accuracy | Within +/-0.2% | Within +/-0.2% |
| Operating temperature range | -40$^{o}$C to +85$^{o}$C | -40$^{o}$C to +85$^{o}$C |
| Communication type | RF Mesh ZigBee | RF Mesh ZigBee |

**Table VII Main parameters between the Sensus iCON A and iCON APX meters**

## CONCLUSION

This paper reviews several important aspects of smart metering. It presents the advantages of smart meter system from the points of view of utilities, consumers and governments respectively. In addition, two kinds of typical technologies for smart meter communication and related research are presented in detail. Moreover, several countries' current situation and the governments' future policy objectives are discussed in detail. Finally, the paper compares some main aspects about latest products of smart meter from different companies.

## REFERENCES

[1] Fang Xi, Misra Satyajayant, Xue Guoliang, Yang Dejun, "Smart Grid – The New and Improved Power Grid: A Survey," Communications Surveys & Tutorials, IEEE, vol. 14, issue. 4, pp. 6-9, 2020.

[2] Lingfeng Wang, Devabhaktuni, V., Gudi, N., "Smart Meters for Power Grid – Challenges, Issues, Advantages and Status," 2021 IEEE/PES Power Systems Conference and Exposition (PSCE), pp. 1-7, March 2021.

[3] "Smart Meter," Available: http://en.wikipedia.org/wiki/Smart_meter

[4] A Joint Project of the EEI and AEIC Meter Committees, "Smart Meters and Smart Meter Systems: A Metering Industry Perspective," Available:http://www.aeic.org/meter_service/smartmetersfinal032511. pdf

[5] Parag Kulkarni, Sedat Gormus, Zhong Fan, and Benjamin Motz, "A Mesh-Radio-Based Solution for Smart Metering Networks," Communications Magazine, IEEE, vol. 50, issue. 7, pp. 86-95, July 2019

[6] Parag Kulkarni, Sedat Gormus, Zhong Fan, Benjamin Motz, "A Self- organising Mesh Networking Solution Based on Enhanced RPL for Smart Metering Communications," 2019 IEEE International Symposium on a

World of Wireless, Mobile and Multimedia Networks (WoWMoM), pp. 1-6, June 2018.

[7] Daniel Geelen, Gert van Kempen, Frans van Hoogstraten, Antonio Liotta, “A Wireless Mesh Communication Protocol for Smart- metering,” 2012 International Conference on Computing, Networking and Communications (ICNC), pp. 343-349, February 2016.

[8] Hamid Gharavi, Chong Xu, “Distributed Application of the Traffic Scheduling Technique for Smart Grid Advanced Metering Applications Using Multi-Gate Mesh Networks,” 2011 IEEE on Global Telecommunications Conference (GLOBECOM 2011), pp. 1-6, December 2019.

[9] Bill Lichtensteiger, Branko Bjelajac, Christian Müller, Christian Wietfeld, “RF Mesh Systems for Smart Metering: System Architecture and Performance,” 2018 First IEEE International Conference on Smart Grid Communications (SmartGridComm), pp. 379-384, December 2018.

[10] Arjun P. Athreya, Patrick Tague, “Survivable Smart Grid Communication: Smart-Meters Meshes to the Rescue,” 2022 International Conference on Computing, Networking and Communications (ICNC), pp. 104-110, February 2022.

[11] Sebnem Rusitschka, Christoph Gerdes, Kolja Eger, “A Low-cost Alternative to Smart Metering Infrastructure Based on Peer-to-Peer Technologies,” Energy Market, 2019. EEM 2009. 6th International Conference on the European, pp. 1-6, May 2019.

[12] Asma Garrab, Adel Bouallegue, Faten Ben Abdallah, “A New AMR Approach for Energy Saving in Smart Grids Using Smart Meter and Partial Power Line Communication,” 2012 First International Conference on Renewable Energies and Vehicular Technology (REVET), pp. 263-269, March 2012.

[13] MD M RAHMAN, AMANULLAH MTO, “Technologies Required for Efficient Operation of a Smart Meter Network,” 2021 6th IEEE Conference on Industrial Electronics and Applications (ICIEA), pp. 809-814, June 2021.

[14] Cen Wei, Zhao Bing, Feng Zhancheng, Fu Yilun, “The Research of Smart Electricity Meter Whole Performance Automatic Detection Technology,” 2022 IEEE International Conference on Computer Science and Automation Engineering (CSAE), pp. 431-434, May 2012.

[15] Rakesh Rao, Srinivas Akella, Gokhan Guley, “Power line carrier (PLC) signal analysis of smart meters for outlier detection,” 2021 IEEE International Conference on Smart Grid Communications (Smart Grid Comm), pp. 291-296, October 2021.

# Chapter: 51

# Future Standard and Fast Charging Infrastructure Planning: An Analysis of Electric Vehicle Charging Behaviour

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**ABSTRACT**

European nations have made a concerted effort to raise the percentage of electric vehicles (EVs). Understanding the charging habits of current EV users in terms of the location where they charge, the amount of energy they need, how long the charge takes, and their preferred charging method is crucial to the rollout of the associated infrastructure. Since the infrastructure deployment started, data were available on the use of charging infrastructure for the whole island of Ireland. In addition to a small amount of household data, this study presents a thorough examination of the charge event data for public charging infrastructure, including data from fast charging infrastructure. According to the available household data, it was shown that EV users prefer to do the majority of their charging at home in the evening, when the electrical grid is at its busiest. This finding suggests that incentives may be needed to move charging away from this peak grid demand period. Fast chargers had the greatest utilisation rates and car parks were the most often used sites for public charging among EV users, showing that public fast charging infrastructure is most likely to become financially viable in the short- to medium-term.

**KEYWORDS:** Electrical vehicle, $CO_2$, ESB

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## INTRODUCTION

In recent years, several European nations have worked very hard to boost the percentage of electrification in the transportation industry. This is largely due to several worries about how the transport sectors are currently doing in European nations. The transport industry in Ireland accounted for the largest portion of primary energy demand (33%), final energy consumption (40%), and energy-related CO2 emissions (35%), as well as being 97.5% dependent on oil products, all of which are imported at an estimated cost of €3.5 billion (SEAI, 2014).installation of charging stations (SEAI, 2015).As a result of various consumer-focused strategies, many European nations have seen significant increases in the share of electrification in their respective transportation sectors. In particular, Norway has seen a very significant increase in EVs as a result of the aggressive approach taken in EV deployment (Assum, et al., 2014). Incentives have been provided in Ireland to encourage the use of electric vehicles (EVs), including a grant towards the cost of an EV, an exemption from vehicle registration tax (VRT), and free housing.In addition, the Electricity Supply Board (ESB), the biggest energy supplier in Ireland, is instrumental in the establishment of a national infrastructure for charging, which includes several fast charging stations (ESB, 2015).As a result, while more slowly than anticipated, Ireland has increased the proportion of EVs in the overall vehicle population; the initial goal of 250,000 EVs by 2020 has subsequently been reduced to 50,000 EVs by 2020 (SEAI, 2014). According to the Central Statistics Office (CSO), the government agency in charge of compiling official statistics for Ireland, 140 EVs were licenced in January and February of 2015, compared to 65 in the same months of 2014 and 13 in the same months of 2013; this represents an increase of over 300% from the 51 EVs that were licenced in 2013 (CSO, 2015). Given the rise in electric vehicles, it is crucial to offer a public charging infrastructure that adequately caters to the needs of all EV users.

**Analysing Behaviour of Customers:** Understanding EV customers' charging habits, including when they charge, how much energy they use, how long they charge for, and which charging infrastructure type they prefer, is essential for the effective deployment of a charging infrastructure effort. The use of charging infrastructure has been assessed by a number of

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research and initiatives. In their analysis of the Switch EV trials in the north-east of England, Robinson et al. (2013) concentrated on the various charge station use scenarios and how they affected CO2 emissions. In van den Hoed et al. (2013), an investigation of the public charging infrastructure in Amsterdam is conducted. In Speidel and Bräunl (2014), the outcomes of the Western Australian Electric Vehicle Trial are discussed. Green eMotion (Green eMotion, 2015), CIVITAS (CIVITAS, 2015), ELCIDIS (ELCIDIS, 2015), and the Victorian Electric Vehicle Trial (State Government of Victoria, 2013) are other initiatives to build up the infrastructure for charging electric vehicles. In addition, it has been claimed that the presence of public charging infrastructure is necessary to ensure the success of the general adoption of EVs (City of Westminster, 2009). Additionally, rapid chargers are increasingly seen as a useful and effective way to allay worries about prolonged charging times. According to Jerram and Gartner (2012), there were around 4200 fast charging stations marketed internationally in 2012, and by 2020, it's predicted that there would be about 460,000 installed globally. Numerous studies are concentrating on the various aspects of fast chargers, such as the best placement and size of fast charging stations (Sadeghi-Barzani et al., 2014), the economics of the infrastructure for fast charging (Schroeder and Traber, 2012), and the integration of fast charging stations into the electrical grid (Sbordone et al., 2015, Dharma Keerthi et al., 2014). Fast chargers have, however, received very little investigation to date because they are a relatively new technology. Using real fast charging data.Thus, the main objective of this article is to carry out a thorough analysis of the charge event data captured by data loggers situated in charge points distributed over Ireland and Northern Ireland. Understanding the charging habits of EV users at various charge point types is crucial for meeting the changing needs of a growing EV population and for selecting the best charging infrastructure rollout strategy in terms of economic and practical effectiveness. To ascertain the consequences of charging behaviours on the electrical grid, analyses are undertaken on the timings of charge events, as well as the energy consumptions and durations of charge events. Aside from thatIn order to determine which charge point types are most often used, use information for various charge point use cases are analysed. Based on the findings of the analysis of the charging infrastructure, policy suggestions will be given. Both data from rapid charging and data from regular charging are included in the analysis.

**Section snippets:**

**Monitored charge points:** A total of 711 charge points were monitored during the analysis period (although there are many more installed within Ireland); of these charge points, 83 are fast chargers. Fast charge points have an input/output nominal power of either 43 kW or 50 kW, delivering the charge through direct current (DC) and through three-phase electric power.

**Comparison between aggregated charge point datasets:** The first set of tests compares the aggregate standard charge point dataset with the aggregate fast charge point dataset. The first chi-square test compares the charge start times of fast chargers and standard chargers. A highly statistically significant result was found with the p-value being less than the alpha significance level of 0.05, indicating that the two datasets are different with respect to charge start timings, and as such the times at which charge events take place.

**Discussion:** The comparisons between the various types and use cases of the public charging infrastructure led to some interesting findings. When comparing the public standard charging infrastructure as a whole (i.e. the aggregated dataset) with the fast charging infrastructure as a whole, it was seen that there are very different usage patterns with respect to time of use. Standard charge points were found to be utilised to a greater extent earlier in the day with fast charge points.

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**Conclusions and policy implications:** This study provided a unique opportunity to analyse the usage statistics for all types of public and private EV charging infrastructure for an entire country. A number of CONCLUSIONs and recommendations can be made in relation to the continuing development of both public and private charging infrastructure in the Irish context, but which would also be pertinent for other emerging EV markets.

## REFERENCES


[1] C.H. Dharmakeerthi *et al.,* Impact of electric vehicle fast charging on power system voltage stability Int. J. Electr. Power Energy Syst. (2014)

[2] A. Robinson, Analysis of electric vehicle driver recharging demand profiles and subsequent impacts on the carbon content of electric vehicle trips Energy Policy, (2013)

[3] P. Sadeghi-Barzani *et al.,* Optimal fast charging station placing and sizing Appl. Energy, (2014)

[4] D. Sbordone, EV fast charging stations and energy storage technologies: a real implementation in the smart micro grid paradigm, Electr. Power Syst., (2015)

[5] A. Schroeder *et al.,* The economics of fast charging infrastructure for electric vehicles, Energy Policy, (2012)

[6] S. Speidel *et al.,* Driving and charging patterns of electric vehicles for energy usage Renew. Sustain. Energy Rev. (2014)

[7] T. Assum *et al.* The Future of Electromobolity in Norway: Some Stakeholder Perspectives (2014)

# Chapter: 52

# Wireless Charging System Design Considerations for Electric and Plug-In Hybrid Cars

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**ABSTRACT**

This paper presents a brief overview about wireless charging technology developed for electric and plugin hybrid vehicles. Presented technology is a complete solution which includes power transfer, foreign object detection, live objects protection and required communication capabilities. Developed technology is very flexible, easy to use and can be easily adopted for various cars, what will be presented e.g. during public trials.

**KEYWORDS:** inductive power transfer -IPT, wireless electric vehicle charging - WEVC, electric vehicle - EV, plugin hybrid electric vehicle - PHEV, foreign object detection –FOD, live object protection -LOP

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## INTRODUCTION

Over the last decade the understanding of environmental problems has grown. Car producers - OEMs strive to reduce fuel consumption and pollution. In order to fulfill these aims new technologies have been launched and rolled out like: Plug-in Hybrids Vehicles (PHEV) and Electric Vehicles (EV). Most of the major car manufacturers have already PHEV and EV series design programs at various stages of development. Some models are already available for purchase, and more are slated for release in 2013. Gaining mass-market adoption of any new product, especially EV, brings new challenges. The main challenges discussed in many public forums and articles are: cost, comfort of use, range of EVs and infrastructure. Qualcomm, as the world leader in the nextgeneration mobile and wireless technologies, has a history of innovation in mobile technology and thus an experience in robust compliance and engineering evaluation requirements. Based on this broad experience, Qualcomm has developed technology which will support the early adoption of EVs. The technology is known as a resonant magnetic induction charging [1, 5, 6], also referred to as wireless EV charging (WEVC). It removes the need to charge–up by plugging-in, brings simplicity and ease-of-use for EV drivers, and opens up new charging and business model opportunities. This paper focuses on the demonstration of Qualcomm's WEVC complete solution which is used in public trials. Following points are important: • general requirements for public trial • magnetic design • interoperability • parking tolerance for ease of use • foreign object detection, both metallic and living/moving • compliance of wireless EV as it moves towards mass adoption.

## TECHNOLOGY

Delivering a commercially compliant WEVC system into the automotive market will require a deep understanding of the technology and its performance characteristics. Compliance requirements are also vital for engineers to meet in order to give the manufacturers confidence in wireless EV charging. None interference with on-board electronics and keyless entry systems must be considered, for example. At a technology level, there is a number of design options [1, 2, 3, 4, 5] that could be considered. Pad and coil architectures as well as operating frequency are key aspects of how the system performs across a wide spectrum of criteria. Coil design decision is predominantly a choice between double pole and variations of single pole structures, which are presented in Figure 1.

| | Circular | Solenoid | Polarized |
|---|---|---|---|
| Emissions | ++ | + | ++ |
| Efficiency | ++ | + | ++ |
| Tolerance | + | ++ | +++ |
| Size / Weight | – | ++ | +++ |
| Interoperability | + | – | +++ |
| **Overall** | + | ++ | +++ |

**Fig.1: Coils architecture for wireless charging**

While double pole wireless charging systems (polarized topology, Fig. 1) have been prevalent in industrial installations including LCD clean rooms for a number of years, automotive requirements – in particular EMC regulations – have resulted in the design and construction of more efficient and compliant circular single pole pad configurations (circular topology, Fig. 1). Single and multiple coil designs can now deliver end to end power transfer efficiencies of 90% and above while tolerating high levels of pad offset, both laterally, (x,y) and vertically, (z), Fig. 2

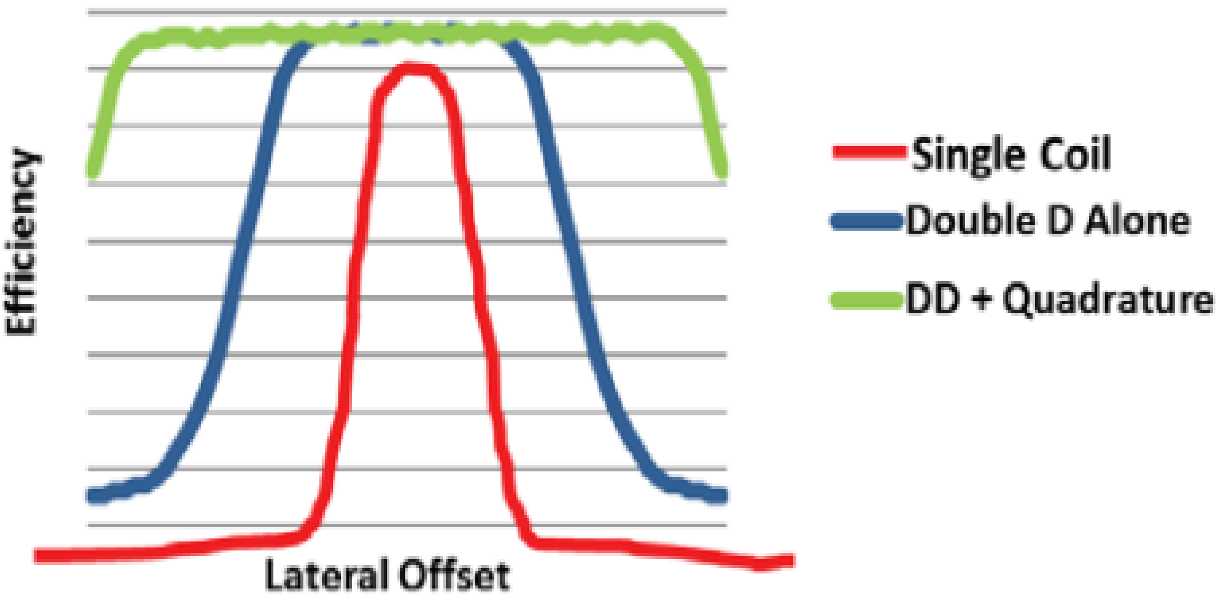


**Fig. 2: Efficiency and lateral offset for different coil systems**

Tolerance to offset of the pads during charging is considered vital to ensure simplicity of use by drivers. The complexity of automatic guidance and parking systems, while offering a good alignment solution for double pole based systems, add cost and increase the time to park-both of which will stifle user adoption if implemented. WEVC is evolving from a strong foundation of 3.3kW for home use to 7kW for home and public use, as well as 20kW fast charge solutions for commercial and public site installations. Qualcomm solutions cover entire range of output power, what is presented in Figure 3.

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**Fig. 3: Power range for Qualcomm solution**

The operating frequency of the resonant magnetic induction system has also been discussed at length in open forums [1] and in standards groups such as the Society of Automotive Engineers (SAE). Early systems have tended to focus around the sub 40kHz band due to the cost and availability of high power electronic components at high frequencies. There is however a direct link to power transfer efficiency and frequency and therefore the industry is discussing alternative options below 150kHz, generally regarded as the upper limit due to a broadcast license being needed in many regions above this frequency. Companies, including Qualcomm are designing and testing systems at frequencies above 70kHz.

## COMPLIANCE

Compliance to requirements for non-interference with implantable medical devices has been a key focus of Qualcomm's compliance engineering team based in San Diego. The team benefits from more than 20 years of EMC and regulatory engineering experience and has been a key function in ensuring that the Qualcomm Halo WEVC system meets the delivery criteria of the partners participating in the London wireless EV charging trial. Figure 4 shows a typical example of the work carried out by the compliance engineering team on an existing electric vehicle. Bodywork structure, layout and materials can be included in modelling to analyse the effects on the wireless charging magnetic fields and to determine compliance with e.g.: Pacemaker immunity. This assessment is the key, when considering the integration of WEVC into the vehicle.

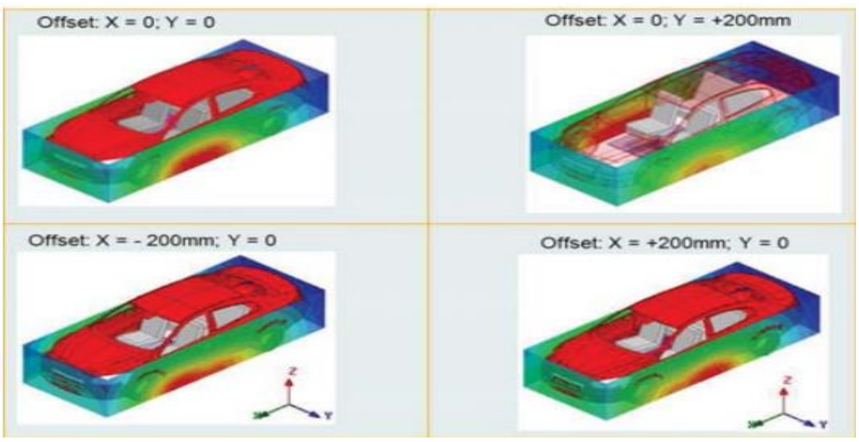


**Fig. 4: Pacemaker EMI Analysis (PC69-2007 Limit-Bystander)**

RF (radio frequency) exposure must also be assessed when considering operation of the WEVC system to ensure compliance with regulated exposure limits such as those based on the International Commission for Non Ionizing Radiation Protection (ICNIRP).

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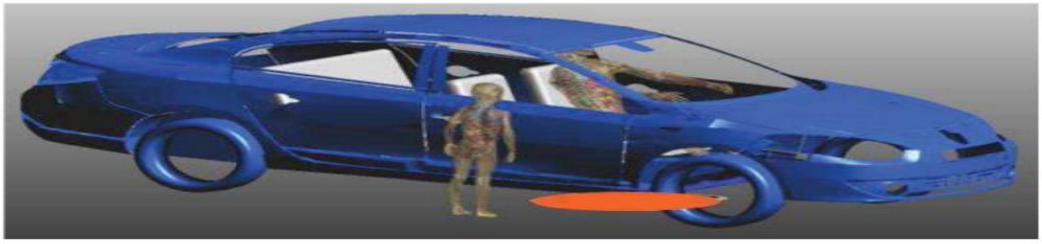

**Fig. 5: RF Exposure Assessments**

Again, working directly with OEMs on their EV design enables simulations to be carried out to ascertain the exposure levels that would be expected with different car materials and charging pad locations as well as offset positions of the base-charging and vehicle-charging pads. Figure 5 shows an EV saloon with considerations for assessing induced effects into bystanders outside the vehicle as well as humans inside the vehicle. Foreign Object Detection systems must detect all instances of a ferrous object coming between the pads, either before charging commences, or during the charging process. Large objects are easy to detect, and notice if they are on the pad as the driver approaches the charging bay, but small metallic objects can be more difficult to see so the FOD system must ensure rapid suspension of charging if the instant detection occurs.

## CONCLUSIONS

Development of complete wireless charging solution requires companies to be able and willing to invest long term in WEVC technology and to support a range of diverse customers with varying needs. The comprehensive knowledge in area like: magnetic design, power electronic design, communication, compliance and regulatory for automotive is required. Future deployments may also incorporate semi dynamic and full-dynamic charge-on-the-move capabilities, which will require substantial R&D investments to make this version of WEVC a commercial reality. There is a limited number of companies that can deliver on the WEVC vision and Qualcomm is one of those that has the knowledge, history and experience to do just that.

## REFERENCES

[1] T. Boys, G. A. Covic, “IPT Fact Sheet Series: No. 1 – Basic Concepts”, 2012 http://www.qualcommhalo.com

[2] M. Budhia, G.A. Covic, T. Boys, “Design and Optimization of Circular Magnetic Structures for Lumped Inductive Power Transfer Systems”, Power Electronics, IEEE Transactions on Volume: 26 , Issue: 11 Digital Object Identifier: 10.1109/TPEL.2011.2143730 Publication Year: 2011 , Page(s): 3096 – 3108

[3] M. Budhia, G.A. Covic, J.T. Boys, and C.Y. Huang, “Development and evaluation of single sided flux couplers for contactless electric vehicle charging,” in Proc. IEEE Energy Conv. Cong., 2011, pp. 614- 621

[4] O. H. Stielau and G. A. Covic, “Design of loosely coupled inductive power transfer systems”, in Proc. IEEE POWERCON, 2000, pp. 85–90

[5] M. Yilmaz, P. Krein, “Review of charging power levels and infrastructure for plug-in electric and hybrid vehicles”, Electric Vehicle Conference (IEVC), 2012 IEEE International Digital Object Identifier: 10.1109/IEVC.2012.6183208 Publication Year: 2012 , Page(s): 1 – 8 vivek yadav

[6] H. H. Wu, Hunter, A. Gilchrist, D. K. Sealy, P. Israelsen, J. Muhs, “A review on inductive charging for electric vehicles” Electric Machines & Drives Conference (IEMDC), 2011 IEEE International Digital Object Identifier: IEMDC.2011.5994820 Publication Year: 2011 , Page(s): 143 – 147.

# Chapter: 53

# Self-Regulating Solar Tracker System

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**ABSTRACT**

Although strength conservation and control has performed a main position for enhancing the strength performance in growing countries. In India, industries are especially centered on the strength conservation and control. Educational institutions/ private/ authorities hostels and resorts have now no longer fully applied the strength conservation and control (ECM) measures. This paper specializes in the strength conservation and control technique, with out affecting the great and amount of electrical and thermal load in boy's hostel at The Gandhigram Rural Institute (GRI) - Deemed University. The GRI mess is one after the other furnished with Electrical Service Connection from Tamilnadu Electricity Board (TNEB) and thermal strength wished for the cooking has been furnished through Wood feeding Boiler and LPG. Additionally, DG set has been furnished to be able to guide on the time of energy failure. The electric load and thermal load of boiler cooking of mess can be optimally compensated thru Cogeneration mixed cycle method. By incorporating this method, Wood intake for boiler can be avoided. In addition to this energy intake from TNEB is reduced. Economic take a look at on changing LPG gas cooking through Biogas is likewise done. This paper talk approximately the monetary financial savings after the implementation of Cogeneration. Additionally, the monetary technique is prolonged for the moreover ECM technique in GRI mess (substitute of fluorescent tube lamps with LED tube lamps). This paper also discusses the monetary impact of cogeneration through moreover ECM technique and usual economics and overall performance after and earlier than imposing ECM activities.

**KEYWORDS:** Connected load; Combined Heat and Power (CHP); Energy Conservation and Management (ECM); Cogeneration; Biogas plant; Payback period; economics.

## INTRODUCTION

Energy conservation is one of the issues which need to be addressed with utmost importance in today's world. Today energy plays the major role in all areas. Energy conservation is essential to improve the energy efficiency in the present industrial world. In spite of the increasing number of power plants which mainly depends on Conventional fossil fuels to meet the present energy demands, we have to adopt some Energy conservation measures to address Energy crisis. Here the energy conservation measures, and management is carried out in a smarter way by incorporating CRP technique rather than increasing energy production. Since one unit of energy saved is equivalent to three units of energy produced, CRP can be regarded as the zone to use the energy in an optimized way. Combined Heat and Power is also called as Cogeneration process in which the sequential generation of two different useful form energy from a single primary energy source, typically mechanical energy and thermal energy [15]. As we have many decentralized power plants and sugar factories in India the combined heat and power technique can be implemented on a wider scale. The government of India has taken steps to implement renewable energy in educational institutes and industries. Biogas which acts as an alternative for LPG plays an important role in present world for the energy conservation in homes, hostels, hotels etc. The by-product (slurry) of the biogas is used as manure which can be able to sell at a 6 Rs/kg. Biogas production is more economic at educational institutional hostels. In this paper, Economics of Energy conservation measures in GRI boy's hostel has been discussed by incorporating CRP without affecting the quality of the energy.

## LITERATURE REVIEW

M. Adam Mydeen et al. (2015) [2] carried out a case study in CHP applications in IC Engines. This paper concluded that 60% of wasted heat is extracted from the exhaust of IC engines. M.

Dentice d_ Accadia (2003) [3] dealt with application of micro-cogeneration (electrical power. economic dispatch (CHPED) problem. The proposed algorithm gives the better solution compared to conventional methods and is an efficient search algorithm for CHPED problem. Gianni Bidini (199S) [6] carried out case study of CHP technologies with an internal combustion engine and area heating for the faculty of engineering of the University of Perugia. The cost benefit analysis in the first year of operation was carried out and it resulted in eventual changes in heat and power management, reduce pay-back period and increase the internal rate of return of the investment. R.J. Braun (2006) [7] was applied the CHP system in solid oxide fuel cell and its applications in residential houses. This paper also focused on the modelling and simulation of cell-stacks including the balanceof-plant equipment. Effective system concepts and performance parameters were identified.

This leads to an increase in performance efficiency by 6%. D.P. Papadopoulos et al. (2002) [S] developed a computer programming tool for finding the biomass energy survey with geographical area and also identifying the techno-economic assessment integrated with the Cogeneration. This paper also presented a result of case study of w.g.a at northeast part of Eastern Macedonia Thrace Region of Greece by taking techno-economic constraints into account. A.D. Hawkes (2007) [9] investigated cost-effective operating strategies for three micro-CHP technologies like sterling engine, gas engine and solid oxide fuel cell. The results showed that it is sensitive to electricity buy-back rate and lowest carbon dioxide emissions. Louise Trygg (2007) [10] converted vapour compression chillers to absorption chillers in a combined heat and power (CHP) system to measure sustainability as electricity consumption is replaced with electricity generation. This case study proposed that by incorporating CHP energy effective system, global emissions of CO2 can be reduced to SO%, a 300% lower system cost, and a 170% reduction of the cost of producing cooling due to revenues from electricity production. The results also showed that, with these prerequisites, a decrease in COP of the absorption chillers will not have a negative impact on the cost-effectiveness of the system, due to increased electricity production. G. G. Maidment (2002) [11] described the cooling/heating/power requirements of a typical supermarket and then reviewed a number of CCHP options involving the use of different cooling in engine technologies.

Finally, this paper calculated the energy savings/Investments of the different options against typical conventional supermarket technology and compared results. Florian Heberle (2010) [12] was considered geothermal resources at a temperature level below 450 K by combined heat and power generation. The series and parallel circuits of organic rankine cycle (ORC) and an additional heat generation were compared by second law analysis. The results showed that due to a combined heat and power generation, the second law efficiency of a geothermal power plant can be significantly increased in comparison to a power generation. A. Rentizelas et al. (2009) [13] introduced the new concept called biomass tri-generation. This same concept was applied as a case study in various energy conversion technologies like ORC and gasification. This paper discussed the comparison study of Gasification and ORC in technological and financial aspects in the way that gasification attracts more investment. M. Venkateshwaran et al. (2015) [14] carried out the energy auditing at an educational complex using power analyzer to calculate the connected load and maximum demand. By using the above said results, the energy conservation and efficient opportunities has been recommended and also discussed the economic analysis of the opportunities. C. Sreenath et al. (2015) [15] discussed the energy auditing results of the small-scale tiles factory. This paper gave suggestions and recommendations of energy conservation opportunities and also for reducing the power quality issues. K. Kamaleswaran et al. (2015) [16] studied about the power consumption and saving potential of coir industries using online power analyzer and thermal imager. This paper concluded that proper sequencing of balancing load in R, Y & B phase's leads to reduce power and also avoided power factor penalty. Miet Van Dael et al. (2013) [17] introduced concept called biomass Energy Conversion Park (ECP). This paper performed the techno-economic assessment case study in Netherlands to illustrate the concept and comparative measure of highly integrated system with two mono dimensional models. Finally, this paper is useful for policy makers on the policy instruments concerning manure processing or biogas production. Molla Asmare (2014) [IS] was designed a cylindrical tropospherical fixed dome bio digester for cooking application in the condominium houses at Debiza site in Debre Markos, East Gojjam in Amhara Region and the size ofbiogas plant was 53 m3. The input of biogas plant are as follows: kitchen waste, food waste and human excreta from 357 people in 120 residence and amount of gas is obtained at an average of 0.21 m3/per household per day for cooking purposes.

## METHOD OF CASE STUDY

### Observation

TABLE I. GENERAL OBSERVATION

| Particulars | Values |
|---|---|
| Total Number of students | 650 |
| Staff & Workers | 60 |
| Total Number of rooms | 130 rooms |

*B. Electrical Load of mess*

*1) Peak Load Calculation for Mess*

For Motor Load (ML), Load = 0.74 * hp of motor * no. of load (1)

For light load (LL), fan load (FL) and other load (OL),

$$\text{Load} = \frac{\text{wattage} \times \text{No. of Load}}{1000} \qquad (2)$$

*2) Total Electrical Load in Mess*

For Motor Load (ML), Load = 0.74 * hp of motor * no. of load * No. of hrs. (3)

For light load (LL), fan load (FL) and other load (OL),

$$\text{Load} = \frac{\text{wattage} \times \text{No. of Load} \times \text{No. of hrs.}}{1000} \qquad (4)$$

**CHP Technique in GRI Mess:** Current working condition of GRI Boys Hostel is shown in figure 1. Biogas is not able to given in CHP as an input fuel directly because calorific efficiency or conversion efficiency of using biogas as follows: 55% in stove, 24% in engines and only 3% in lamps [12]. So it is given as an input fuel for gas stove cooking. At the same time, LPG gas given to an input fuel for CHP because it's having hive calorific value compared to biogas.

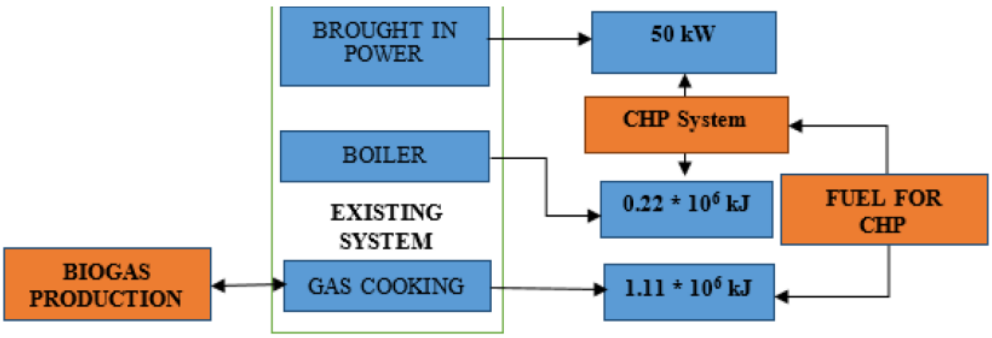


**Fig. 1- Existing system and Energy Plan in CHP**

By Gas Generator (GG) set, total power produced is 11.85kW and wasted heat of 18.93kW. Through CHP system, useful heat recovered from the exhaust wasted heat is 12.68 kW which is shown in figure 2. Total power produced by GG set is greater than Total Peak load. So, the CHP system will not affect the electric load working in full load condition. Fig. 2 calculations are explained below:

Energy utilized by modified gas engine = Input Power of LPG/sec. * max. efficiency of modified gas engine (41 %). (15)

Energy wasted by modified gas engine or wasted heat = Input Power of LPG/sec. - Energy utilized by modified gas engine. (16)

Energy output by generator or Power output = Energy utilized by modified gas engine * max. efficiency of generator (90%). (17)

Energy recover through waste heat recovery system or useful heat = wasted heat * max. efficiency of waste heat recovery (67%). (18)

Total energy produced by system = Energy output by generator + Energy recover through waste heat recovery system (19)

Total energy wasted by the system = Input Power of LPG/sec. - Total energy produced by system (20)

% of loss = {[Input Power of LPG/sec. - Total energy produced by system]/ Input Power of LPG/sec.} * 1 00 (21)

Overall efficiency of the system = 100 - % of loss (22)

Heat to power ratio = Useful heat recover from CHP/ Power output by CHP (23)

Total electrical power produced by the CHP system/day = Power output by CHP * working hrs. (24)

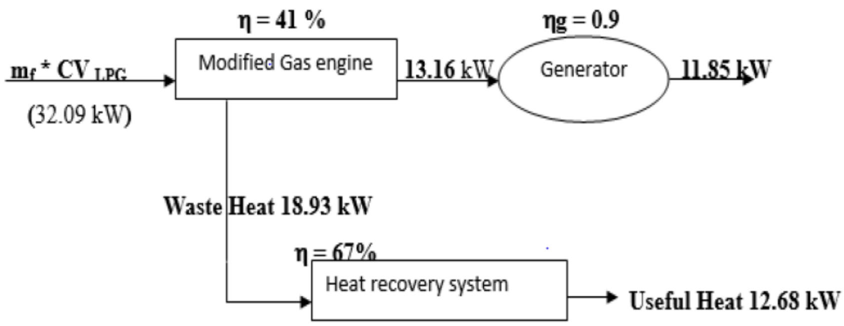


**Fig.2 Output performance ofCHP system**

This excess power can be supply to hostel office load consisting of two fans, two tube lights, one computer and remaining can be stored in batteries through Inverters. At the same time, excess heat utilize for preheating. At the time of power failure in hostel, DG set power utilized for mess and office, When diesel engine is modified into gas engine, the cost required is Rs. 1,50,000/- and other cost = Rs. 1,00,000/- (including Heat recovery system, Control system and Pipe lines)

Payback period for Implementation of CHP System from modifying existing System in days = Total Investment of Implementation of CHP System from modifying existing System Net Savings (31)

Payback period for Implementation of CHP System from modifying existing System in years = Payback period for Implementation of CHP System from modifying existing System in days/365. From this study, the CHP technique implemented from modifying the existing system is more economic than new CHP system which is going to be established. So, further study of total Investment of CHP is Rs. 2,50,000/-. 5).Total cost of energy consumption per day in GRI mess after cogeneration by adopting this cogeneration, the wood and electrical energy consumption from grid were optimally conserved and managed. Energy consumption cost after implementing CHP system = Total cylinder cost/day for cooking + Cost of LPG Cylinder used for Cogeneration per day.

## PERFORMANCE OF EVERY ECM ACTIVITIES AND OVERALL ECM APPROACH

The total electric energy required for mess is 50 units per day (already calculated in section 3.3.1) and total heat energy required for boiler is 0.2016 * 106 kJ (already calculated in section 3.2.2). Working hours of boiler is 12 hours and therefore converts 0.2016 * 106 kJ into units or kWh. We get (0.2016 * 106)/ (12*3600) = 4.67 kJ/s or 4.67 kW = 4.67 * 12 = 56 kWh or 56units. Let us assume power station efficiency is 40%, heat boiler efficiency 85% and CHP plant efficiency is 85% [1]. From figure 3, we know that energy is required and also assumed the conversion efficiency. Using the values, we calculated the fuel required. In the existing system, fuel required for the power station is 50/0.4 = 125 units as same as fuel required. for boiler 56/0.85 = 65.8 units. So, the total fuel required for the existing system is 125 + 65.8 = 190.8 units and loss in existing system is 190.8 - (50+56) = 84.8 units. In CHP system, fuel required is (50+56)/0.85 = 124.7 units and the difference of 124.7 - (50+56) = 18.7 units of loss in CHP. The loss and input fuel given to the system are drastically reduced.

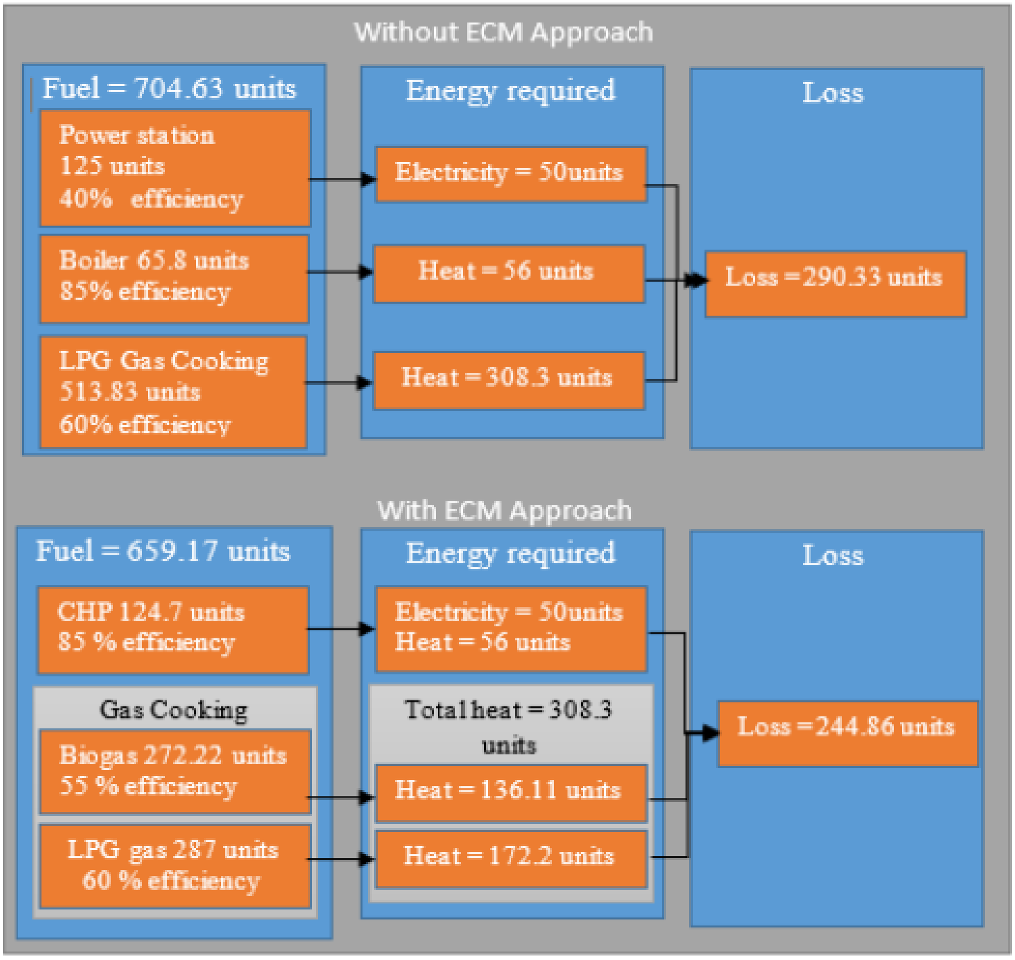


**Fig. 3 Performance and economics of CHP system**

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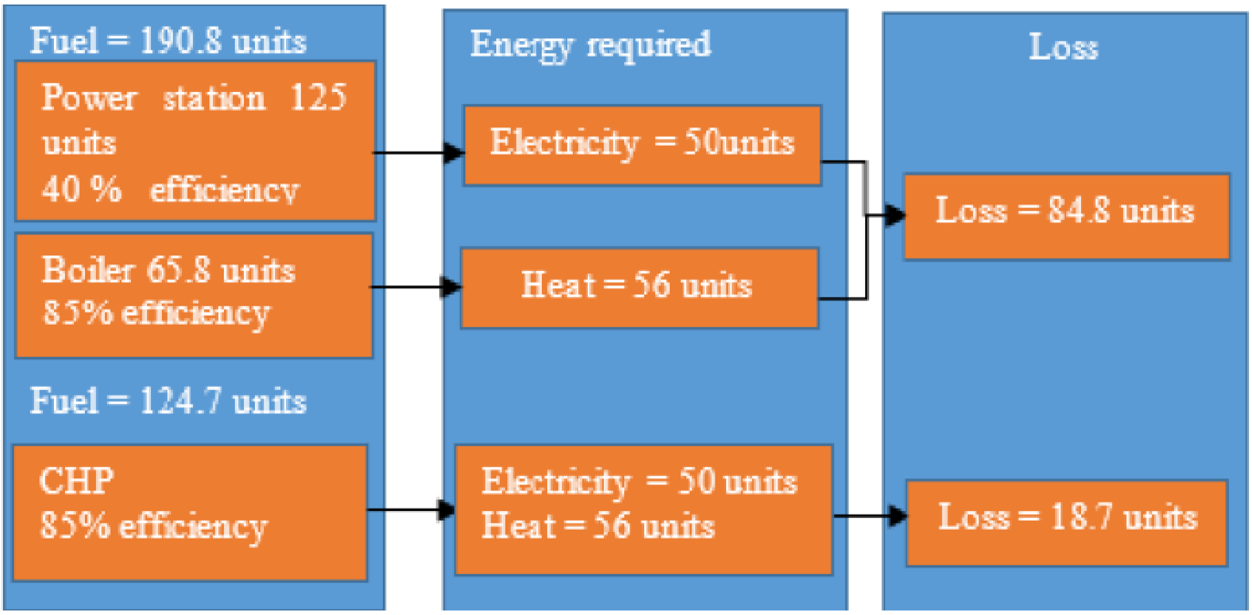


**Fig. 4 Performance of existing system and CHP system**

## OTHER OUTPUTS DUE TO THIS ECM APPROACH

**Wood savings:** The wood used for boiler is 140 kg/day. By implementing this CHP technique wood consumption is stopped which indirectly reduces the C02 emission. The profit earned by the wood = 140 * 5 = Rs. 700/day.

**Water recovery through steam cooking:** In boiler after cooking, the steam is converted into liquid which is distilled water. In hostel 37.5 litres of water is used for boiler cooking. The distilled water thus obtained is used for batteries in university. The cost of distilled water is Rs. 10/litre. Totally the cost of 37.5 * 10 = Rs. 375/day can be saved through this way. Cost consumption pattern of step by step before and after ECM approach Total cost of energy consumption per day before ECM approach in GR! mess = Rs. 2300/day Total cost of energy conservation after implementation of cogeneration = Rs. 2600/day Total energy cost consumption per day after implementation of CRP & additional ECM approach = Rs. 2600/day. The total cost energy consumed per day through after ECM Approach = Rs. 1872/day.

## RESULT AND DISCUSSION

After implementing CRP technique, the savings of fuel is high and approximately the losses are decreased by 4.5 times as in the existing system which is shown in Fig. 5 and Fig. 3 respectively. The Connected electrical load of the mess is lesser than the Output given by CHP system. So, the peak load of the mess is compensated by the CHP system. For better efficiency, the HIP ratio should be in the range of I to 1.7. Here the HIP ratio is 1.071 which indicates that the thermal energy available from CHP system is enough to satisfy the Electrical load of the mess. The reduction in payback period and the equal net savings tells the Investment to implement the CHP system instead of modifying the existing system is more economic than the new CHP system. By implementing CHP technique in mess, the cooking and electrical load needs to be satisfied and the remaining thermal and electrical load can be used for other purpose needed for the hostel. Due to this CHP approach, the wood consumption is completely avoided. Thus the air pollution is reduced. The final output of boiler is condensed distilled water which is used for batteries present in the campus.

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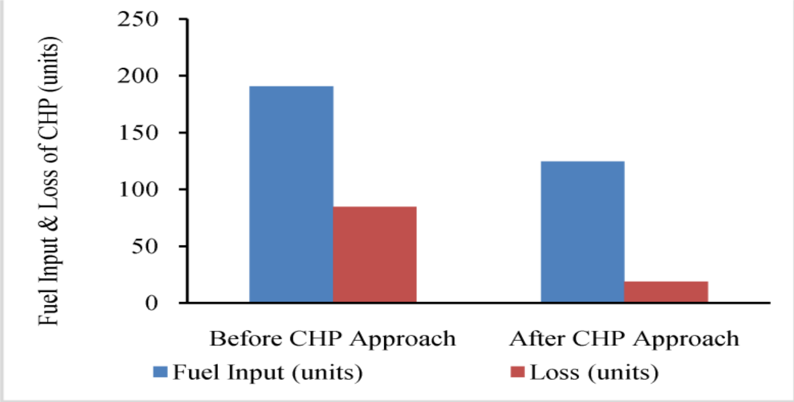


**Fig. 5 Performance of CHP Approach**

By implementing additional ECM technique in mess (Florescent to LED), the net savings and investment are increased compared to normal CHP system without additional ECM approach. This leads to equalization of payback periods. The electric load consumption is reduced compared to electric energy production in CHP system. This leads to increase in surplus electricity at the same time net savings also increased. So, this surplus electricity used for different applications. The total volume of biogas produced per day is 44.95 m3/day and amount of energy account with biogas is 0.62 * 106 k1. This amount of energy is not able to meet the gas cooking thermal load in the mess. So, additionally one LPG cylinder is added to it per day in order to meet out the gas cooking thermal load of the mess. By implementing the biogas plant, the total cost of energy input is reduced. Additionally, the net savings of biogas is increased more due to output of digested slurry. This leads to payback period is reduced at the same time loss due to purchasing LPG cylinder was neutralized by the net savings of digested slurry. Finally, the total investment was increased. The fuel input and energy loss is reduced after ECM approach compared to before ECM approach which is shown in Fig 6 and Fig. 4. The total investment and net savings of implementation of overall ECM approach without additional ECM approach (Fluorescent to LED light) is less than that of total investment and net savings of after implementation of overall ECM approach with additional ECM approach (Fluorescent to LED light). The payback period is almost same for both the system. Compared with normal system, 10 units per day is reduced by additional ECM approach.

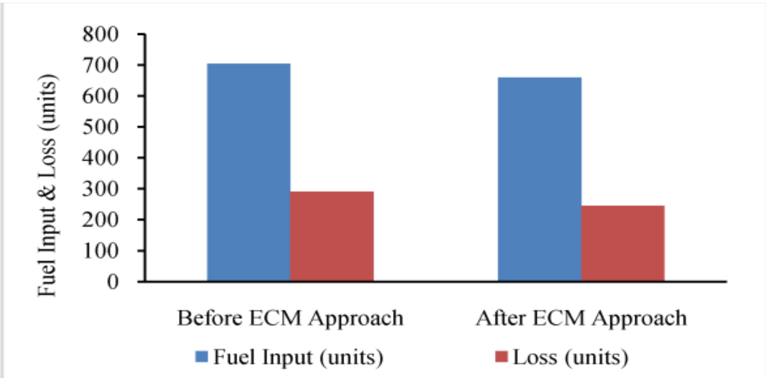


**Fig. 6 Performance of before and After ECM approach**

## CONCLUSIONS

Normally, CHP technique is more economic compared to the normal systems. But CHP technique is more economic by the implementation of CHP from modifying the existing system. This leads to reduction in investment of the system at the same time payback period also reduced. This CHP technique achieved excess amount of electrical load and thermal load of

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boiler cooking compared to requirement in GRI boy's hostel mess. The excess load utilized for the additional applications. So, this helps to conserve the wood and also reduce the air pollution as well as cutting of trees in GRI campus. After boiler cooking, the end product is distilled water which is reusable and also used for different applications like battery present in the GRI campus. The fuel input and loss are reduced more after implementing CHP technique. Especially loss is reduced approximately 4.5 times compared to the existing system. The fuel cost. was reduced after implementing CHP technique compared to the before ECM approach.

• For implementing additional ECM approach (Fluorescent and LED) in GRI mess, this helps to reduce the power consumption by ) 0 units per day compared the normal system. So, the excess power used in additional places in the hostel. This leads to reduce the energy consumption from the TNEB. The Investment and net savings are required more for after additional ECM technique (Fluorescent and LED). But payback period is ahnost same for before and after implementing the additional ECM approach.

• Biogas helps to reduce the LPG gas consumption. This leads to increase the net savings through digested and reduce the cost of the fuel.

• The fuel input and loss are reduced after implementing the ECM activities. Thus the cost of energy consumption is reduced due to implementation of ECM activities in GR) mess.

• By implementing the ECM approach in hostel and mess leads to reduce the energy production, pollution, increase of energy efficiency and sustainable development.

• Due to the implementation of ECM activities in residential houses, industries, hotels, institutions, hostels etc... to reduction of energy usage, energy cost, and increase in energy conservation for sustainable development as well as usage of energy in effective manner.

## REFERENCES

[1] http://www.fao.org/docrep/t0269e/t0269e02.htm [Accessed on: I 7/08/2015]

[2] M. Adam Mydeen, Mr. Siva Sakthi Velan. S, V.Kirubakaran, Combined Heat and Power Applications in IC Engines: A Case Study, Journal of Chemical and Pharmaceutical Sciences, Special Issue: 6, pp - 343-344, 2015.

[3] M. Dentice d_Accadia, M. Sasso, S. Sibilio, L. Vanoli, "Microcombined heat and power in residential and light commercial applications", Appl. Therm. Eng., Vol. 23, pp. 1247-1259,2003.

[4] P.A Pilavachi, "Mini- and micro-gas turbines for combined heat and power", Appl. Therm. Eng., Vol. 22, pp. 2003-2014,2002.

[5] A Vaseb, M. Fesanghary, S.M.T. Bathaee, "Combined heat and power economic dispatch by harmony search algorithm", Int. J Elec. Power, Vol. 29, pp. 713-719,2007.

[6] Gianni Bidini, Umberto Desideri, Stefano Saetta, Pierluca Proietti Bocchini, "Internal combustion engine combined heat and power plants: Case study of the University of Perugia power plant", Appl. Therm. Eng., Vol. 18, pp. 401-412,1998.

[7] R.1. Braun, SA Klein, D.T. Reindl, "Evaluation of system configurations for solid oxide fuel cell-based micro-combined heat and power generators in residential applications", 1. Power Sources, Vol. 158, pp. 1290-1305,2006.

[8] D.P. Papadopoulos, P.A Katsigiannis, "Biomass energy surveying and techno-economic Assessment of suitable CHP system installations", Biomass and Bioenergy, Vol. 22, No.2, pp. 105-124,2002.

[9] AD. Hawkes, M.A Leach, "Cost-eflective operating strategy for residential micro-combined heat and power", Energy, Vol. 29, pp. 711- 723,2007.

[10] Louise Trygg, Shahnaz Amiri, Appl. Energ., Vol. 84, pp. 1319-1337, 2007.

[11] G.G Maidment, R.M Tozer, "Combined cooling heat and power in supermarkets", Appl. Therm. Eng., Vol. 22, pp. 653-665,2002.

[12] IoanDoroftei; Victor Grosu and VeaceslavSpinu; “Omnidirectional mobile robot- Design and Implimentation” from “Gh.Asachi” Technical university of Iasi, Romania.

[13] Florian Heberle, Dieter BrUggemann, "Exergy based fluid selection for a geothermal Organic Rankine Cycle for combined heat and power generation", Appl. Therm. Eng., Vol. 30, pp. 1326-1332,2010.

ISBN: 978-81-961781-9-2

[14] A Rentizelas , S. Karellas, E. Kakaras, I. Tatsiopoulos, "Comparative techno-economic analysis of ORC and gasification for bioenergy applications", Energy Conversion and Management, Vol. 50, No.3, pp. 674-681,2009.

[15] Venkateshwaran, M. M., Harinath, M. P., Velan, M. S. S. S., Sreenath, M. C., & Kirubakaran, V. Green Campus Intiatives of GRI: A Critical Anaysis of an Academic Complex. International Journal of Applied Engineering Research, 10(10),2015

[16] ] Sreenath, c.; Prabhakaran, S.; Rajakumaran, V.; Shankar, C.; Velan, S.Siva Sakthi; Kirubakaran, v., "Energy auditing of payment tiles making small scale industry: Suggestions and recommendations for energy conservation," International Conference on, pp.I-4, 19-20 March 2015.

[17] Kamaleswaran, K.; Venkateshwaran, M.; Harinath, P.; Mydeen, M.Adam; Kirubakaran, v., "Energy conservation potential in rural industry: A case study on coir industry," Circuit, Power and Computing Technologies (ICCPCT), 2015 International Conference on , vol., no., pp.I,5, 1920 March 2015.

[18] Miet Van Dael, Steven Van Passel, Luc Pelkmans, Ruben Guisson, Patrick Reumermann, Nathalie Marquez Luzardo, Nele Witters, Jan Broeze, "A technoeconomic evaluation of a biomass energy conversion park", Appl. Energ., Vol. 104, pp. 611-622,2013.

[19] Mona Asmare, "Design of Cylindrical Fixed dome Bio Digester in the Condominium Houses for Cooking Purpose at Dibiza Site, East Gojjam, Ethiopia", Am. J. Energ. Eng., Vol. 2, pp. 16-22,201 vivek yadav 4.

[20] Energy Eficiency in Thermal Utilities, Bureau of Energy Eficiency Standard book for Energy Manger and Auditor Examination, 2005.

ISBN: 978-81-961781-9-2

# Chapter: 54

# Research on Measuring Methods and Sensors of High Voltage DC Electric Field

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**ABSTRACT**

Since many applications in the power system depend on the intensity of the electric field, DC electric field measurement has received a lot of attention during the past 50 years. Designing a sensitive and accurate DC electric field sensor (EFS) is highly challenging due to various special qualities, such as high field amplitude, space charged ions, and the complex electromagnetic environment. EFSs can be divided into two groups based on their operational principles: mechanical vibrating type and electro-optical type. Massive progress has been achieved in recent years with the fabrication of EFS using MEMS technology. These three primary types of EFS, which include the rotating electric field mill, MEMS electrostatic field metre, and integrated Optical E-field Sensor, were introduced together with their mechanisms in this work. The traits and variances were carefully compared.

**Key words-** DC electric field; rotating electric field mill; MEMS; integrated electro-optic sensor.

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## INTRODUCTION

The use of HVDC for power transmission has increased significantly in recent years. By the end of 2011, China has installed an 800kV HVDC system. A key factor in determining the best design for DC transmission lines and converter stations is the measurement of the e-field, one of the most important electromagnetic environment characteristics in an HVDC system. The study of meteorological events like lightning storms can benefit greatly from reliable electric field measurements taken at various altitudes [1]. The outcomes are crucial for the launch of rockets[2].

There are many free space ions in the area between the anode and the cathode or between the wires and the ground, which makes it difficult to create a good DC EFS even though DC E-field has some unique qualities. The DC E-field will be distorted by the charged ions, which will affect the measurement. Additionally, when the DC E-field is combined with the field created by these charged ions, the strength of the compound field can reach several kilovolts per metre. DC E-field measurement has been completed by a number of universities, according to the literature.

The traditional rotating electric field mill, MEMS electrostatic field metre, and integrated electrooptic methods are three categories into which the methods can be divided. The theories of operation of these three different types of EFSs will then be introduced in this paper, and a number of their characteristics will be contrasted.

## ROTATING ELECTRIC FIELD MILL

To test the electromagnetic environment parameters, the rotating electric field mill has been increasingly popular in recent years [3-5].Two circular plate-type electrodes that are coaxially fixed and mutually insulated make up its primary body. There are a number of uniformly spaced sector-type holes on each of the two electrodes. The shielding electrode is the upper electrode, while the sensing electrode is the lower electrode. The shielding electrode can revolve with the motor and is electrically grounded. The sensing electrode, on the other hand, is connected to the measurement circuits but does not rotate. The Fig.1 reveals the structure of the rotating electric field mill.

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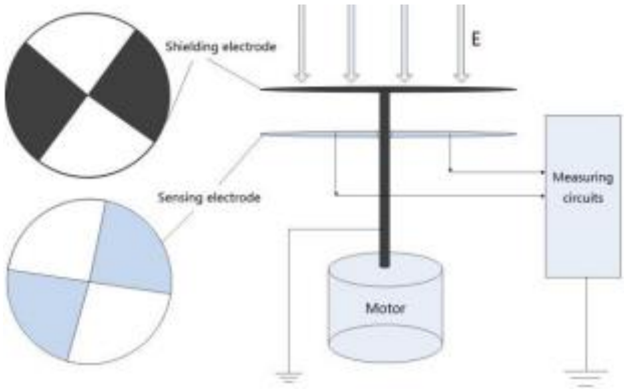


**Fig. 1. Structure of the rotating electric field mill**

The shielding electrode rotates with a consistent speed when the field mill is positioned in a steady and even DC E-field.The electric charge will build up on one sector of the detecting electrode when it is subjected to the E-field.If the electric charge quantity is Qs(t), then the following equation can be used:

$$Q_S(t) = \varepsilon_0 * E * A(t) \qquad (1)$$

A(t) is the area of the sensing electrode which is exposed to the electric field, and its unit is m2, whereas 0 is the dielectric properties of the vacuum, which equal 8.854pF/m, E is the strength of the electric field under measurement, and V/m. When the quantity of the electric charge is Qs(t),the current is can be performed by this following equation :

$$i_S(t) = \frac{dQ_S(t)}{dt} = \varepsilon_0 * E * \frac{dA(t)}{dt} \qquad (2)$$

So, when we get the value of the is, the value of the E-field can be calculated.

**Mems-Based Electrostatic Field Sensor:** The acronym "MEMS" stands for "Micro Electro-Mechanical Systems". With the development of micro-electro-mechanical system (MEMS) technology, more and more researchers [6-13] are focusing on electric field microsensors. MEMS technologies have advanced quickly in recent years. The theory of functioning of the MEMS-based electric field sensor is based on the charge induction concept. In order to vary the amount of induced electric charge on the sensing electrodes on a periodic basis, the grounded shielding electrodes made with MEMS technologies are utilised to control the electric field at their surface. The peak value of an alternating current signal changes depending on how strong the electric field is surrounding the sensor. Additionally, it will be filtered, amplified, and finally changed to the output voltage, allowing us to calculate the strength of the E-field.

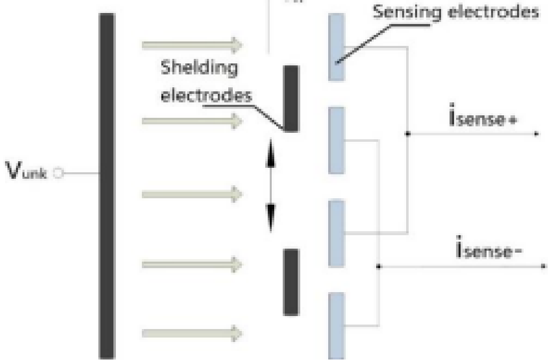


**Fig. 2. Structure of the sensing capacitance**

The MEMS-based field sensor's working principle is shown in Fig. 2. When the sensor is tested in the lab, the DC E-field is created by applying an already known voltage, VUNK, to a target

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plate that is parallel to the sensor's sense plate. The effective capacitances between the target surface and the sense+ plate and the sense- plate, respectively, are Csense+ and Csense- The oscillation of the shielding electrodes efficiently adjusts the sense capacitances Csense+ and Csense- since capacitance is proportional to area of overlap. The following equations can be used to present the Csense+ and Csense-:

$$C_{sense\pm}=N\frac{\varepsilon_0 l_{sense}}{d_{sense}}X_0 \pm N\frac{\varepsilon_0 l_{sense}}{d_{sense}}X_m \sin(\omega_{res}t) \qquad (3)$$

In the equations above, X0 stands for the REFERENCE position midway between the sense+ and sense- plates, Xm for the largest amplitude of the displacement in the x direction, and res for the MEMS structure's resonant angular frequency. The sensing plates' length is represented by lsense, and dsense is the measurement of the separation between the sensing electrode and the shielding electrode. The target surfaces and the sense+ and sense- plates' overlap regions are modulated by the shutter's oscillation in the x direction. The number of sense shutters is Nsense. The dynamic currents produced through the sinusoidal movement of the shielding electrodes are given by:

$$i_{sense\pm}=\pm NV_{UNK}\frac{dC_{sense\pm}}{dt}=NE\varepsilon_0 l_{sense}\omega_{res}\cos(\omega_{res}t) \qquad (4)$$

In accordance with the notion of producing force to move. The MEMS-based electric field sensors' shielding electrodes can be divided into two categories: propelled by electrostatic comb both the thermally induced structure and the structure. Both of the two structures have advantages and disadvantages. The thermally driven structure requires more power dissipation and is more difficult to get to work accurately at resonance frequency. Electrostatic comb driven EFS has better stability but always needs high driving voltage in air. structure. In addition to the Csense's shielding and sensing plates, this structure additionally includes two additional sets of MEMS.

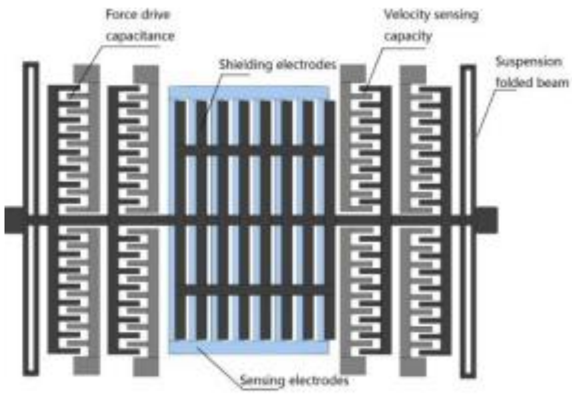


**Fig. 3.A typical electrostatic comb driven structure**

The velocity sense capacitance Cvelocity and the force drive capacitance Cforce. One fixed plate and one moving plate are present in both Cforce and Cvelocity, and the moving plate is mechanically connected to the shielding plate of Csense. The moving plate of Cforce and, consequently, the shutter are moved by an electrostatic force created by a time-varying voltage Udrive applied to the plates. The dynamic current velocity is related to the velocity of the moving shielding plates. The input, Udrive, to the force drive capacitance is created by converting Ivelocity to a proportionate voltage using a transresistance amplifier. The entire drive loop uses negative feedback to make sure that the voltage drive applied to the Cforce plates is at the resonant frequency of the shielding plates. This causes the shielding plates to move to their maximum displacement and, as a result, the system output node Uout has the highest signal-to-noise ratio possible.

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The force capacitance's comb structure can be distilled down to Cforce+ and Cforce-, each of which has a stationary plate but shares a moving plate, as seen in Fig. 4. Additionally, voltages are delivered to the force+ and force-plates, respectively, by Udrive and Udrive. A voltage given to the Cforce+ and Cforce plates will cause an electrostatic force to be induced, which will cause the moving plate to move forcefully in the x direction. The energy derivative determines the strength of this electrostatic force.

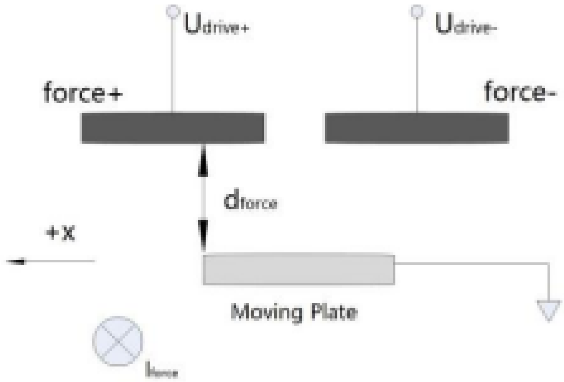


**Fig. 4. Structure of the force capacitance**

stored in Cforce with respect to the x position coordinate. The electrostatic force can be defined as: $\vec{F} = \frac{dE}{dx}$ (5) and, the dynamic capacitances C force+ and C force- can be presented as: $C_{force\pm} = 2N_{force}\frac{\varepsilon_0 l_{force}}{d_{force}}X_0 \pm 2N_{force}\frac{\varepsilon_0 l_{force}}{d_{force}}X_m \sin(\omega_{res}t)$ (6) In this equation, Wres is the resonant angular frequency of the MEMS structure ˈFor maximum shutter displacement, the drive loop will maintain the frequency of Udrive+ and Udrive- at the frequency of Wres DŽAs shown in the Fig.4, force represents the length of the plates ,and the distance between the moving plate and the fixed plate is defined as d force. The oscillation of the shutter in the ±x direction modulates the areas of overlap between the target surface and the sense+ and sense- plates. N force is the number of single combs. So, the electrostatic force can be:

$$\vec{F} = \frac{dE}{dx} = \pm\frac{1}{2}2N_{force}\frac{\varepsilon_0 l_{force}}{d_{force}}(U^2_{drive+} - U^2_{drive-})\hat{x} \qquad (7)$$

**Ujala:** In order to start replacing current bulbs with LEDs, the UJALA scheme was launched in January 2015. It was designed to replace about 770 million incandescent lights, and it launched a nationwide push for energy saving. The plan's two goals are to create LED bulbs for less money than the market would bear and to sell them to domestic customers. In order to achieve this, Energy Efficiency Services Limited (EESL), a super energy services company supported by the government, has developed a business model in which it purchases a significant amount of LED bulbs from private manufacturers through competitive bidding and sells them through distribution centres at prices significantly below market prices. Customers can pay for these bulbs either through a bill-financing model (partially upfront and then in installments) or by paying them in full up front. The price of LEDs has significantly decreased over the course of EESL's procurement rounds, going from Rs 310 per bulb in January 2014 to Rs 38 per bulb in the most recent round of bidding in September 2016.Additionally, the market has grown phenomenally; in 2014–2015, just 3 million LED bulbs were delivered, but in 2015–2016, that number reached 150 million, with about 90 million of them going to UJALA alone. More than 180 million LEDs had been dispersed across 22 states as of December 2016. In addition to its two main goals, UJALA also aims to reduce the pick demand of discoms. As of December 9, 2016, this plan has helped reduce grid load by around 4703 MW. In addition

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to its two main goals, UJALA aims to reduce the pick demand of discoms. As of December 9, 2016, the initiative has contributed to a reduction of around 4703 MW in the load on the grid. Through these activities, 23 million kWh of energy are saved annually, saving Rs 93 billion and reducing CO2 emissions by 19.2 million tonnes.

With the replacement of 770 million bulbs, the country's connected load would be reduced by an estimated 20,000 MW, yielding annual energy savings of 100 billion kWh. With an average electricity tariff of Rs 4 per kWh, the total amount of money consumers would save on their electricity bills would be close to Rs 400 billion. The final costs of bulbs vary across states and are typically in the range of Rs 75–95 per bulb as a result of various state-specific taxes and other administrative costs like distribution that are added to the pooled procurement price.

## CONCLUSION

According to the electrical lamp and component manufactures association, UJALA has had a significant impact on the lighting market. The LED market has grown by 579 percent from 2010 to 2014 and is currently worth Rs 33.95 billion. It is predicted to reach at least Rs 50 billion by 2016-2017. In addition, India's share of the global LED market has increased from 0.1% to 10%. In CONCLUSION, market-driven efficient procurement methods and low procurement prices under UJALA have assisted customers in overcoming the price barrier, monetizing energy savings, and drawing in investments.

## REFERENCES


[1] Prasad Bhukya, Dr. Debasish Basak, Energy Saving Technologies in Industries- An overview, International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014 ISSN 2250-3153.

[2] M. Yang, Closing the Gap,DOI: 10.1007/978-1-4471-4516-5_2,World Bank 2013.

[3] Mr. Jeremy Snyder, Advancing the effective use of light for society and environment. —Volume 2

[4] Malkiat Singh, Gurpreet Singh, Harmandeep Singh, ENERGY AUDIT: A CASE STUDY TO REDUCE LIGHTING COST, 5 (2012) 119 – 122.

[5] Abhishek Garg and Rajasekar.S, “A New Modulation Technique to Eliminate Leakage Current in Transformerless PV Inverter”, Engineering and Systems (SCES), 2013 Students Conference.

[6] G. Buticchi et al,“Compensation Strategy of Actual Commutations for PV Transformerless Grid-Connected Converters”, Electrical Machines (ICEM), 2010 XIX International Journal.

[7] D. Barater et al, “A new proposal for ground leakage current reduction in Transformerless Grid-Connected Converters for Photovoltaic Plants”, Industrial Electronics, 2009. IECON '09. 35th Annual report

# Chapter: 55

# Review on Gas Metal Arc Welding (GMAW) of Mild Steel Using Taguchi Technique

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**ABSTRACT**

MS is ductile steel belonging to low carbon steel group. It is widely used for better weld. In present review paper study is focused on effect of different processparameters i.e welding current, voltage, gas flow rate, welding speed and gas pressure on mechanical properties like tensile strength and percentage of elongation of GMAW welded joints of MS plates. GMAW welding is a high deposition rate welding process where wire is continuously feeded fromgun or spool. This welding gives several advantages example welding can be done in all positions, long weld is possible without slag. Optimum welding conditions was determined for maximizing tensilestrength and percentage elongation of weldedjoints. Final test was also conducted for validating optimumparameters. From study of review papers, It was found that with increase in weldingcurrent, voltage, GFR, tensilestrength decreases, but when welding speedincreases, the tensile strength also increases.

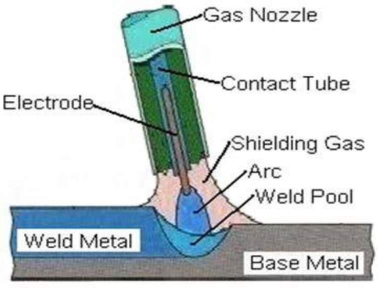
**Key Words:** MS, Tensile strength, Percentage of elongation, Taguchi Technique, Current, voltage, Gas Flow Rate.

## INTRODUCTION

Welding is a process of joining two similar and non-similar metal or non-metal with the application of heat and pressure, but in some cases without the application of pressure the process has been done. The filler wire is used to join the metal in GMAW process with the help of spool gun. Welding is used for making permanent joints. It is used for the manufacturing of automobile parts, railway wagons, aircraft frames, machine parts, tanks, structural works,boilers, ship building furniture etc. Gas Metal Arc Welding (GMAW) is an arc welding process which produces the coalescence of metals by heating them with an arc between a continuously fed filler metal electrode and thework. The arc and the weld pool are shielded from atmospheric contamination by passing a suitable gas through the nozzle to form aprotective shield around the welding area.

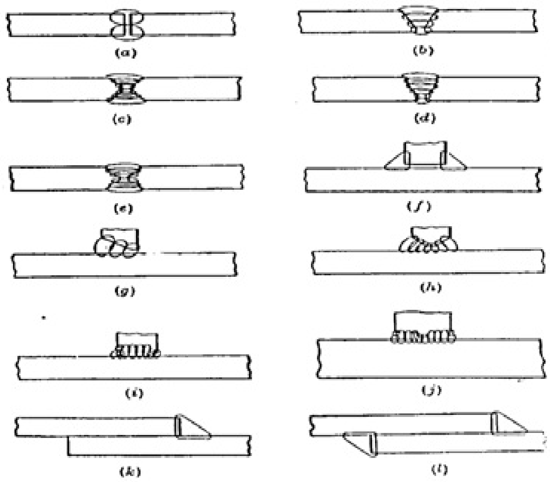
### Process Parameters:

- Electrode Size
- Welding Current
- Welding Voltage
- Arc Travel Speed
- Electrode Extension
- Electrode Position
- Gas Flow Rate and Types of shieldinggases




Gas Metal Arc Welding Process

**Types of Welding Joint**



**Types of welding joints (a) square butt joint; (b) single-v butt joint; (c) double-v butt joint; (d) single-u butt joint;(e) double-u butt joint; (f) square-t joint; (g) single-bevel t-joint; (h) double-bevel t-joint;(i) single-u t-joint; (j) double-u t-joint; (k) single-bead lap joint; (l) double-bead lap joint.**

**The Chemical Composition of MS**

| Sr. No. | Element | Content |
|---|---|---|
| 1. | Carbon, C | 0.14 - 0.20 % |
| 2. | Iron, Fe | 98.81 - 99.26 % |
| 3. | Manganese, Mn | 0.60 - 0.90 % |
| 4. | Phosphorous, P | ≤ 0.040 % |
| 5. | Sulphur, S | ≤ 0.050 % |

**Advantages of GMAW:** The advantages of GMAW welding are as follows:

- This method is economical due to high welding speed and long arc time can be maintained as there is no frequent changing of electrode rods.
- This method gives the opportunity for rational welding of materials which are difficult to weld.
- Welding is possible in all positions.
- The arc and the weld pool are clearly visible.
- Only used little after treatment of the weld is necessary.

**Disadvantages of GMAW:** Some of the disadvantages of GMAW welding are as follows:

- There is a risk of serious welding errors such as lack of fusion, etc. if the welder is not sufficiently skilled with a profound knowledge of the process and its welding parameters.
- The necessary, but costly, shielding of the welding place at outdoor jobs.
- Greater investments in welding equipment and expenses to maintenance to the welding equipment.

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**Applications of GMAW**

- GMAW is usually used in Aluminium, ordinary mild steels, Stainless steels, Copper and copper alloys.
- It is also suitable for magnesium, nickel and a number of other metals and their alloys.
- It has been used successfully in industries like aircraft, automobile and ship building.
- It gives high surface hardness and a soft core to parts that include studs, worms, ratchets, dogs, chain needles, pins, liners, machinery frames, special bolts, oil tool slips, tie rods, anchor pins, etc.

**Mechanical Properties of MS**

| Sr. No. | Mechanical Properties | Range |
|---|---|---|
| 1. | Brinell Hardness | 126 |
| 2. | Knoop Hardness | 145 |
| 3. | Rockwell Hardness | 71 |
| 4. | Vickers Hardness | 131 |
| 5. | Tensile Strength, Ultimate | 440 MPa |
| 6. | Tensile Strength, Yield | 370 MPa |
| 7. | Elongation | 15.0% |
| 8. | Reduction of area | 40.0% |
| 9. | Modulus of Elasticity | 205 GPa |
| 10. | Bulk Modulus | 140 GPa |
| 11. | Poissons Ratio | 0.290 |
| 12. | Machinability | 70% |
| 13. | Shear Modulus | 80 GPa |

**LITERATURE REVIEW**

1. Ghosh et al. (2016) reviewed that the plate of 3mm thickness is used for butt joint. X ray test shows that lack of penetration and visual inspection indicate the undercut spatter and blow holes in some samples. The optimum parameters founded by Taguchi method are current 10A, gas flow rate 20l/min and nozzle distance 15mm and current is more significant as compared to gas flow rate and nozzle distance.[3]
2. Prakash et al. (2016) Present work deals with optimization of welding process variables by using MIG welding. In this process input variables are arc voltage (V), current (A) and

welding speed(S) with tensile properties, hardness & penetration as responses of low carbon steel. Design ofexperiments based on taguchi orthogonal array [L9]; and analysis of variance (ANOVA) is used to determine the impact of parameters with the optimal condition [4].

3. Singhmar et al. (2015) Reviewed that various combination of parameters were obtained by conducting the experiment as per the orthogonal array. Arc current has the highest influence on the tensile strength withcontribution of 41%followed by Arc voltage with contribution of 20% and gas flow rate with contribution of 16%.[5]
4. Kalita et al. (2015) In present work effect of t parameters of MIG welding; welding voltage, current and shielding gas flow rate on the tensile strength of C20 steel has been studied. An experiment has been designed using Taguchi's L9 orthogonal Array with three repetitions. All welding work has been carried out using ER70S-4 electrodes.Results shows that welding voltage has significant effect, both on mean and variation of the tensile strength of the weld having 87.019% and 85.398% contribution respectively, whereas welding current has significant effect on mean only (10.807% contribution).Shielding gas flow rate has insignificant effect on the tensile strength of weld. From analysis of experimental data the optimal setting is found to be: Welding current 200 amp. Welding voltage 30V and Shielding gas flow rate (CO2) 8lit/min. we can use other variable parameters also like electrode size, root gap, plate thickness &welding speed etc. with other materials combinations [6].
5. Patil et al. (2014) Reviewed that the among main input welding parameters the effect of the welding speed is significant. By increasing welding speed and decreasing current influences also increase the ultimate tensilestrength of welded joint. In this research work done it was observed that the voltage did notcontribute such as to weld strength .Regardlessof the set of the quality characteristic, greater S/N ratio relates to better the quality characteristics [7].Kumar et al. (2013) Paper shows that the result of the analysis of variance for the Hardness .The analysis of variance was carried out at 95% confidence level to investigate the influence of the design parameters on hardness by indicating that which parameter is significantly affected the quality characteristics. In this experimentation work, the authors have generated results for S/N ratios of Hardness.
6. Anoop c a et al. (2013) Has discussed an application of Taguchi method for investigating the effects of process parameters on the weld micro hardness; grain size and HAZ width in the GTA Welded aluminium alloys. From the analysis of the results using the S/N ratio approach, analysis of variance and Taguchi's optimization method, the following can be concluded: Peak current of 150 A, base current of 75A and pulse frequencyof 150Hz are the optimized welding parameters for getting highest micro hardness, smallesteqiuxed weld grains and minimum HAZ width. Out of three selected parameters, peak currenthas the highest contribution i.e. 61.58%.
7. Chhabra et al. (2013) Studied process parameters are optimized by using theTaguchi's techniques based on Taguchi's L9 orthogonal array. Experiments is conducted based on shielding gases, welding current and arc travel speed and three levels of each parameters were carefully selected. Micro hardness has been predicted for the optimum welding parameters and parameters percentage of contribution in producing a better joint is calculated, by applying the effect of the S/N ratio and analysis of variance. Based on the study, shielding gas was found to be the most significant variable over the other process parameters while the welding current and arc travel speed took the second and third rank

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respectively. The optimum parameters for the high micro hardness obtained through the taguchi is the combination of process parameters of Ar+CO2 shielding gas, 190 Amp. welding current and 22 cm/min arc travel speed. Maximum hardness, in terms of optimum value of 432 HV is achieved. Shielding gas (Ar+CO2) was most significant with 68.36% contribution.

## CONCLUSION

From the review paper study, it is found that when the welding current ,voltage ,GFR increases ,The tensile strength decreases ,but when welding speed increases ,the tensile strength also increases. In the case of elongation is also same to tensile strength. Optimization was done to find optimum welding conditions to maximize tensile strength and percentage of elongation of welded joints. Thisstudy presented the optimization of GMAW parameters of Mild Steel 1018 by Taguchi's experimental design. The process was applied using a specific set of controllable parameters Voltage, Current, Gas Flow Rate for the response variables of Tensile Strength. L9 orthogonal array, S/N ratio analysis of variance were used for this study. The Study found that the control factors had varying effects on the response variables.

## REFERENCES

[1] https://goo.gl/images/9RYCZY
[2] https://en.wikipedia.org/wiki/gas_metal_arc_welding
[3] Nabendu Ghosh, et al, (2016) "ParametricOptimization of MIG Welding on 316L Austenitic Stainless Steel by Grey-basedTaguchi Method. "ProcediaTechnology, 25, 1038-1048.
[4] Abhishek Prakash & Raju S. S. et. al,(2016) "Parametric optimization of metal inert gas welding by using taguchi approach. "International Journal ofResearch in Engineering and Technology, Volume: 05 Issue: 02, Feb-2016).
[5] Singhmar et. al, (2015),"Experimental study for welding aspects of austenitic stainless steel (aisi 304) on tensile strength by taguchitechnique." International Journal ofMechanical Engineering and Robotics Research 439.
[6] Diganta Kalita.et al, (2015) "Taguchi Optimization of MIG WeldingParameters Affecting Tensile Strength ofC20 Welds. "International Journal of Engineering Trends and Technology (IJETT) – Volume 26 Number 1- August2015. ISSN: 2231-5381.
[7] S. R. Patill, et al, (2014) "Optimization ofMig Welding Parameters for ImprovingStrength of Welded Joints." International Journal of Advanced Engineering Research and Studies E-ISSN2249 8974.
[8] Kumar, P. et al, (2013). "Parameters Optimization for Gas Metal Arc Welding of Austenitic Stainless Steel (AISI 304) & Low Carbon Steel using Taguchi's Technique. " International Journal of Engineering and Management Research, 3, 2250-0758.

# Chapter: 56

## Review on the Friction and Wear of Thermodynamics —A Review

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**ABSTRACT**

With an overview of the significant contributions made by prominent researchers, an in-depth review of the publications relevant to the thermodynamic approach to tribo-systems is provided. This method, in particular, uses the theory of entropy as a natural time foundation.

**KEYWORDS:** Friction; wear; energy dissipation; contact temperature; entropy production; non-equilibrium thermodynamics; self-organization

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### 1. INTRODUCTION

The study of lubrication, friction, and wear is known as tribology, and it deals with a wide range of both man-made and natural systems of interacting bodies in motion. About one-third of the world's energy resources are used by friction, which is the primary cause of wear and energy dissipation, as people try to find a way to get around it. It seems sense to try to create a thermodynamic framework for analyzing the properties of friction processes since they are usually accompanied by energy transition. The idea of thermodynamic entropy formation is a perfect instrument for delving into the complicated behaviour of energy dissipation in friction processes since it naturally reflects an irreversible phenomena.This study reviews the current research and offers the authors' viewpoint on the possibilities of modelling sliding contacts in tribosystems using the thermodynamic approach to friction and wear. The following is the paper's outline: In Section 2, we get started by going over the relevant literature on the energetic approach to friction. Section 3 discusses the rise in inter-facial temperature brought on by friction. Next, two general aspects of friction—wear and the development of dissipative structures—are examined in Sections 4 and 5, using entropy generation as a yardstick for degradation.

**2. Friction and Energy Dissipation:** Pressing two bodies together and setting the contact in motion is always accompanied by dissipation of energy. The main factor that controls the behavior of energy generation within the contact of a sliding system is the interfacial friction. The frictional energy generated between contacting bodies is governed by the combination of applied load and velocity. Other contacting factors such as the material properties, relative velocity and size also influence the distribution and dissipation of the frictional energy. The friction and heat dissipation are, therefore, intimately related. In Section 2.1, we begin by describing the nature of energy dissipation due to friction within nonsliding contacts. By non-sliding contact, we mean rubbing between two surfaces with very small amplitude (typically of the order of microns) in oscillatory motion. This phenomenon is generally referred to as fretting wear. In Section 2.2, energy dissipation in contacting bodies in continuous relative motion is considered and its relation to wear is discussed.

**2.1. Non-Sliding Contact:** Known as fretting damage, repetitive, small-amplitude oscillatory motion between two contacting bodies degrades the contact surfaces due to repeated shear forces. The energy dissipation and associated surface damage in contacting bodies subjected to an oscillating tangential force has been known for decades, starting with the pioneering work

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of Cattaneo et al. [2]. Figure 1 shows a schematic of fretting contact subjected to normal load, P, and oscillatory tangential force, Q, within the contact region of 2a.

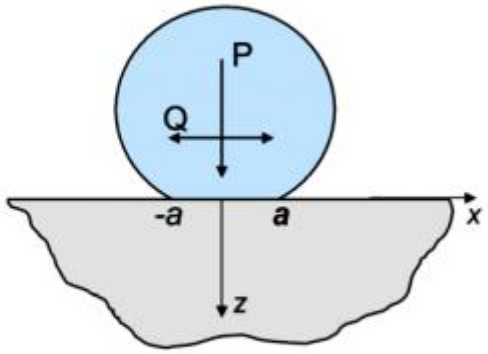


**Figure 1. A schematic of two bodies in contact under fretting load.**

Major advances were later made by Mindlin [3] and his co-authors [4], who are probably the first to theoretically derive an expression for energy dissipation during non-sliding contact. Their analysis of energy dissipation in fretting contact is extended by Mindlin and Deresiewicz [5] to include the effect of oscillation of an oblique force, inclined to the surface of contact. Deresiewicz [6] published a very comprehensive summary of the work of Mindlin. The preceding theoretical studies have been subjected to extensive experimental investigation by Johnson [7,8], Goodman and Bowie [9] and Goodman and Brown [10]. Johnson [8] concludes that the increase in energy dissipation in fretting contact results in increase in surface damage. The surface damage increases rapidly with the angle of obliquity, reaching the maximum when the force in tangential. Earles [11] theoretically investigates the energy dissipation in nominally flat contacting bodies under fretting and postulates that comparable energy can be dissipated similar to that of visco-elastic materials. Subsequent works include publications by Earles and Philpot [12], Brown [13], Boothroys et al. [14], Rogers and Boothroyd [15] and Wilson et al. [16], among others. Investigation on the assessment of energy dissipation during non-sliding contacts is followed by the theoretical work of Hanson et al. [17], who model an actual fretting fatigue experimental situation and estimate the energy dissipation under cyclic tangential loading. They estimate the energy dissipation by taking into account the hysteresis loop of tangential force versus tangential displacement. Their analysis shows that the energy dissipation drops off rapidly as the distance between the contact region and the boundary increases. Extensive studies have been reported by Fouvry and collaborators [18–24] who analyzed the fretting phenomenon of contacting surfaces with particular attention to coated surfaces, on the basis of energy dissipation in a fretting contact. They argue [18] that energy dissipation is the primary parameter needed to quantify damage. A so-called global energy wear law is considered in their work, and it is confirmed that the wear volume could be correlated with the cumulative dissipated energy with a linear relationship as:

$$W=\mathbf{C}_1\mathbf{E}_d + \mathbf{C}_2 \quad (1)$$

where W is the wear volume, $c_1$ is energy wear coefficient, $E_d$ is energy dissipation and $c_2$ is the residual volume. Figure 2 shows the wear volume as a function of the cumulated dissipated energy [18]. The results are presented for TiN and HSS (high-speed steels) versus alumina contacts, and both present a linear evolution.

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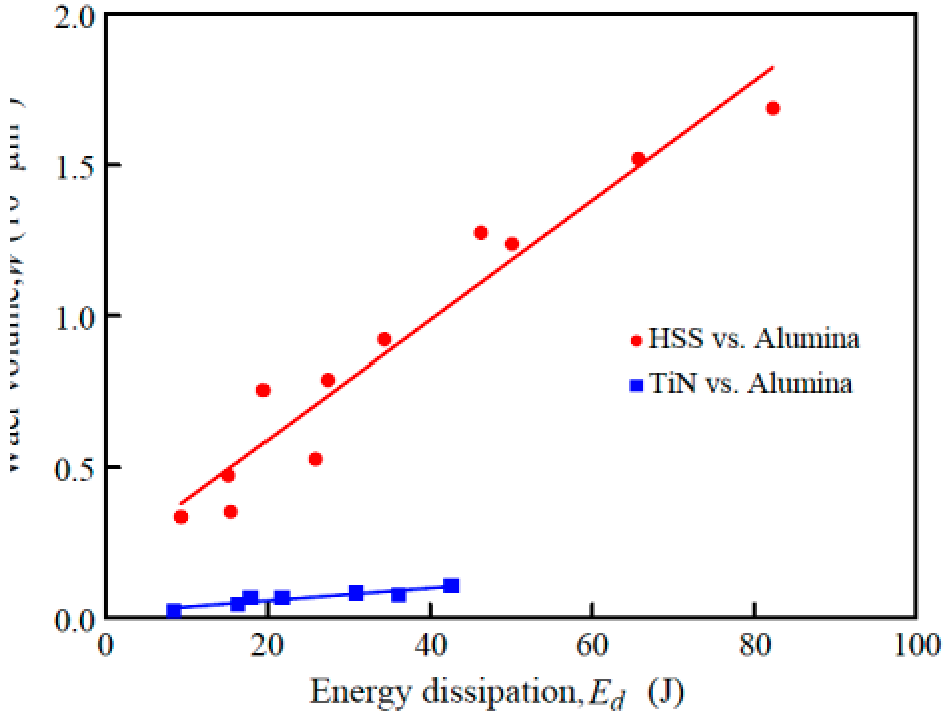


**Figure 2. Wear volume as a function of cumulative dissipated energy (reproduced from data in Fouvry et al. [18]).**

They also conclude that the commonly used coefficient of friction (i.e., μ = Q/P) can overestimate the global friction behavior. Therefore, an energy friction coefficient of the following form is introduced to average the friction response:

$\mu = E_d /4P\delta0$ (2)

where $\delta_0$ is the sliding amplitude. The energy approach proposed by Fouvry and co-workers to characterize fretting contact is formulated for non-adhesive wear tribosystems, displaying a weak influence of third body. However, in many applications the presence of third body is a concern.

The use of frictional energy dissipation approach for evaluating the behavior of non-sliding (fretting) triobsystem remains to be of great importance to researchers. Among them, are the works of Zhang et al. [25], Bureauy et al. [26], Attia et al. [27], Magaziner et al. [28], Dini and Hills [29], and Korsunsky and Kim [30].

**2.2. Sliding Contact:** Similar to non-sliding tribological systems, the irreversible energy dissipation due to frictional work in sliding systems has been of great interest to researchers. In the present paper, most significant and relevant works on energetic approach to sliding contact are reviewed. Friction is an energy transformation process. Using a near-equilibrium analysis, one can demonstrate (see Section 4) how sliding energy is dissipated. Rymuza [31] considers friction as a process that transforms the external mechanical energy to the energy of internal processes. Rymuza proposes that the traditional 'laws' of friction is incapable of reflecting its energetic nature and suggests a new parameter called 'coefficient of friction losses' (CFL), so as to reflect both the dissipate nature of friction process and simultaneously provide a useful formulation for application in engineering practice. The definition of CFL is input energy REFERENCEd speed sliding load by presented friction of energy friction) by (caused losses CFL. In comparison to traditional coefficient of friction, CFL depends not only on the properties of the contacting bodies, but also on load, sliding speed, environmental

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conditions, etc.,, However, as pointed out by Rymuza, this energetic approach lacks generality, in a sense that the CFL seems to enable easy and adequate description of friction process only in a macro scale. In Rymuza's work, the scale of observation of tribological process is fundamental. That is, the CFL is useful to estimate the energetic 'averaged' losses in the tribosystem being analyzed. Chen and Li [32] extend the micro-scale dynamic model (MSDM) of wear simulation, originally proposed by Li et al. [33], followed by Elalam et al. [34], and Chen and Li [35,36]. They investigate the thermal aspects of friction processes with the emphasis on friction heating and its relation to plastic deformation. They perform a quantitative analysis of energy conversion and distribution during sliding. In their work, the first law of thermodynamics is applied to assess the energy distribution. The frictional energy is a part of mechanical energy lost during the sliding process. It includes three parts: strain energy, fracture energy, and thermal energy. They show that during sliding only a portion of friction energy is converted to heat and the remainder results in plastic deformation, micro-cracks, and a change in surface roughness. Figure 3 shows the distribution of generated heat by deformation with distance from the contact surface (reproduced from the data presented in [32]). It can be seen that the heat is concentrated in the surface layer and that it sharply decreases with an increase in the distance from the contact surface. Similar results are presented by Neder et al. [37].

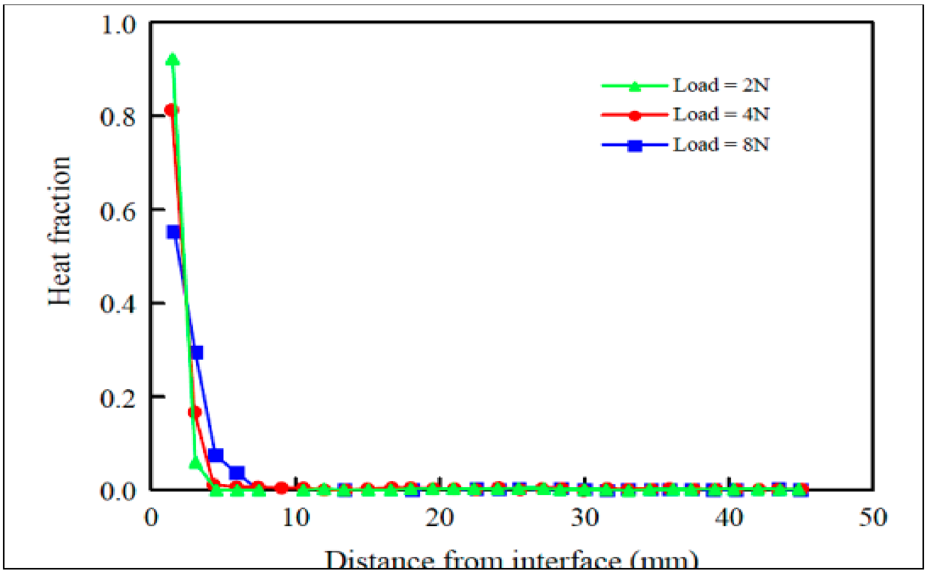


**Figure 3. Distribution of heat generated by deformation with the distance from the contact surface (reproduced from [32]).**

The energy analysis done by Chen and Li [32] is limited to the friction processes in which the change in the surface roughness is not a concern. As they point out, for simplicity of the analysis, the energy consumption corresponding to the change in surface morphology during the friction process is assumed negligible and there is no marked wear involved. This assumption may not be applicable during running-in operating period. Energy analysis has gained considerable attention for assessment of tribosystems involving wear. Gershman and Bushe [38] consider wear as a generic and fundamental characteristic of friction; energy dissipates into the contacting bodies, giving rise to wear. Uetz and Fohl [39] have considered the energy dissipation by friction and its relationship to wear. Huq and Celis [40–42] propose a procedure to correlate the volumetric wear loss with the dissipated energy for unidirectional and bidirectional ball-on-flat configuration wear test for hard coatings like TiN and (Ti, Al)N, and multilayer (Ti, Al)N/TiN coatings. Their experimental work shows that wear volume is

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linearly correlated with dissipated energy and that the slope of the linear correlation is useful not only to compare the wear resistance of different materials, but also to compare the wear resistance in different environmental conditions. The effect of relative humidity on the wear of different coatings is investigated. Figure 4 shows an example of the results obtained in the work of Huq and Celis [42]. In this figure, fretting wear volume is plotted against the energy dissipation for multilayer (Ti, Al)N/TiN coating at different relative humidity. The linearity between wear volume and energy dissipation is substantially affected by humidity of the surroundings. Huq and Celis [42] conclude that the more complexity in wear process arises when one considers the interactions not only between the contacting surfaces but also with the surroundings multilayer coating at different relative humidity. Operating Conditions: 1N load and 10Hz frequency (reproduced from Huq and Celis, [42]). A similar study on the energetic approach to wear is reported by Ramalho and Miranda [43].

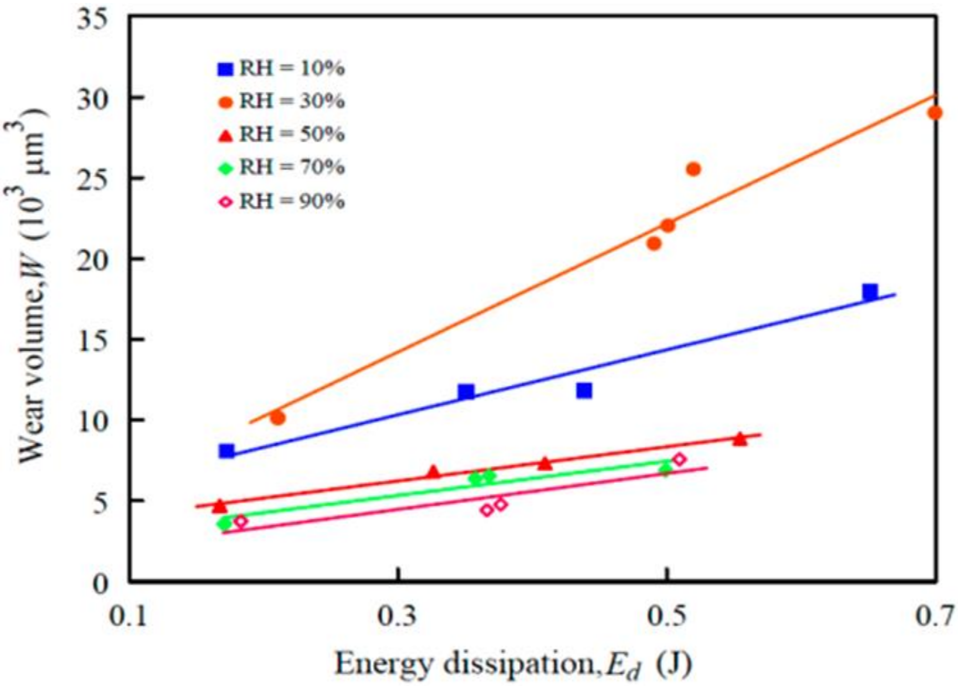


**Figure 4. Fretting wear against dissipated energy for 140 nm (Ti, Al)N:140nm TiN**

Interestingly, they show that the energy dissipated in the contact is linearly correlated with the wear volume during sliding wear and that the results can be used to quantify the wear coefficient in Archard's equation. Archard's wear equation relates the wear volume W, to the normal load N, the sliding distance S, and the inverse of hardness H, through a proportionality constant K, often referred to as the wear coefficient (Archard [44])Amonton-Coulomb law of sliding friction relates the normal load N, to friction force F, as F = μN.

Therefore, wear volume and friction force are directly related in accordance to the following relationship:

$$W \alpha FS$$

where the right hand side of expression (4) physically represents the work of friction force. Therefore, the volume of wear is directly proportional to the energy dissipated by friction. Figure 5 shows several experimental results reported by Ramalho and Miranda [43] for wear volume versus dissipated energy for different materials.

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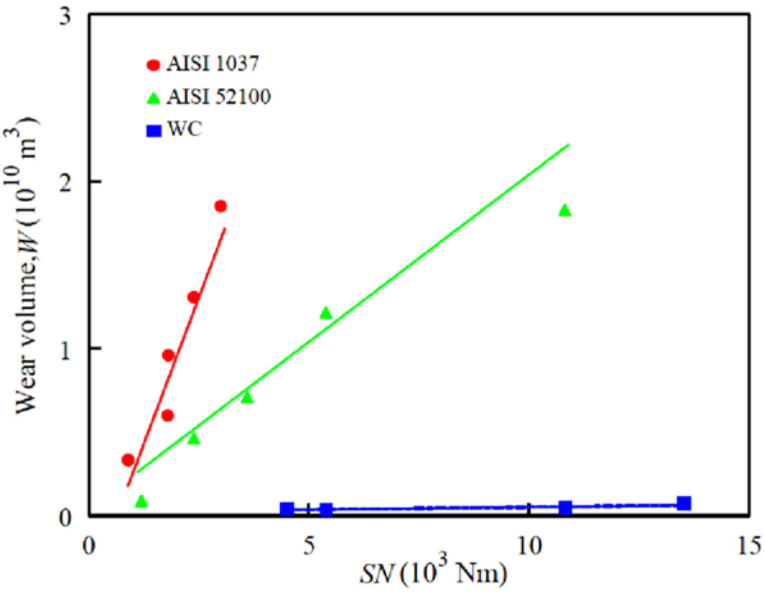


**Figure 5. Wear volume against SN for three different materials (reproduced from Ramalho and Miranda, [43]).**

Indeed, experimental results of Ramalho and Miranda [43] reveal that the rate of change in the wear volume is linearly related to the dissipated energy and that the slope of the line represents an estimation of the wear coefficient, K/H = W/SN. The relationship between wear and dissipated energy has been of interest in the research community. Among them, the most recent and pertinent works are: Savkoor and Ouwerkerk [45], Gupta et al. [46], Kuhn and Balan [47], Scherge et al. [48], Shakhvorostov et al. [49], Larbi et al. [50], Li et al. [51], Abdel-Aal [52–54], Maeda et al. [55], Colaco et al. [56], and Nurnberg et al. [57]. The foregoing review of literatures on the state of the art pertaining to the energy approach to wear processes reveals that the frictional energy dissipation is a promising feature of tribosystems to characterize wear process. In fact, the linearity between wear and energy dissipation holds for both non-sliding and sliding tribosystems. The beauty of energy approaches to the wear process is that the effect of load, velocity, environmental conditions, etc., on the wear rate can be accounted for by considering frictional energy dissipation within a contact. Further, the amount of energy dissipation can be considered as an indication of the changes in mechanical and metallurgical properties of contacting bodies. This is described in the next section.

**3. Frictional Temperature Rise:** It is generally accepted that most of frictional work during the wear process is converted into heat, which in turn, raises the interface temperature. The temperature distribution within the contacting bodies, and particularly the near-surface temperature in sliding systems, has been of great interest for many researchers during past decades; See for example, Alyabev et al. [58]; Ling [59], Kennedy [60,61], Greenwood and Alliston-Greiner [62], and Knothe and Liebelt [63]. Temperature rise at the interface can be high enough so as to modify the mechanical and metallurgical properties of sliding surfaces—e.g., as accompanied by formation of oxide layer(s) on the surface or even by melting (Lim and Ashby [64])—and thus drastically changes the behavior of tribological systems (Welsh [65], Blau [66], Quinn [67]). Indeed, the flash temperature in a contact area of a sliding system involving wear of steel, could reach 750–800 ºC, which in turn, might induce phase transformation, cause oxidation and reduce the wear resistance [68]. As discussed in Sections 4 and 5, the temperature, and particularly temperature gradient within the mating bodies plays an important role in assessment of entropy generation in a tribosystem. Both theoretical and

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experimental methods have been developed for determination of temperature rise at the contact surface. Blok [69] is credited to be the first researcher who proposed a model for determination of the temperature rise at the surfaces of contacting bodies under boundary lubricated condition. He considers the temperature rise due to a heat source whose dimension is small with regard to the body of the surface to which it is applied. In the model, two different shapes of heat source, i.e., round and square, at low and high Peclet numbers are considered. In his seminal publications, Blok [69,70] highlights the concept of the flash temperature—the highest temperatures of short duration at the actual contact areas—and gives the formula to estimate its magnitude.

Jaeger [71] follows the concept of flash temperature proposed by Blok [69] to study the surface temperature rise at sliding interface for various shapes of a moving heat source with constant velocity in the surface of a semi-infinite medium. He, also, presents an approximate solution for interface temperature rise at the intermediate Peclet numbers. Although Czichos [72] speculates that it is nearly impossible to obtain the surface temperature or temperature field during sliding by means of experimental methods, there are some experimental measurements of surface temperature reported in the literature. For example, Wang et al. [73] employ a thermal video system to capture a real-time record of the temperature distribution within sliding bodies in a pin-on-ring configuration. Figure 6 shows the measured temperature evolution at about 2 mm and 10 mm from the sliding distance of the pin specimen (Wang et al. [73]). It can be seen that the temperature of the pin specimen rapidly increases with the sliding time during the early period of friction and wear. The temperature rise close to the surface increases to hundreds of degree Celsius in a few seconds during the very early period of sliding. Wang et al. [73], also propose a mathematical model of temperature field in the surface layer during sliding friction and wear as follows:

$$K(t)= t^{1/2}/Ꞁ Ʋ[A0T0 \exp[-A0t^{2}]+ A0'T0' \exp[A0'T0'^{1/2}] ]$$

which is based on the solution of one-dimensional transient heat conduction equation with K(t) given as

$$T(x,t) = (1-x/L)\, f1(t) + (x/L)\, f\, 2(t) - k(t) \sin(ꞀƲ/L)x$$

wheretf1 and tf 2are boundary conditions, A0 are constants that depend on the material properties and T0T0’ are the temperature limits in the moving range. They show that the bulk surface temperature corresponding to the transition from mild wear mechanism to the severe wear mechanism is about 200 °C for steel 52100.

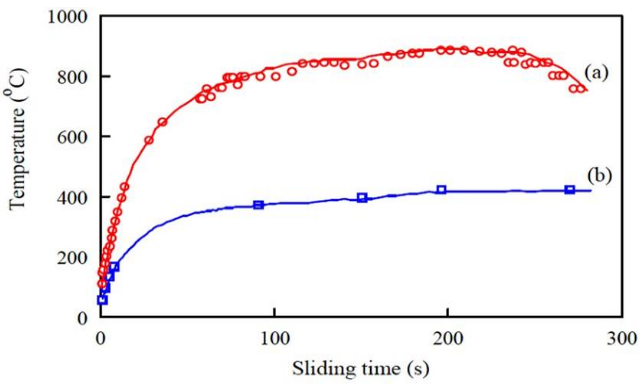


**Figure 6. Measured temperature profiles of a pin of steel 52100: (a) at about 2 mm from sliding surface; (b) 10 mm from the surface (reproduced from Wang et al. [73]).**

Additional notable experimental investigations on measurement of surface temperature during frictional contact include the work of Tian et al. [74,75] and Szolwinski et al. [76]. Tian et al. [74] use the thin-film thermocouple (TFTC) technique for polymer pin against Al2O3-coated glass in a dry oscillatory sliding system to measure the surface temperature. Szolwinski et al. [76] use an infrared thermographic technique to assess the magnitude and distribution of near-surface temperature within a fretting contact between an aluminum alloy cylinder and flat. An interesting investigation is reported by Tian and Kennedy [77] to analyze the surface temperature rise for a semi-infinite body due to different moving heat sources for the entire range of Peclet number. Using the concept of partitioning heat between two contacting bodies, originally proposed by Blok [70], Tian and Kennedy [77] present the solutions of interface flash temperature for general sliding contact. Let Q represent the total heat flux generation at the interface. Then, the heat transferred to body 1 is ηQ, where η is the heat partitioning factor. The heat flux entering body 2 is (1– η)Q. By matching the maximum surface temperature at real contact area, Tian and Kennedy [77] end up with the following expression for partitioning factor:

$$\eta = \frac{1}{1+\frac{k_2}{k_1}\sqrt{\frac{1+Pe_2}{1+Pe_1}}} \qquad \text{..........................(7)}$$

where k1, k2 and $P_{e1}$, $P_{e2}$ are the thermal conductivity and Peclet number of first and second bodies, respectively. The concept of heat partitioning factor is very useful in analysis of a tribosystem. By having the total heat generation at the interface of contacting bodies, one can estimate the amount of heat flux entering bodies. Recently, the authors of the present paper (Amiri et al. [78]) have carried out a series of sliding wear tests pertain to a ring-on-ring configuration for two sets of contacting materials: Bronze SAE 40 on Steel 4140 and 70–30 Brass on Steel 4140. Temperature evolution within contacting bodies during wear tests are recorded using thermocouple. A thermocouple is placed close to interface (at 2.4 mm from sliding surface), giving reasonable values that can be taken as the representative of the interface temperature. Also, wear of the softer material is measured using a Linear Variable Differential Transformer (LVDT) sensor. The temperature rises during the early period of wear test, then, reaches a steady-state conditions; see Figure 6. The steady-state heat generation due to friction can be expressed as:

$$Q = \mu N_u \qquad (8)$$

where μ is the coefficient of friction, u is the velocity and N is the normal load. Using the concept of heat partitioning factor, the amount of heat transfers to the first body Q1is:

$$Q = \eta\mu N_u \qquad (9)$$

Elimination of normal load N, between Equation (9) and Archard's law in Equation (3), results in:

$$Q_1 = Kw/(\eta\mu HA) \qquad (10)$$

where w= W/A is the wear rate, and A is the area of contact. The results of the experiments show that there is a linear relationship between temperature rise at interface and the heat transferred to body 1. Figures 7 shows the results of temperature rise plotted against the heat dissipation.

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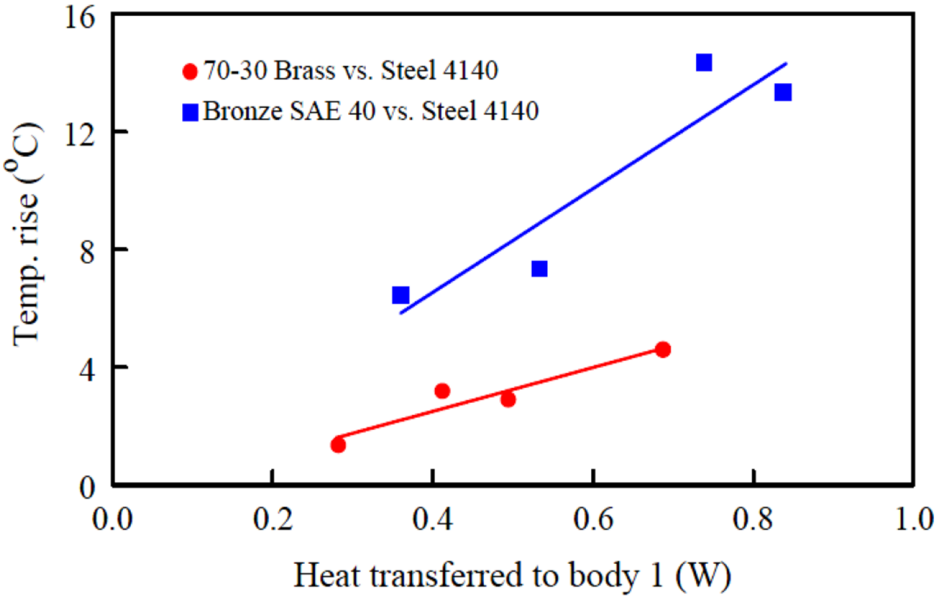


**Figure 7. Temperature rise ∆T, against the heat entering body 1, Q1 (reproduced from Amiri et al. [78]).**

The linearity between the temperature rise and heat entering body 1 can be expressed as:

  $\Psi = TQ_1$ (11)

where Ψ is the slope of the line. It is analytically shown by Özisik [79] that the constant Ψ can be evaluated from the solution of quasi-steady state heat conduction equation. Substitution of Q1 from Equation (11) into Equation (10) gives a relation for the wear coefficient K as follows:

$$K=(\eta\mu HA\Psi)w/\Delta T \qquad (12)$$

Equation (12) offers a methodology for evaluation of the wear coefficient merely by measuring the contact temperature. This method provides a simple and effective technique to quantitatively characterize the wear behavior of a dry sliding system. Figure 8 shows the calculated wear coefficients for Bronze and Brass on Steel for different operating conditions (Amiri et al. [78]). The average value of wear coefficient obtained for the Brass on Steel pair is Kbrass = $4.3 \times 10^{-4}$ and for Bronze on Steel pair is $K_{bronze} = 2.02 \times 10^{-4}$

. The published value of wear coefficient for Brass on Steel (Rothbart, [80]) and Bronze on Steel (Rabinowicz, [81]) are:

$$K_{brass} = 6 \times 10^{-4} \qquad (13)$$

$$10^{-4} < K_{bronze} < 10^{-4} \qquad (14)$$

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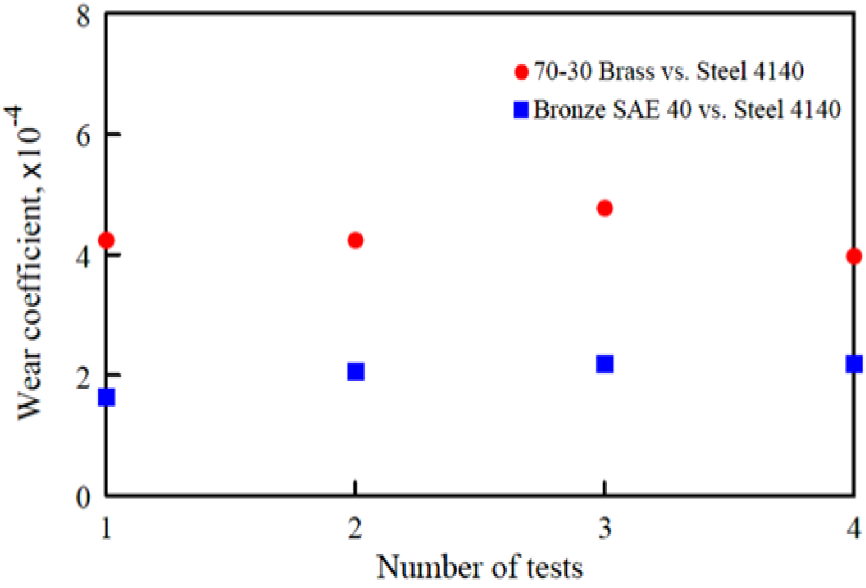


**Figure 8. Wear coefficients for Brass and Bronze on Steel (reproduced from Amiri et al. [78]).**

Comparison of the wear coefficients with the work of Rothbart [80] and Rabinowicz [81] shows very good agreement. It is, hence, concluded that temperature rise at the interface of the contacting bodies is of prominent importance in characterizing the behavior of the tribosystem. This method is particularly useful because of the availability of analytical and experimental results for predicting contact temperature under various operating conditions and configurations. Among them are the works of Kalin and Vizintin [82], Dwivedi [83,84], Chen and Li [32], Mansouri and Khonsari [85], Wen and Khonsari [86], and Bansal and Streator [87].

**4. Entropy—Wear Relationship:** According to Ramalho and Miranda [43], the friction energy is dissipated mainly through three processes: temperature rise of contacting bodies, generation of wear particles and entropy change due to material transformation in the interface. Relationship between energy dissipation with temperature rise and wear is discussed in previous sections. In this section, we focus our attention to characterization of friction process and wear within a thermodynamic framework. Here, we employ entropy production as a measure of irreversibility to characterize degradation in a tribosystem, which manifests itself in the form of wear. Manufacturing transforms raw materials into highly organized components, while aging and degradation—via irreversible processes such as wear, corrosion, etc.—tend to return these components back to their natural states (Ling et al. [88]). According to Gershman and Bushe [38], a friction process develops its characteristics and parameters with time. Therefore, above and beyond its initial and final stage, the way that this process evolves should be considered. Thermodynamic analysis of the evolution of two characteristics of friction process—i.e., wear and formation of secondary structures—is discussed in this section and Section 5.

Perhaps Klamecki [89–92] is the first researcher who correctly describes the friction process based on the concepts of irreversible thermodynamics. He demonstrates [91] that the process of sliding of two bodies in contact with non-zero relative velocity is a non-equilibrium process. Using a near-equilibrium analysis via entropy production, he shows the occurrence of energy dissipation in sliding processes. Klamecki [89,90] shows that entropy can be defined to describe the state of the bodies in sliding contact and the definition of entropy can be generalized to include all pertinent energy dissipation mechanisms, particularly wear process.

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He studies the structure that develops near-surface regions of sliding surfaces, and postulates that when energy supplied to the system is not dissipated uniformly through the sliding bodies, the system response will be unstable and definite non-uniform structures are expected to develop [91]. The formation of such structures influences the properties and usefulness of the contacting bodies. Klamecki [92], further, analyzes the plastic deformation energy dissipation based on the model developed by Rigney and Hirth [93] and Heilmann and Rigney [94]. He proposes that the energy input into sliding system by friction, dissipates through two components of the total plastic deformation process. These components are: metallic structural change and heat generation, included in the analysis by means of an expression for entropy. The model proposed by Klamecki introduces a new school of thought for characterizing wear based on the thermodynamic response of the wearing system. However, as it is pointed out by Abdel-Aal [95], in the work of Klamecki, the entropy flow due to mass loss is not explicitly expressed so that a direct correlation between wear and entropy is not apparent. Zmitrowicz [96–98] develops a complete mathematical framework to formulate a basic system of equations and boundary conditions for two bodies in contact and for third body (cf. Godet, [99]) in the interface. In the first paper (Zmitrowicz, [96]), he presents a model for formulation of the governing equations of mass, momentum, momentum of momentum, energy and entropy inequality for rubbing and wearing solids and third body. Also, a set of dependent variables describing properties of contacting bodies and third body is given from thermodynamics viewpoint. Zmitrowicz [97] also presents the constitutive equations and linearized theories for the contacting bodies and third body. Further, he introduces [98] the constitutive equations for friction, wear and frictional heat within the context of thermodynamical theory. The constants in constitutive equations are governed by two thermodynamic requirements: the second law of thermodynamics, and constraints of the energy dissipation at the frictional contact. Zmitrowicz [100] reviews the modeling of wear of materials, wear patterns and laws of wear. Dai et al. [101], propose a model for analysis of fretting wear based on the irreversible thermodynamic and the concept of entropy balance and the stability of the irreversible processes.work of Dai et al. [101] is notable in the sense that, it is the first study to quantitatively characterize a tribosystem based on the irreversible thermodynamic concept, particularly for correlating wear and entropy generation during fretting wear test. Doelling et al. [102] experimentally demonstrate that wear is correlated with entropy flow. Experimental wear tests pertain to a slider-rider configuration in boundary lubricated regime. The rider is a stationary copper specimen and the slider partner is a steel cylinder mounted on a rotating shaft. Continuous measurement of entropy flow is made by a calorimeter. Entropy flow is calculated using

$$S_n = \sum {}^{n}\Delta Q^{(n)}/T^{(n)}$$

where $\Delta Q^{(n)}$is the heat input to the rider during the nth time interval, and $T_{(n)}$is the average absolute surface temperature of the rider during the $n^{th}$ time interval. Figure 9 shows their experimental results, plotted for normalized wear as a function of normalized entropy. Wear and entropy are normalized by the maximum value of the set in each test. Figure 9 demonstrates a strong relationship between normalized wear and normalized entropy flow, that is: Normalized wear = normalized entropy flow. Doelling et al. [102], showed that the slope of Figure 9 is representative of wear coefficient in classical Archard's wear model (K in Equation (3)). They postulate that the Archard's wear law is a thermodynamic consequence and is subsumed in their generalized functional relationship between wear and entropy flow. It is discussed later, that at steady-state conditions the flow of entropy equals to the value of entropy production. It is important to note that, Doelling et al. [102] formulation is based on the entropy flow rather than entropy production. This important clarification was not made until the work of Bryant et al. [103] and Bryant [104].

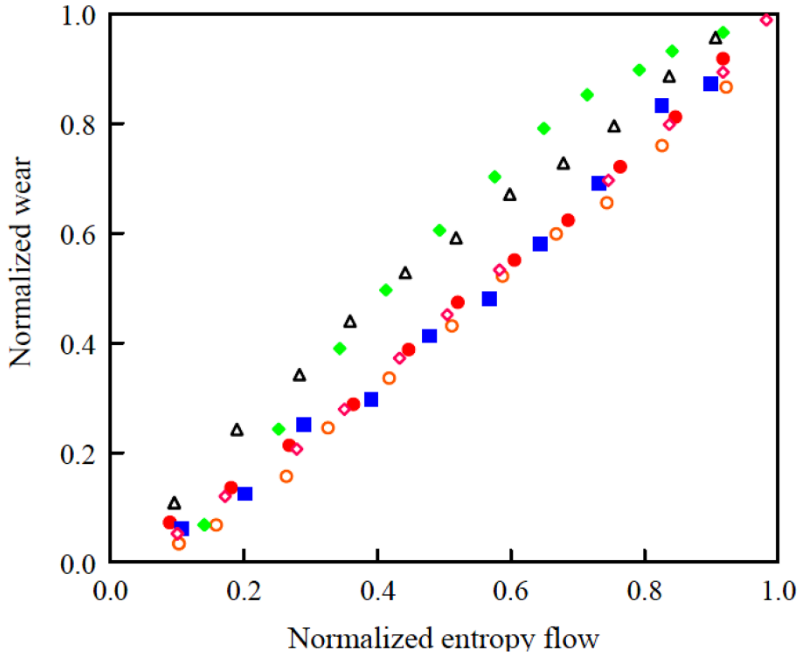


**Figure 9. Normalized wear against normalized entropy (reproduced from Doelling et al. [102]).**

As a continuation of Doelling et al. [102], Ling et al. [88] report a new set of experiments to the limiting case wherein there is neither wear nor production of entropy flow. They designate this set of experiments as Category II in comparison to their previous work as Category I. In Category I, the normal load is so high, that only a small portion of it is carried by the lubricant. In contrast, in Category II, lubricating fluid carries all of normal load and consequently wear is zero. In Category II, the tests are in the mixed and hydrodynamic lubrication regime, as typically identified on the Stribeck curve. In the mixed lubrication regime, the wear and production of entropy flow are moderate. In contrast, in the hydrodynamic regime the both wear and entropy flow are nil. Brahmeshwarkar [105] experimentally verified the concept proposed by Doelling et al. [102] and Ling et al. [88], by developing a relationship between the normalized wear and the normalized entropy flow in a totally different test set up, representing a different category of operating conditions. His work involves relating wear to production of entropy flow in a ring-on-ring configuration under dry sliding condition. A theoretical model that simulates thermal response in sliding contact is presented to verify the proposed relation. The model is based on the fact that sliding contact of two bodies would result in plastic deformation in the near surface region, referred to as the ‘severely deformed region’ (SDR). The plastic deformation results in heat generation in the SDR and subsequently gives rise to the temperature of contacting bodies. The heat generation at the interface is calculated considering plastic deformation energy dissipation in SDR region. The temperature distribution in contacting bodies due to heat generation in SDR region is then calculated. Having determined the heat generation and temperature distribution, he evaluates the entropy flow. The verification of his model, which basically involves comparison of the Archard’s wear coefficient calculated using the theoretical model with the published values, reveals a comparable agreement. Recently, a general theorem—the so called degradation-entropy

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generation theorem—was developed by Bryant et al. [103] that relates entropy generation to irreversible degradation, via generalized thermodynamic forces X and degradation forces Y. In an open system capable of exchanging heat and matter with its surroundings (see Figure 10), the change of entropy consists of sum of two parts (Prigogine, [106]):

$dS = d_eS + d_iS$ ……………………………(15) in which $d_eS$ is the entropy exchange with surroundings and diS is the entropy produced internally by the system. The second law of thermodynamics states that the entropy production must be non-negative, i.e.:

$d_iS \geq 0$ …………………………..(16) Steady-state conditions are of great interest in analysis of a tribosystem. It is known that at the steady-state conditions, change of entropy, dS, does not depend on time. Therefore, it follows from Equations (15) and (16) that in stationary state:

$d_eS + d_iS = 0;\ d_eS = -d_iS < 0$……………….. (17)

An interpretation of Equation (17) is that for an open system operating at steady-state conditions, the flow of entropy has to leave the system, i.e., the equality of entropy generation and entropy flow at steady-state conditions. Further, the convenience of measurement of entropy flow in contrast to analytical prediction of entropy production has led some researchers to evaluate the tribosystem performance using entropy flow. This is the fact behind the assumption made by Doelling et al. [102] in correlating wear with entropy flow, instead of entropy production.

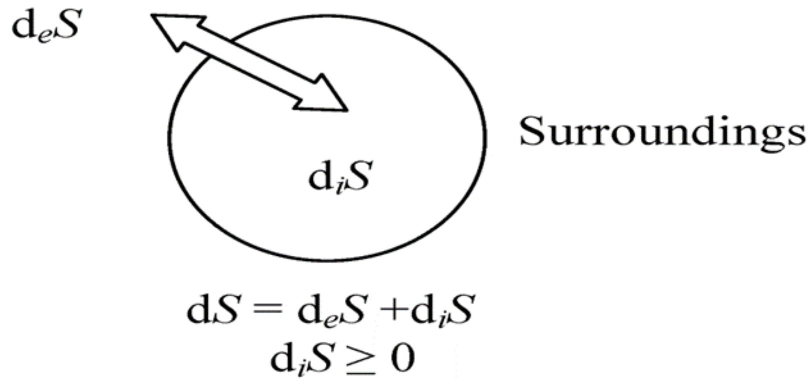


**Figure 10. Entropy exchange with surroundings and entropy generation in an open system.**

However, it is the internal entropy generation of a system that manifests the degradation of a system. To obtain an explicit expression for entropy production $d_iS$ in terms of experimentally measurable quantities, one must invoke the concept of thermodynamic forces and thermodynamic flows (Kondepudi and Prigogine, [107]). Suppose the system is divided into j = 1, 2, …, n subsystems with dissipative processes $p_j$, where each depends on a set of time-dependent phenomenological variables k = 1, 2, …, $m_j$. The entropy production can be expressed as the sum of products of the thermodynamic forces and the corresponding thermodynamic flows:

$$\frac{d_iS}{dt} = \sum_j \sum_k \left( \frac{\partial_i S}{\partial p_j} \frac{\partial p_j}{\partial \zeta_j^k} \right) \frac{\partial \zeta_j^k}{\partial t} = \sum_j \sum_k X_j^k J_j^k$$

…………………(18) where $kX_j$ are the thermodynamic forces and $k_jJ$ are the conjugate thermodynamic flows. Bryant et al. [103] introduce the concept of degradation forces to obtain an expression for degradation as follows:

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$$\frac{dw}{dt} = \sum_j \sum_k \left( \frac{\partial w}{\partial p_j} \frac{\partial p_j}{\partial \zeta_j^k} \right) \frac{\partial \zeta_j^k}{\partial t} = \sum_j \sum_k Y_j^k J_j^k$$

………………..(19) where k $Y_j$ are the degradation forces. Since Equations (18) and (19) share $k_j$ J , degradation coefficients can be defined as:

$$B_j = \frac{Y_j^k}{X_j^k} = \frac{(\partial w/\partial p_j)(\partial p_j/\partial \zeta_j^k)}{(\partial_i S/\partial p_j)(\partial p_j/\partial \zeta_j^k)} = \left.\frac{\partial w}{\partial_i S}\right|_{p_j}$$

………………(20) which suggests $B_j$ measures how entropy production and degradation interact on the level of dissipate processes $p_j$. Bryant et al. [103] successfully applied their theorem to sliding systems involving wear and fretting. They conclude that the well-known Archard law for assessing wear in friction wear and energy-based models for fretting wear are the consequence of the laws of thermodynamics and the degradation-entropy generation theorem. It is worthwhile to mention that the degradation-entropy generation theorem provides a powerful tool in analyzing a system undergoing degradation within an irreversible thermodynamic framework. The theorem expresses the rate of degradation and entropy generation by applying the chain rule and makes no assumption on the thermodynamic state of the system (Bryant [108]). Therefore, it can be applied to the systems $d_iS$ $d_eS$ Surroundings $dS = d_eS + d_iS$

$d_iS \geq 0$operating far from equilibrium. However, the applicability of the theorem in describing other type of degradation processes, i.e., wear and fretting, are yet to be experimentally investigated. Dai and Xue [109] review some fundamental problems in modeling friction and wear and development of thermodynamic approaches towards tribology problems. They point out that relating micro-, meso- and macro-scale features of friction can be obtained by introducing entropy as a key parameter to represent energy dissipation and material loss by using the theory of non-equilibrium thermodynamics.

**5. Entropy and Self-Organization during Friction:** Irreversible thermodynamic aspect of wear as an attribute of friction process is discussed in the preceding section. Here, another characteristic of friction process—the formation of dissipate structure during friction—is discussed. The process of formation of dissipate structures is called self-organization and it occurs under significant deviation from thermodynamic equilibrium state. The formation of dissipate structures during friction process results in reduction of wear rate. In development of wear resistance materials, technologies that help the system to form the dissipate structures faster are very desirable (cf. Gershman and Bushe [110]). Interests in selection of materials for contacting bodies that increase the intensity of non-equilibrium processes during friction are growing. Self-organization has been widely studies in different disciplines such as mechanics, chemistry and biochemistry since the publication of the pioneering work by Glansdorff and Prigogine [111]. Several types of dissipative structures exist in fluid mechanics, chemical and biological reactions (Glansdorff [112]). A comparatively extensive literature survey is given by Gershman and Bushe [38]. Here, we present pertinent works done on the development of self-organization processes in the field of tribology and surface engineering. It is well known that for a system at thermodynamic equilibrium state entropy has the maximum possible value whereas entropy production vanishes; that is, $d_iS/dt = 0$ in Equation (18). Therefore, it is inferred that k $X_j$= 0, $J^k{}_j$= 0(Prigogine, [113]). As stated earlier, a tribosystem is an open, non-equilibrium system. Hence, its entropy is lower than the equilibrium state and entropy production is not zero. The lower entropy of the system asserts an increase in orderliness and self-organization. Generally, a system does not reach equilibrium because of the interference of external elements. In a tribosystem, external elements such as load, velocity, temperature, humidity, etc.,, push the system to operate far from equilibrium. Therefore, to prevent entropy growth, a highly ordered intermediate body forms on the interface. This is commonly referred to as tribo-film. Formation of tribo-films is the response of the system to external stimulus to reduce wear rate. If tribo-films are not formed during friction, tribosystem stops the friction by seizure or jamming (Gershman and Bushe [38]).

Formation of tribo-films needs dissipation of energy. The required energy is spent for non-equilibrium processes instead of damaging the contact surfaces and producing wear particles. In tribo-films a dispersion of energy occurs. More than 90% of frictional energy is dissipated as heat in the thin layer of tribo-films (Garbar and Skorinin, [114]). This phenomenon has attracted attention of researchers in development of wear resistant coating which can resist heat generation at contact surfaces. A very recent study on the thermodynamic approach to the self-organization and self-healing of coating during friction is presented by Nosonovsky et al. [115]. They postulate that the mechanisms of self-organization involve interactions with different characteristic length scales. For example, Figure 11 shows the self-healing of large-scale cracks and voids which contribute to the decrease of entropy at macro scale, while fracture of micro-capsules increases disorder and entropy at the mesoscale. Hence, the decrease in entropy at macro scale is done at the expense of mesoscale. It is to be noted that microcapsules are microscale capsules embedded in the material and contain healing liquid. During a crack propagation process, the microcapsules fracture and release healing liquid to prevent crack propagation [115].

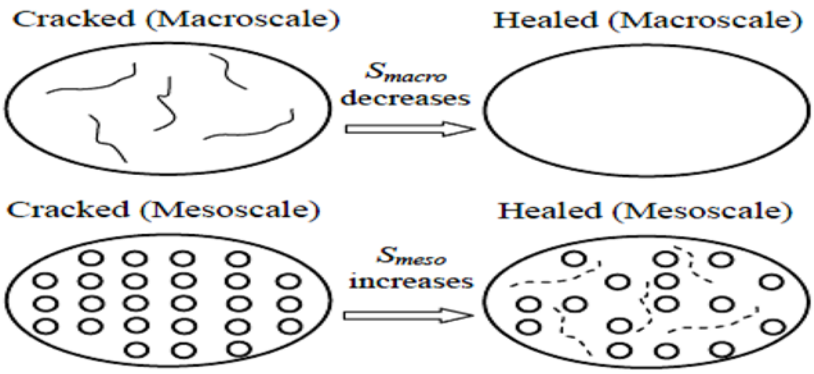


**Figure 11. Crack healing by embedded capsules at the micro and mesoscales (reproduced from Nosonovsky et al. [115]).**

Nosonovsky et al. [115] propose that the net entropy of the entire system comprises of the entropies associated with structures and processes at different scale levels:

$$S_{net} = S_{macro} + S_{meso} + S_{nano} \quad (21)$$

where net, macro, meso and nano indicate the net entropy, macroscale, mesoscale and nanoscales component of entropy, respectively (Nosonovsky and Esche, [116]). Therefore during self-organization, the entropy production at one scale level can be compensated at another level. This means that a decrease in entropy at one level is accompanied by an increase in entropy at another level, so that the net entropy grows in accordance to the second law of thermodynamics [116]. Nosonovsky et al. [115] also propose a simple model that provides a criterion for self-healing. Analogous to the degradation parameter (w in Equation 19) introduced by Bryant et al. [103], Nosonovsky et al. [115] define a healing parameter ζ that characterizes the healing or decrease in degradation. A criterion for self-healing is proposed to account for self-healing that occurs when the rate of healing is higher than the rate of degradation. A system of simplified equations is given in their work to assess the rate of self-healing in a system; however, quantitative comparisons for experimental verification await further research.

Nosonovsky and Bhushan [117] study the entropy associated with multiscale features of degradation and self-organization processes in detail. They analyze the thermodynamics of biological objects with abilities of adoption and self-healing from the view point of entropy production. Very interesting CONCLUSIONs can be drawn from the analysis of the work of Nosonovsky and Bhushan [117] in which they account variation of coefficient of friction and thermal conductivity during friction analysis. Similar analysis has been carried out before their work by Gershman and Bushe [38]. From the thermodynamic stability analysis, the second-order variation of entropy about the stationary value, $\delta_2 S$, can be expressed as:

$$\frac{1}{2}\frac{\partial}{\partial t}\left(\delta^2 S\right)=\sum_i \delta X_i\,\delta J_i \quad \ldots\ldots\ldots\ldots\ldots(22)$$

where $\delta X_i$ and $\delta J_i$, are the deviations of Xi and $J_i$ from their stationary values, respectively. Depending on the detailed form of the flows $J_i$ and forces $X_i$, the state of the system could be stable or unstable.Therefore, the right-hand side of Equation (22) could be negative or positive (Coveney [118]). For a thermodynamically stable system, the right-hand side of Equation (22) should be non-negative. In what follows, it is shown how dependence of coefficient of friction and thermal conductivity on load,N and velocity, u could either retain system in stable condition or drive the system away from equilibrium. Assume that friction is the only source of energy dissipation in a system. According to Equation(18) the entropy production can be expressed as:

$$d_i S_d / dt = XJ \qquad (23)$$

Considering $X = \nabla(1/T) = -\nabla T/T^2$ and $J = -k\nabla T = \mu N_u$, where μ and k are coefficient of friction and thermal conductivity, a phenomenological coefficient, L, can be defined as:

$$L=J/X=-k\nabla T - \nabla T/T^2 = kT^2 \qquad (24)$$

Assume that the coefficient of friction and thermal conductivity change during friction due to the change of a variable, like λ. In present analysis, λ can be sliding velocity, u, normal load, N, or temperature T. Using Equation (24) and assuming that thermodynamic flow, J, and force, X, depend on the variable λ, Equation (22) can be written as:

$$\delta X \delta J = \left(\frac{\partial X}{\partial \lambda}\delta\lambda\right)\left(\frac{\partial J}{\partial \lambda}\delta\lambda\right) = \left[\frac{1}{L}\left(\frac{\partial J}{\partial \lambda}\right)^2 - \frac{J}{L^2}\left(\frac{\partial J}{\partial \lambda}\right)\left(\frac{\partial L}{\partial \lambda}\right)\right](\delta\lambda)^2 \quad \ldots\ldots\ldots(25)$$

First, we consider the case in which the coefficient of friction and thermal conductivity depend on the sliding velocity, u. Equation (25) is, then, expressed as:

$$\delta X \delta J = \frac{N^2}{kT^2}\left(\frac{\partial \mu}{\partial u}u + \mu\right)\left(\frac{\partial \mu}{\partial u}u + \mu - \frac{\mu u}{k}\frac{\partial k}{\partial u}\right)(\delta u)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (26)$$

Self-organization occurs if the system loses its stability, i.e., the right-hand side of Equation (26) becomes negative. One possible way is that the sign of the product □ becomes positive.

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This means, the tribosystem is likely to enter the self-organization regime if the coefficient of friction and thermal conductivity simultaneously increase or decrease with velocity. Similar CONCLUSION can be drawn if the coefficient of friction and thermal conductivity depend on normal load or temperature.

Equation (25) results in Equations (27) and (28) if the effect of load and temperature are considered, respectively:

$$\delta X \delta J = \frac{u^2}{kT^2}\left(\frac{\partial \mu}{\partial N}N + \mu\right)\left(\frac{\partial \mu}{\partial N}N + \mu - \frac{\mu N}{k}\frac{\partial k}{\partial N}\right)(\delta N)^2 \quad \text{……………………(27)}$$

$$\delta X \delta J = \left[\frac{N^2u^2}{kT^2}\left(\frac{\partial \mu}{\partial T}\right)^2 - \frac{\mu N^2 u^2}{k^2T^4}\left(\frac{\partial k}{\partial T}T^2 + 2kT\right)\left(\frac{\partial \mu}{\partial T}\right)\right](\delta T)^2 \quad \text{…………(28)}$$

From Equation (27), it can be concluded that the system loses its stability if the sign of the product ∂μ/∂N∂k/∂N becomes positive. Similarly, Equation (28) implies the system is likely to lose it stability if the sign of the product ∂μ/∂N∂k/∂N becomes positive. Therefore, if the system loses its stability from equilibrium state, there is a possibility that self-organization occurs and consequently friction and wear decrease. It is to be noted that the process of self-organizations during friction occurs if beside friction, one or more independent processes affect the system. As discussed above, variation of thermal conductivity during friction is an additional excitation to the system which tries to derive system away from equilibrium. Existence of more independent processes during friction enhances the non-equilibrium processes and increases the probability of self-organization. Another interesting example is given by Greshman and Bushe [110] who theoretically investigate the lubricating effect of electric current on the friction process. This particular analysis, which is based on the non-equilibrium thermodynamics, is verified by experimental results. In the sliding of current collection materials, the entropy production in Equation (18) is comprised of two terms:

$d_i/d_t = [X_1/J_1+X_2/J_2]$………………………… (29)

The first term accounts for entropy production due to frictional heating, $X1= -\nabla T/T^2$and $J1 = -k\nabla T = \mu Nu$,, and the second term for current collection entropy production, $X_2 = X_e/T$and $J_2=J_e.X_e$, $X_e$ and $J_e$ are voltage and electrical current, respectively. Therefore, the entropy production can be written as:

$$\frac{d_iS}{dt} = \frac{(\mu N u)^2}{kT^2} + \frac{X_eJ_e}{T} \quad \text{……………(30)}$$

Gershman and Bushe [110] postulate that during stationary conditions, the mathematical condition of minimum coefficient of friction, μ, depending on electrical current, $J_e$is:

$$\left(\frac{d}{dJ_e}\right)\frac{d_iS}{dt} = \frac{2\mu(Nu)^2}{kT^2}\left(\frac{d\mu}{dJ_e}\right) + \frac{X_e}{T} = 0 \quad \text{…………………(31)}$$

Integration of Equation (31) leads to:

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$$\mu = \sqrt{\mu_o^2 - \frac{X_e J_e T k}{(Nu)^2}}$$ ………………………………………….(32)

where $\mu_o$ is the coefficient of friction without electrical current. Equation (32) suggests that with application of electrical current, $J_e$, in frictional contact the coefficient of friction decreases. Also, the higher the voltage, Xe, the lower is the coefficient of friction. It is to be noted that in derivation of Equation (32), the entropy production, i dtSd , is first differentiated with respect to $J_e$ and set to zero, then the coefficient of friction, μ, is integrated over $J_e$. Abdel-Aal [52–54,119,120], has done an extensive investigation on the effect of thermal properties, particularly thermal conductivity, on the wear resistance of the surfaces during friction process. He defines a region on the frictional contacting surface, a so-called mechanically affected zone (MAZ) which transfers heat from high temperature asperity layers to low temperature sub-layers and postulates that wear is significantly influenced by the ability of MAZ to remove frictional heat away from the surface. The efficiency of MAZ depends on the themo-mechanical loading during the friction process. Abdel-Aal shows that the thermal conductivity of MAZ is influenced by the local distribution of strain rate, defined by an effective thermal conductivity $K^*$ , as follows:

$$K^* = K_\circ (1 + \beta T) - \frac{3\dot{\varepsilon} K_b K_\varepsilon}{\nabla^2 T}$$ ……………………(33)

where $K_o$is the thermal conductivity at REFERENCE temperature (e.g., ambient temperature), β is the temperature coefficient of conductivity, is the strain rate, Kb and Kε are bulk modulus and coefficient of thermal expansion, respectively [52–54]. Abdel-Aal concludes that the variation in strain rate can cause anisotropy in thermal conduction, which in turn, may lead to blockage of heat flow in MAZ. The accumulated energy within MAZ may result in formation of protective layer, i.e., dissipate structure. Therefore, Abdel-Aal [54] postulates that formation of dissipate structures is the inherent response of the tribosystem to the external stimulus. Kozyrev and Sedakova [121] perform a theoretical and experimental analysis within a non-equilibrium thermodynamic framework to derive a dependence of wear rate on the load in stationary state. They demonstrate that the linear increase in wear rate with an increased load may be interrupted as a result of reduction in wear rate. They observe a nonlinear behavior of wear W as a function of pressure p. That is, in a particular range of load, wear can decrease by increasing the pressure. This phenomenon is explained by tribological reactions that results in formation of wear resistant oxide layers. Kozyrev and Sedakova take into account the effect of another independent process which is the diffusion of material into tribo-film, beside the friction process. The diffusion process can be considered as an external element that lead to self-organization and wear reduction. Considering two dissipative processes, friction with forces and flows as $X_1 = -\nabla T/T^2$ and $J_1 = -k/\nabla T = \mu Nu$ and diffusion, with $X_2 = -\nabla\varphi/T$ and $J_2 = -\gamma D\nabla\varphi$,Equation (18) results in the following expression for entropy production:

$$\frac{d_i S}{dt} = \frac{(pu)^2 \mu^2 A^2}{kT^2} + \frac{\gamma_D (\nabla\varphi)^2}{T}$$ ……………………… (34)

where φ is the chemical potential, γD is the transport coefficient, p and A are pressure and nominal area of contact, p = N/A. Kozyrev and Sedakova assume that in non-equilibrium stationary state, the wear of the tribo-film is proportional to γD and the product of pu is a

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characteristic of friction. Therefore, during stationary conditions, the analysis is performed for the conditions of minimum γD depending on pu. Hence, the mathematical condition for that is:

$$\left(\frac{d}{d(pu)}\right)_T \frac{d_i S}{dt} = \frac{2(pu)\mu^2 A^2}{kT^2} + \frac{d\gamma_D}{d(pu)}\frac{(\nabla\varphi)^2}{T} \qquad \text{.................... (35)}$$

Setting (35) to zero and integrating, we obtain:

$$\gamma_D = \gamma_{D0} - \frac{(pu)^2 \mu^2 A^2}{kT(\nabla\varphi)^2} \qquad \text{...................................(36)}$$

where γD0 is the integration constant. Equation (36) indicates that under stationary conditions, as pu increases, γD decreases. It is to be mentioned that γD was assumed to be proportional to wear W. Therefore, under the stationary non-equilibrium conditions, Equation (36) offers a procedure for decreasing wear with increase in pu. Figure 12 shows the experimental wear results of the work of Kozyrev and Sedakova [121] for two different materials. Experimental wear tests pertain to a ring-plane configuration for two sets of contacting materials: F4K15M5 on 35KhM Steel and Sigma-3 on 35KhM Steel. Figure 12 shows that in some range of pu, the wear W does not grow with pu but even decreases. The length of this zone depends on material properties.

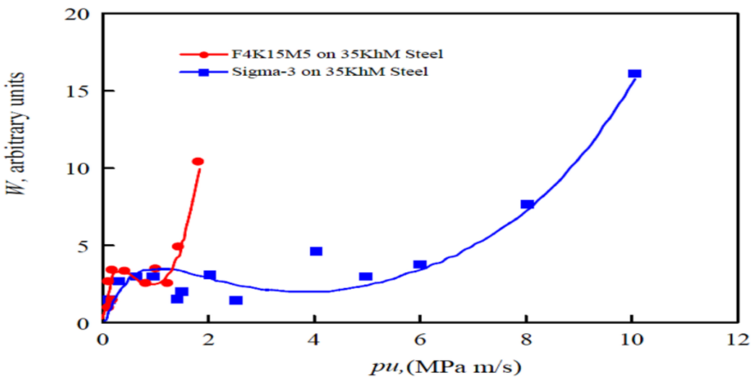


**Figure 12. Wear as a function of pu for two different materials (reproduced from Kozyrev and Sedakova, [121]).**

During the past decade, other researchers have successfully applied the concept of self-organization to characterize the behavior of tribosystem during friction process. Contributions include: Bershadsky [122], Kostetsky [123], Fox-Rabinovich et al. [124–126], Wilson and Alpas [127], Usychenko [128], Figueiredo et al. [129] and Kovalev et al. [130]. Recently, Fox-Rabinovich et al. [131] perform a theoretical study based on the irreversible thermodynamic concept to investigate the probability of the occurrence of the self-organization processes under complex conditions. The complex condition is defined as the severe operating condition (e.g., aggressive cutting conditions) along with a number of simultaneously processes that occur during friction. It is postulated that by increasing the number of interrelated processes during friction, probability of initiation of the self-organization increases. As stated earlier in this section, self-organization can only occur if the system losses its thermodynamic stability. Fox-Rabinovich et al. [131] postulate that the probability of losing stability can be calculated as follows:

Probability of losing stability = 1 – (1/2n) (37) where n is the number of interrelated processes. Equation (37) suggests that by increasing the number of simultaneous processes (i.e., increasing the complexity of the system), the possibility for self-organization increases (Fox-Rabinovich et al. [131]). As a result of self-organization, the wear rate decreases. Experiments are carried out by Fox-Rabinovich et al. [131] to verify the theory. Experiments pertain to dry high-speed end milling of tool steel on a complex nano-multilayered coating. The results of wear tests of multilayered coating are then compared to that of monolayered coating. The complex multilayered coating is able to last longer in comparison to the monolayered coating and this effect is related to the ability of the multilayered coating to form tribo-films during friction process.

In summary, the present work reviews the major applications of thermodynamics in the field of tribology, with particular interest in the energetic/entropic approach. The temperature rise due to the frictional heating at the interface of contacting bodies is an important parameter in machinery and components where the friction is a concern. Therefore, the subject has captured the attention of numerous scientific papers. However, practical applications of the entropic/thermodynamic approach in the field of tribology have not yet become widespread. We believe that the application of irreversible thermodynamics and specifically entropy generation provides new scientific research opportunities for engineering designs and developments of new materials with improved tribological performance. Further, the in-depth studies of the formation of dissipative structures in tribo-films can result in the development of materials that offer substantially improved resistance to wear. Future developments in surface engineering toward inventing wear resistant materials, should also take advantage of grand knowledge of self-organization within the non-equilibrium thermodynamic framework. It is believed that the concept of stability analysis provides a key, enabling factor for proper characterization of tribo-films. Tribo-films can form only if system losses its stability. That is, by changing the external stimulus—like load and velocity—one can increase the probability of formation tribo-films, thereby decreasing the wear rate. These concepts offer new and exciting research in the field of tribology for years to come.

## REFERENCES

[1] Stachowiak, G.W.; Batchelor, A.W. Engineering Tribology. Tribology Series, 24; Elsevier Science: Amesterdam, Netherlands, 1993.

[2] Cattaneo, C. Sul Contatto di Due Corpi Elasti: Distribuzione Locale degli Sforzi. Accademia Nazionale dei Lincei, Rendiconti 1938, 27, 342–348.

[3] Mindlin, R.D. Compliance of elastic bodies in contact. J. Appl. Mech. 1947, 71, 259–268.

[4] Mindlin, R.D.; Mason, W.P.; Osmer, T.F.; Deresiewicz, H. Effects of an oscillating force on the contact surfaces of elastic spheres. In the Proceedings of the 1st US Nat. Congr. Appl. Mech.1951,

[5] Mindlin, R.D.; Deresiewicz, H. Elastic spheres in contact under varying oblique forces. ASME J. Appl. Mech. 1953, 20, 327–344.

[6] Deresiewicz, H. Bodies in contact with applications to granular media. In R. D. Mindlin and Applied Mechanics; Herrmann, G., Ed.; Pergamon: Oxford, UK, 1974.

[7] Johnson, K.L. Surface interaction between elastically loaded bodies under tangential forces. Proc. R. Soc. A 1955, 230, 531–548.

[8] Johnson, K.L. Energy dissipation at spherical surfaces in contact transmitting oscillating forces. J. Mech. Eng. Sci. 1961, 3, 362–368.

[9] Goodman, L.E.; Bowie, G.E. Experiments on damping at contact of a sphere with flat planes. J. Exp. Mech. 1961, 1, 48–54.

[10] Goodman, L.E.; Brown, C.B. Energy dissipation in contact friction: constant normal and cyclic tangential loading. J. Appl. Mech. 1962, 29, 17–22.

[11] Earles, S.W.E. Theoretical estimation of the frictional energy dissipation in a simple lap joint. J. Mech. Eng. Sci. 1966, 8, 207–214.

[12] Earles, S.W.E.; Philpot, M.G. Energy dissipation at plane surface in contact. J. Mech. Eng. Sci. 1967, 9, 86–97.

[13] Brown, C.B. Factors affecting the damping in a lap joint. In Proceedings of the American Society of Civil Engineers. J. Struct. Div. 1968, 94, 1197–1217.

[14] Boothroyd, G.; Poli, C.; Migliozzi, L.P. Damping in a preloaded metallic interface. S.M.E. Technical paper 1972, MR72–229.

[15] Rogers, P.F.; Boothroyd, G. Damping at metallic interfaces subjected to oscillating tangential loads. J. Eng. Ind. 1975, 197, 1087–1093.

[16] Wilson, W.R.D.; Aggarwal, B.B.; Russel, R.A. Frictional damping at preloaded metallic interfaces under tangential loading. In the Proceedings of the 7th Leads-Lyons Symp. I Mech. E.: London, UK, 1981.

[17] Hanson, M.T.; Keer, L.M.; Farris, T.N. Energy Dissipation in Non-Hertzian Fretting Contact. STLE Tribol. Trans. 1989, 32, 147–154.

[18] Fouvry, S.; Kapsa, Ph.; Zahouani, H.; Vincent, L. Wear analysis in fretting of hard coatings through a dissipated energy concept. Wear 1997, 203–204, 393–403.

[19] Fouvry, S.; Kapsa, Ph. An energy description of hard coatings wear mechanisms. Surf. Coating Tech. 2001, 138, 141–148.

[20] Fouvry, S.; Liskiewicz, T.; Kapsa, Ph.; Hannel, S.; Sauger, E. An energy description of wear mechanisms and its applications to oscillating sliding contacts. Wear 2003, 255, 287–298.

[21] Fouvry, S.; Duo, P.; Perruchaut, P. A quantitative approach of Ti–6Al–4V fretting damage: friction, wear and crack nucleation. Wear 2004, 257, 916–29.

[22] Fouvry, S.; Paulin, C.; Liskiewicz, T. Application of an energy wear approach to quantify fretting contact durability: INTRODUCTION of a wear energy capacity concept. Tribol. Int. 2007, 40, 1428–1440.

[23] Paulin, C.; Fouvry, S.; Deyber, S. Wear kinetics of a Ti 6Al–4V alloy under constant and variable fretting sliding conditions. Wear 2005, 259, 292–299.

[24] Mary, C.; Fouvry, S. Numerical prediction of fretting contact durability using energy wear approach: Optimisation of finite-element model. Wear 2007, 263, 444–450. Entropy 2010, 12 1044.

[25] Zhang, X.; Lauwerence, W.; Stals, L.; He, J.; Celis, J-P. Fretting wear rate of sulphur deficient MoSx coatings based on dissipated energy. J. Mater. Res. 2001, 16, 3567–3574.

[26] Bureauy, L.; Caroli C.; Baumberger, T. Elasticity and onset of frictional dissipation at a non-sliding multi-contact interface. Proc. R. Soc. A 2003, 459, 2787–2805.

[27] Attia, H.; Gessesse, Y.B.; Osman, M.O.M. Experimental investigation. Wear 2007, 263, 419–429.

[28] Magaziner, R.S.; Jain, V.K.; Mall, S. Wear characterization of Ti–6Al–4V under fretting–reciprocating sliding conditions. Wear 2008, 264, 1002–1014.

[29] Dini, D.; Hills, D.A. Frictional energy dissipation in a rough hertzian contact. J. Tribol. 2009, 131, 021401.

[30] Korsunsky, A.M.; Kim, K. Dissipated energy and friction coefficient evolution during fretting wear of solid lubricant coatings. Tribol. Int. 2010, 43, 861–867.

[31] Rymuza, C. Energy concept of the coefficient of friction. Wear 1996, 199, 187–196.

[32] Chen, Q.; Li, D.Y. A computational study of frictional heating and energy conversion during sliding processes. Wear 2005, 259, 1382–1391.

[33] Li, D.Y.; Elalem, K.; Anderson, M.J.; Chiovelli, S. A micro-scale dynamical model for wear simulation, Wear 1999, 225, 380–386.

[34] Elalem, K.; Li, D.Y.; Anderson M.J.; Chiovelli, S. Modeling abrasive wear of homogeneous and heterogeneous materials. ASTM STP 1339, 2001, 90–104.

[35] Chen, Q.; Li, D.Y. Computer simulation of a composite material by solid-particle erosion. Wear 2003, 255, 78–84.

[36] Chen, Q.; Li, D.Y. Investigation on the mechanisms of corrosive wear process of alloy with a micro-scale dynamic model, Mater. Sci. Eng. A 2004, 369, 284–293.

[37] Neder, Z.; Varadi, K.; Man, L. Numerical and finite element contact temperature analysis of steel bronze real surfaces in dry sliding contact. Tribol. Trans. 1999, 42, 453–462.

[38] Gershman, I.S.; Bushe, N.A. Advanced surface-engineered materials and systems design; Fox-Rabinovich, G.S., Totten, G.E., Eds.; CRC Taylor & Francis: Boca Raton, FL, USA, 2006.

[39] Uetz, H.; Fohl, J. Wear as an energy traasformation process. Wear 1978, 49, 253–264.

[40] Huq, M.Z.; Celis, J.–P. Reproducibility of friction and wear results in ball-on-disc unidirectional sliding tests of TiN-alumina pairings. Wear 1997, 212, 151–159.

[41] Huq, M.Z.; Celis, J.–P. Fretting wear of multilayered (Ti,Al)N/TiN coatings in air of different relative humidity. Wear 1999, 225–229, 53–64.

ISBN: 978-81-961781-9-2

[42] Huq, M.Z.; Celis, J.–P. Expressing wear rate in sliding contacts based on dissipated energy. Wear 2002, 252, 375–383.
[43] Ramalho, A.; Miranda, J.C. The relationship between wear and dissipated energy in sliding systems. Wear 2006, 260, 361–367.
[44] Archard, J.F. Contact and rubbing of flat surfaces. J. Appl. Phys. 1953, 24, 981–988.
[45] Savkoor, A.R.; Ouwerkerk, H. Tribological transitions due to heat dissipation during braking on contaminated rails. Wear 1995, 181–183, 391–396. Entropy 2010, 12 1045
[46] Gupta, V.; Hahn, G.T.; Bastias, P.C.; Rubin, C.A. Calculations of the frictional heating of a locomotive wheel attending rolling plus sliding. Wear 1996, 191, 237–241.
[47] Kuhn, E.; Balan, C. Experimental procedure for the evaluation of the friction energy of lubricating greases. Wear 1997, 209, 237–240.
[48] Scherge, M.; Shakhvorostov, D.; Pöhlmann, K. Fundamental wear mechanism of metals. Wear 2003, 255, 395–400.
[49] Shakhvorostov, D.; Pöhlmann, K.; Scherge, M. An energetic approach to friction, wear and temperature. Wear 2004, 257, 124–130.
[50] Larbi, A.B.C.; Cherif, A.; Tarres, M.A. Improvement of the adhesive wear resistance of steel by nitriding quantified by the energy dissipated in friction. Wear 2005, 258, 712–718.
[51] Li, W.; Wang, Y.; Yan, M.F. Wear rate, frictional temperature, and energy consumption of steel 52100 with different microstructures during sliding. J. Mater. Sci. 2005, 40, 5635–5640.
[52] Abdel-Aal, H.A. On the interdependence between kinetics of friction-released thermal energy and the transition in wear mechanisms during sliding of metallic pairs. Wear 2003, 254, 884–900.
[53] Abdel-Aal, H.A. Efficiency of thermal energy dissipation in dry rubbing. Wear 2003, 255, 348–364.
[54] Abdel-Aal, H.A. On the role of intrinsic material response in failure of tribo systems. Wear 2005, 259, 1372–1381.
[55] Maeda, K.; Bismarck, A.; Briscoe, B. Effect of bulk deformation on rubber adhesion. Wear 2007, 263, 1016–1022.
[56] Colaco, R.; Gispert, M.P.; Serrob, A.P.; Saramago. B. An energy-based model for the wear of UHMWPE. Tribol. Lett. 2007, 26, 119–124.
[57] Nurnberg, K.E.; Nurnberg, G.; Golle, M.; Hoffmann, H. Simulation of wear on sheet metal forming tools—An energy approach. Wear 2008, 265, 1801–1807.
[58] Alyabev, Y.A.; Kazimirchik, Yu.A.; Onoprienko, V.P. Determination of temperature in the zone of fretting corrosion. J. Mater. Sci. 1973, 6, 284–286.
[59] Ling, F.F. Surface Mechanics; Wiley: New York, NY, USA, 1973.
[60] Kennedy, F.E. Surface temperatures in sliding systems-a finite element analysis. J. Lubr. Tech. 1981, 103, 90–96.
[61] Kennedy, F.E. Thermal and thermomechanical effects in dry sliding. Wear 1984, 100, 453–476.
[62] Greenwood, J.A.; Alliston-Greiner, A.F. Surface temperature in a fretting contact. Wear 1992, 155, 269–275.
[63] Knothe, K.; Liebelt, S. Determination of temperatures for sliding contact with applications for wheel-rail systems. Wear 1995, 189, 91–99.
[64] Lim, S.C.; Ashby, M.F. Wear mechanism maps. Acta Metall. 1987, 35, 1–24.
[65] Welsh, N.C. Frictional heating and its influence on the wear of steel. J. Appl. Phys. 1957, 28, 960–968.
[66] Blau, P.J. Friction and Wear Transitions of Materials: Break-In, Run-In, Wear-In; Noyes Publications: Park Ridge, NJ, USA, 1989.
[67] Quinn, T.F.J. Oxidational wear modeling: I. Wear 1992, 135, 179–200.
[68] Archard, J.F. The temperature of rubbing surfaces. Wear 1969, 2, 438–455. Entropy 2010, 12 1046.
[69] Blok, H. Theoretical study of temperature rise at surfaces of actual contact under oiliness lubricating conditions. In Proceedings of the General Discussion on Lubrication and Lubricants; Institute of Mechanical Engineers: London, UK, 1937; Volume 2, pp. 222–235.
[70] Blok, H. The flash temperature concept. Wear 1963, 6, 483–494.
[71] Jaeger, J.C. Moving sources of heat and the temperature at sliding contacts. Proc. R. Soc. N.S.W. 1942, 76, 203–224.
[72] Czichos, H. Tribology–A Systems Approach to the Science and Technology of Friction, Lubrication and Wear; Elsevier: Amsterdam, The Netherlands, 1978.
[73] Wang, Y.; Lei, T.; Yan, M.; Gao, C. Frictional temperature field and its relationship to the transition of wear mechanisms of steel 52100. J. Phys. D: Appl. Phys. 1992, 25, A165–A169.

ISBN: 978-81-961781-9-2

[74] Tian, X.; Kennedy, F.E.; Deacutis, J.J.; Henning, A.K. The development and use of thin film thermocouples for contact temperature measurement. Tribol. Trans. 1992, 35, 491–499.
[75] Tian, X.; Kennedy, F.E. Contact surface temperature models for finite bodies in dry and boundary lubricated sliding. J. Tribol. 1993, 115, 411–418.
[76] Szolwinski, M.P.; Harish, G.; Farris, T.N.; Sakagami, T. In-situ measurement of near-surface fretting contact temperatures in an aluminum alloy. J. Tribol. 1999, 121, 11–19.
[77] Tian, X.; Kennedy, F.E. Maximum and average flash temperatures in sliding contacts. J. Tribol. 1994, 116, 167–174.
[78] Amiri, M.; Khonsari, M.M.; Brahmeshwarkar, S. Tribol. Lett. 2010, accepted for publication.
[79] Ozisik, M.N. Boundary Value Problems of Heat Conduction; Dover Publication Inc.: New York, NY, USA, 2002.
[80] Rothbart, H.A. Mechanical Design Handbook; McGraw-Hill: New York, NY, USA, 1996.
[81] Rabinowicz, E. Wear Control Handbook; American Society of Mechanical Engineers: New York, NY, USA, 1980.
[82] Kalin, M.; Vizintin, J. Comparison different theoretical models for flash temperature calculation
[83] under fretting conditions. Tribol. Int. 2001, 34, 831–839.
[84] Dwivedi, D.K. Sliding temperature and wear behavior of cast Al-Si base alloy. Mater. Sci. Tech. 2003, 19, 1091–1096.
[85] Dwivedi, D.K. Sliding temperature and wear behavior of cast Al-Si-Mg alloys. Mater. Sci. Eng. A 2004, 382, 328–334.
[86] Mansouri, M.; Khonsari, M.M. Surface temperature in oscillating sliding interfaces. ASME J. Tribol. 2005, 127, 1–9.
[87] Wen, J.; Khonsari, M.M. Transient temperature involving oscillatory heat source with application in fretting contact. J. Tribol. 2007, 129, 517–527.
[88] Bansal, D.G.; Streator, J.L. A method for obtaining the temperature distribution at the interface of sliding bodies. Wear 2009, 266, 721–732.
[89] Ling, F.F.; Bryant, M.D.; Doelling, K.L. On irreversible thermodynamics for wear prediction. Wear 2002, 253, 1165–1172.
[90] Klamecki, B.E. Wear—An entropy production model. Wear 1980, 58, 325–330.
[91] Klamecki, B.E. A thermodynamic model of friction. Wear 1980, 63, 113–120. Entropy 2010, 2 1047.
[92] Klamecki, B.E. Energy dissipation in sliding. Wear 1982, 77, 115–128.
[93] Klamecki, B.E. Wear—An entropy based model of plastic deformation energy dissipation in sliding. Wear 1984, 96, 319–329.
[94] Rigney, D.A.; Hirth, J.P. Plastic deformation and sliding friction metals. Wear 1979, 53, 345–370.
[95] Heilmann, P.; Rigney, D.A. An energy-based model of friction and its application to coated systems. Wear 1981, 72, 195–217.
[96] Abdel-Aal, H.A. Wear and irreversible entropy generation in dry sliding. The annals university “Dunarea De Jos” of galati fascicle VIII, 2006 (XII), ISSN 1221-4590 Tribology.
[97] Zmitrowicz, A. A thermodynamical model of contact, friction and wear: I Governing equations. Wear 1987, 114, 135–168.
[98] Zmitrowicz, A. A thermodynamical model of contact, friction and wear: II Constitutive equations for materials and linearized theories. Wear 1987, 114, 169–197.
[99] Zmitrowicz, A. A thermodynamical model of contact, friction and wear: III Constitutive equations for friction, wear and frictional heat. Wear 1987, 114, 199–221.
[100] Godet, M. The third body approach: a mechanical view of wear. Wear 1984, 100, 437–452.
[101] Zmitrowicz, A. Wear patterns and laws of wear-a review. J. Theor. Appl. Mech. 2006, 44, 219–253.
[102] Dai, Z.; Yang, S.; Xue, Q. Thermodynamic model of fretting wear. J. Nanjing Univ. Aeronaut. Astronaut. 2000, 32, 125–131.
[103] Doelling, K.L.; Ling, F.F.; Bryant, M.D.; Heilman, B.P. J. Appl. Phys. 2000, 88, 2999–3003.
[104] Bryant, M.D.; Khonsari, M.M.; Ling, F.F. On the thermodynamics of degradation. Proc. R. Soc. A 2008, 464, 2001–2014.
[105] Bryant, M.D. Entropy and dissipative processes of friction and wear. FME Trans. 2009, 37, 55–60.
[106] Brahmeshwarkar, S. A thermodynamic model for wear in sliding contact. M.S. Thesis; Department of Mechanical Engineering, Louisiana State University: Baton Rouge, LA, USA, 2006.
[107] Prigogine, I. Etude Thermodynamique des Processus Irreversible, 4th ed.; Desoer: Liege, Belgium, 1967.
[108] Kondepudi, D.; Prigogine, I. John Wiley & Sons, Inc.: New York, NY, USA, 1998.

ISBN: 978-81-961781-9-2

[109] Bryant, M.D. Unification of friction and wear. In Recent Developments in Wear Prevention, Friction and Lubrication; Nikas, G., Ed.; Old City Publishing: Philadelphia, PA, USA, 2010; pp. 159–196.

[110] Dai, Z.; Xue, Q. Progress and development in thermodynamic theory of friction and wear. Sci. China Ser E-Tech. Sci. 2009, 52, 844–849.

[111] Gershman, I.S.; Bushe, N.A. Thin films and self-organization during friction under the current collection conditions. Surf. Coating Tech. 2004, 186, 405–411.

[112] Glansdorff, P.; Prigogine, I. Thermodynamic Theory of Structure, Stability and Fluctuations; Wiley-Interscience: New York, NY, USA, 1971. Entropy 2010, 12 1048

[113] Glansdorff, P. Irreversibility in macroscopic physics: from carnot cycle to dissipative structures. Foundations Phys. 1987, 17, 653–666.

[114] Prigogine, I. INTRODUCTION to Thermodynamics of Irreversible Processes; Charles C. Thomas: Springfield, IL, USA, 1955.

[115] Garbar, I.I.; Skorinin, J.V. Metal surface layer structure formation under sliding friction. Wear 1978, 51, 327–336.

[116] Nosonovsky, M.; Amano, R.; Lucci, J.M.; Rohatgi, P.K. Physical chemistry of self-organization and self-healing in metals. PCCP. Physical chem. chemical phys. 2009, 11, 9530–9536.

[117] Nosonovsky, M.; Esche, S.K. A paradox of decreasing entropy in multiscale monte carlo grain growth simulation. Entropy 2008, 10, 49–54.

[118] Nosonovsky, M.; Bhushan, B. Philos. Trans. R. Soc. A 2009, 367, 1607–1627.

[119] Coveney, P.V. The second law of thermodynamics: entropy, irreversibility and dynamics. Nature 1988, 333, 409–415.

[120] Abdel-Aal, H.A. The correlation between thermal property variation and high temperature wear transition of rubbing metals. Wear 2000, 237, 147–151

[121] Abdel-Aal, H.A.; Nouari, M.; El Mansori, M. the effect of thermal property degradation on wear of WC-CO inserts in dry cutting. Wear 2008, 265, 1670–1679.

[122] Kozyrev, Y.P.; Sedakova, E.B. Application of a thermodynamic model for analysis of wear resistance of materials. J. Machinery Manuf. Reliab. 2008, 37, 60–62.

[123] Bershadsky, L.I. On self-organizing and concept of tribosystem self-organizing. J. Frict. Wear 1992, 13, 101–114.

[124] Kostetsky, B.I. Evolution of structural and phase state and mechanism of self-organization in materials at external friction. J. Frict. Wear 1993, 14, 120–129.

[125] Fox-Rabinovich, G.S.; Kovalev, A.I.; Shuster, L.S.; Bokiy, Y.F.; Dosbayeva, G.K.; WainsteIn, D.L.; Mishina, V.P. Characteristic features or wear in HSS-based deformed compound powder materials at cutting. Wear 1997, 206, 214–220.

[126] Fox-Rabinovich, G.S.; Kovalev, A.I.; Shuster, L.S.; Bokiy, Y.F.; Dosbayeva, G.K.; WainsteIn, D.L.; Mishina, V.P. Characteristic features of alloying HSS-based deformed compound powder material with consideration for tool self-organization at cutting 2. Cutting tool friction control due to the alloying of the HSS-based deformed compound powder material. Wear 1998, 214, 279–286.

[127] Fox-Rabinovich, G.S.; Veldhuis, S.C.; Kovalev, A.I.; WainsteIn, D.L.; Gershman, I.S.; Korshunov, S.; Shuster, L.S.; Endrino, J.L. J. Appl. Phys. 2007, 102, 074305.

[128] Wilson, S.; Alpas, A.T. Tribo-layer formation during sliding wear of TiN coatings. Wear 2000, 245, 223–229.

[129] Usychenko, V.G. Entropy, information, and complexity of the steady states of open systems not satisfying the principle of local equilibrium. Technical Phys. 2005, 50, 551–559. Entropy 2010, 12 1049.

[130] Figueiredo, M.R.D.; Neidhardt, J.; Kaindl, R.; Reiter, A.; Tessadri, R.; Mitterer, C. Formation mechanisms of low-friction tribo-layers on arc-evaporated TiC1−xNx hard coatings. Wear 2008, 265, 525–532.

[131] Kovalev, A.; Wainstein, D.; Fox-Rabinovich, G.; Veldhuis, S.; Yamamoto, K. Features of self-organization in nanostructuring PVD coatings on a base of polyvalent metal nitrides under severe tribological conditions. Surf. Interface Anal. 2008, 40, 881–884.

[132] Fox-Rabinovich, G.S.; Gershman, I.S.; Yamamoto, K.; Biksa, A.; Veldhuis, S.C.; Beake, B.D.; Kovalev, A.I. Self-organization during friction in complex surface engineered tribosystems.

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# Chapter: 57

# Application of Artificial Intelligence Principles in Mechanical Engineering

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**ABSTRACT**

The article deals with methods of Artificial Intelligence and their utilisation in technical diagnostics. A special meaning will be given to methods such as Deep learning. The deep learning method seems to be a very good candidate for defect detection and pattern recognition. The process was applied for technical diagnostics in the automotive factory and the problem will be described in the paper.

**KEYWORDS:** Artificial Intelligence, Deep convolutional neural network, Vision system, Machine learning.

## INTRODUCTION

Primary Innovation is today one of the key benchmarks of successful companies. Conventional approaches and methods applied in the production environment are gradually becoming non-sufficient due to the increasing competitive pressure. For this reason, it is necessary to apply innovative methods and approaches to addressing the entire spectrum of tasks in the production environment. At the same time, market demand for increased flexibility in the behaviour of production companies towards the customer requires the very close interconnection of individual levels of company management, and the required increase in profitability for companies providing goods or services requires the most accurate knowledge of customer requirements. [1] The aforementioned conditions and requirements for companies have recently been addressed through the penetration of IT technologies and automation into the existing conventional technologies and practices of producing companies. At the end of the 20th century and in the first decade of the 21st century, we saw a significant increase in the use of the above-mentioned approaches in the production environment, which gradually eliminated the differences between the industry leaders, with these tools even the small companies gradually eliminated the competitive advantage of big actors by the gradual partial INTRODUCTION of these technologies of by gradual substitution of conventional methods with more progressive ones. [2,3] Natural development is the improvement of established technologies and methods. In addition to implementing optimizations at different levels, improvements can be made by introducing innovations into individual tasks or complex task groups. An innovative idea linking conventional automation and IT technology is the INTRODUCTION of a higher degree of automation. [4] With a higher degree of automation, we understand automation that is not only applied to automate routine work but which has the decision-making ability at a defined level. [5] In this area, the highest degree of automation could be achieved by applying artificial intelligence to the production environment. In our context, we can understand the Artificial Intelligence application as follows: Applied Artificial Intelligence in a production environment is a program (or part of it) that can solve a task without introducing rules for the solution it into the program. [6,7] When applying artificial intelligence in its entirety, we would achieve self-acting and self-governing units in the production environment. When achieving an absolute degree of automation through devices with a high degree of artificial intelligence, we could achieve a self-organized production company that would be in full control of the inputs necessary for production, the production itself as well as quality control and expedition. [8,9] In the real world, achieving this goal is just utopian at the moment. [4] Our task is to ensure innovation through the partial application of artificial intelligence techniques and the achievement of a degree that we can characterize as Advanced Intelligence. Within the framework of cooperation with the industry, a research task was proposed to fully automate the process of quality control of produced tires by the manufacturer. At present, this task is performed by an operator who has an inspection stand consisting of a rotary mandrel, pneumatic drives, PLC controlling individual drives and lighting. The inspection (Fig. 1.) serves only as a device assisting the operator in handling the checked tire (securing it on the rotary thruster and rotating the tire in the selected direction). The entire evaluation process is in the full competence of the operator and is carried out solely on the basis of a quality assessment corresponding to the range of knowledge of the operator of the product. Our goal is to ensure complete automation of the control process. In the initial analysis of the task, we determined that for the elimination of an operator, it will be necessary to automate three different tasks: 1. handling of evaluated tire 2. automatic quality control process 3. automatic detection and removal of any residuals from the moulding and vulcanization process of the tire

**Figure 1Inspection stand used today**

1. Manipulation of the evaluated tire will be implemented by extending the inspection stand with a serial kinematic structure robot, supplemented by a corresponding effector optimized for tire manipulation. The robot will ensure that the tire is removed from the production line or from the in-service container, by placing it on a rotary mandrel, and after completing the quality control process, it will ensure that the tire is stored in the corresponding container.
2. An automated quality control process is described in detail in the next part of our article
3. Automatic detection and removal of any residuals from the moulding and vulcanization process of the tire will be accomplished by a single-purpose handling device with trimming capability. The coordination and synchronization of the tire and handling device will be coordinated on the basis of the analysis of the position, shape and size of unwanted residuals, this information will be obtained from the data obtained in the quality control process.

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**Classification method:** An automatic quality control process will be created on the principle of similarity with the way this process is currently carried out by an operator. Our task is to perform an analysis of the control process after the assignment of a research task and to transform it in order to completely replace the presence of an operator in this process. Based on the analysis, it was determined that the operator of the equipment provides a visual inspection of the tire during its rotation and, based on the experience and knowledge of the operator, the tested tire is evaluated. [10,11] Our proposal for transforming this process consists of designing and assembling a camera system with appropriate illumination to get the image of the tested tire with the required quality. Due to the fact that the occurrence and type of errors on the produced tires are different and at the same time it is necessary to consider the quality of the evaluation process in regard to the deviation Bof the tire characteristics from the defined values. It was necessary to choose the method of data processing with the required performance and the necessary functions that would be able to replace the evaluation by humans. In our case, we decided to apply machine learning methods - specifically for the application of deep convolutional neural networks (DCNN) with a high probability of successful implementation due to their character and potential performance. [12] Machine learning - is a subfield of artificial intelligence that develops algorithms and techniques that enable the computer system (machine) to "learn". In this context, we understand learning as the ability to change the internal state of a system in a way that improves the ability to adapt to changes in the surrounding environment or allow the computer system after learning to extend the content of its knowledge base based on the findings obtained [13]. One approach to interpreting the knowledge needed for machine learning is to acquire and subsequently analyse the images obtained through the camera. Classical forms of visual data detection are using gradient-based techniques such as gradient-oriented histogram (HoG), scale-invariant feature transform (SIFT), spatial pyramids and, where appropriate, representation of basic functions such as Gabor's filters. However, in recent years, we have more powerful tools for extracting and analysing application-specific information by extending deep learning systems, and specifically by creating and implementing deep convolutional neural networks.[14] In our case, we plan to use a deep convolutional neural network to detect and classify the various errors encountered on the surface of the controlled tires. By applying this type of neural network, we assume that there will be a significant increase in the performance of the machine learning system, based on which results the quality control system will be built.[14].

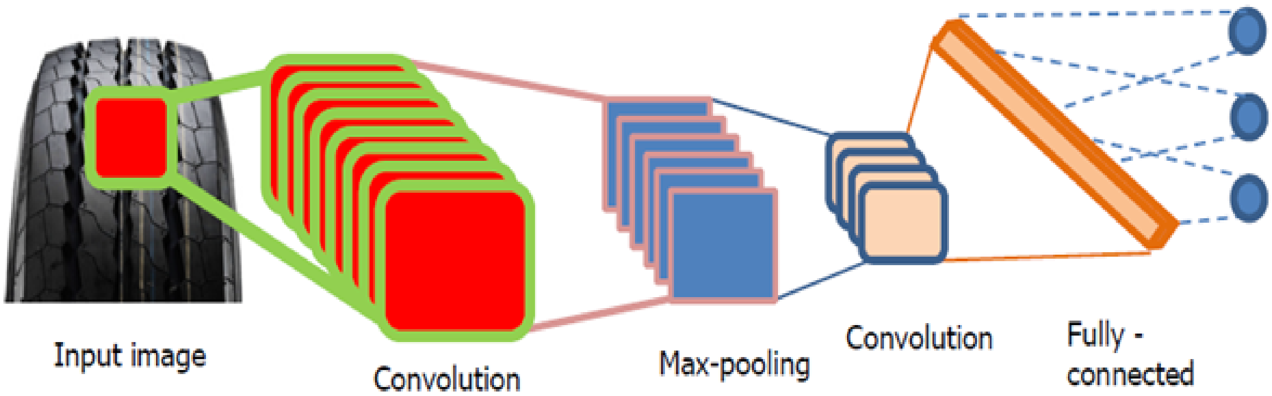


**Figure 2 Convolutional neural network with max-pooling**

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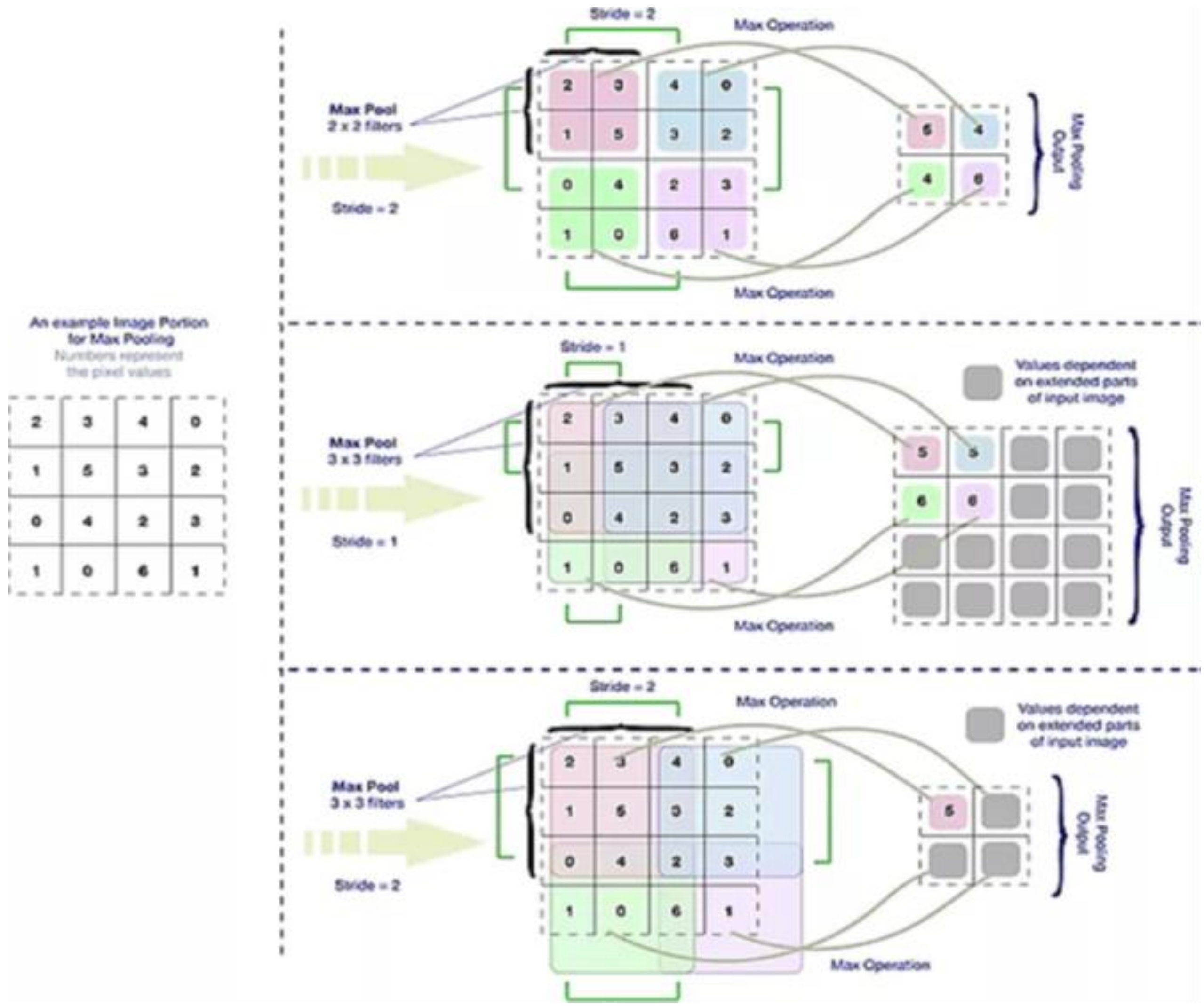


**Figure 3 Max-pooling principles (Suhrit Shankar, University of Cambridge)**

The deep convolutional neural network (DCNN) based on the classical convolutional neural network, according to the LeCun consists of three main components:

- the convolutional layer - is connected with the next layer in a similar way to a traditional bipartite multilayer neural network with the key difference that the scales are shared between the connection sets. Each set of weights-sharing links is a filter that is linked to the input data. Typically, there are several such filters trained in parallel on each layer. Convolution filters are moved through small local sections created on input image data in the image training process. Each filter acts as an element detector. The result of filter application and convolution across images will create a map of elements (Fig. 2.);
- activation function – Is used to discriminate between image classes by being stored at the output of a convolutional filter and performing a nonlinear transformation of the data space. Some examples of activation functions are the hyperbolic tangent function (Tanh), sigmoid function and rectified linear unit (ReLU);
- max-pooling - is a sample-based discretization process (Fig. 3.). The objective is to down-sample an input representation, reducing its dimensionality and allowing for assumptions to be made about features contained in the sub-regions. A convolutional layer and max pooling layers are successfully created to create the DCNN architecture. Compared to shallow architectures, DCNN has several layers that can represent complex functions with higher efficiency and accuracy of generalization. [13]

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**Implementation:** In our solution, we plan to apply training methods that are slightly different from conventionally applied methods. The standard gradient descent method involves optimizing the error across the training set. Because this procedure can be computationally and cost-intensive for a large network, an approximation method called minibatch stochastic gradient descent is often used for DCNN training. [15] A significant difference lies in the fact that instead of calculating the error gradient in the entire training set, each iteration calculates the error gradient for a small portion of the samples. We denote b and n as the minibatch size and the total number of training samples. For the number of minibatch gradients, total T = n / b iterations during training. Therefore, the w parameters are obtained by optimizing the approximate expected value of the error function f defined as:

$$E_t[f(w)] = \frac{1}{b}\sum_{i=(t-1)b+1}^{tb} f(w; x_i)$$

Where t $\mathcal{E}$ $\{1, \ldots . T\}$ iteration index and $x_i$ is i-th training sample. In the every iteration weight will be adjusted by gradient descent rule:

$$w^{(t+1)} = w^{(t)} - \mu \nabla_w E_t[f(w^{(t)})]$$

Where $\mu$ is the learning rate

While the standard gradient descent drops across all the samples in the training set to obtain a single update to the value of w for each iteration, stochastic gradient descent uses only one training sample, and the minibatch stochastic gradient descent method uses each sample iteration b (i.e. minibatch size). The stochastic gradient descent method is computationally much cheaper than standard gradient descent. A minibatch gradient descent method may often be as rapid as a stochastic gradient descent if appropriate vectorization is used to calculate derivative terms. [15]

Problems with non-convex object functions have sometimes shown a stochastic gradient value can escape from the local minimum that often forms a trap for a batch gradient. Therefore, stochastic gradient descent can be better deployed in applications such as DCNN training. [14]

Our data for the automatic evaluation of the quality of the produced tires will be generated by sets of images that will be captured by a high-resolution camera system. The inspection stand will be extended by the aforementioned system of cameras. At the same time, the inspection stand will be extended by a system of additional local lighting to achieve the required image quality (Fig. 4.).

will be necessary to carry out the so-called 'before implementation phase' that allow us to gather the unambiguous definition of acquired images for the process of defining all potentially occurring mistakes arising from the production of tires. At the same time, it will be necessary at this stage to define the ranges of acceptable deviations from the ideal state of the product. All captured and defined examples of images will need to be broken down into classes. A prerequisite for successfully grouping examples into classes is to create classes according to the apparent similarity of its members (geometric, technological, spatial, ...).

After successful completion of the before implementation phase associated with creation of a training set of data, we will perform implementation tests to reveal a suitable variation of the DCNN model. The different test models will be different in the basic parameter combinations (number of element maps, size of applied filters, number of network layers, number of fully interconnected layers). After performing these tests, parameters will be selected to allow the highest accuracy of classification through DCNN.

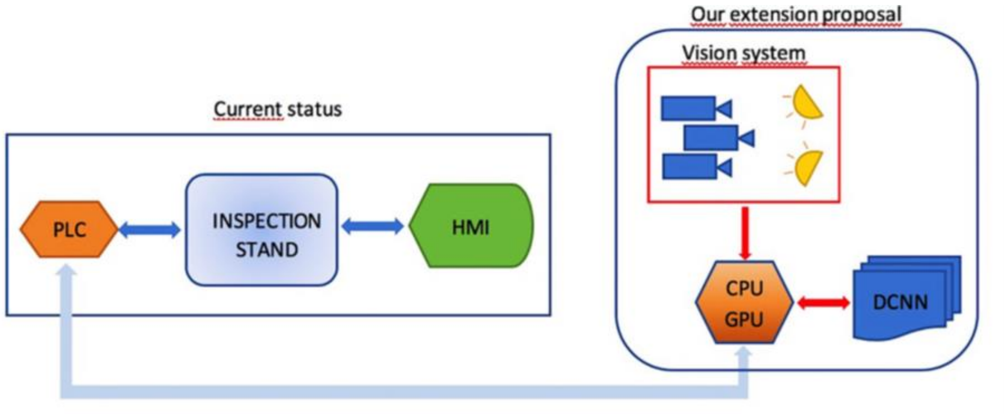


**Figure 4Our extension proposal of inspection stand**

## CONCLUSION

We assume that the DCNN application in an automated quality control process by implementing an automated error detection system on inspected tires will solve the most complex set of tasks associated with the development of an automated inspection device excluding manual inspection. Our assumption is based on the fact that the inspection stand will be extended by proposed camera system, that will generate a huge amount of input data (represented by large sets of images), DCNN will be used to effectively extract and recognize image elements, and to automatically detect the presence of errors and deviations in the controlled product. We have explored the use of DCNN to skip complicated procedures for extracting features required in a classical learning approach; instead, we will use unprocessed images as the only input to the classification model, and then optimize the network using the minibatch gradient descent method. The solution presented in this article is a concept based on the cooperation with the practice We predict the very high demands on part of the practice to given solution. In the next research we will therefore work out other methods of processing the acquired data through the methods of machine learning. Application of a machine learning principles has the potential to create automatic detection systems that are sufficiently generic to allow us to address presently very difficult to detect failures and errors in evaluating different tasks in production environment.

## REFERENCES

[1] J. Brethé, D.Lefebvre, Risk ellipsoids and granularity ration for industrial robot. Inter-national Journal of Factory Automation Robotics and Soft computing, 2, 93-101 (2007).

[2] I. Kuric, V. Bulej, M. Sága, P. Pokorný, Development of simulation software for mobile robot path planning within multilayer map system based on metric and topological maps. International journal of advanced robotic systems, 14, (2017)

[3] B. Mičieta, M. Edl, M. Krajčovič, Ľ. Dulina, P. Bubeník, L. Ďurica, V. Biňasová, Dele-gate MASs for Coordination and Control of One-Directional AGV Systems: A Proof-of-Concept. International journal of advanced manufactur. technology, 94, 415-431 (2018)

[4] W. S. Newman, C. E. Birkhimer, R. J. Horning, A. T. Wilkey, Calibration of a Motoman P8 robot based on laser tracking. Robotics and Automation, 2000. Proceedings. ICRA'00. IEEE International Conference on. 4, 3597-3602 (2000)

[5] M. Císar, I. Zajačko, I. Kuric, Diagnostics based on poositioning performance during circular motion. Inżynier XXI wieku: projektujemyprzyszłość. 536-542 (2016)

[6] A. Sapietová, M. Sága, I. Kuric, Š. Václav, Application of optimization algorithms for robot systems designing. International Journal of Advanced Robotic Systems, 15 (2018)
[7] V. Tlach, M. Císar, I. Kuric, Zajačko, Determination of the Industrial Robot Positioning Performance. MATEC Web of Conferences. 137 (EDP Sciences, 2017)
[8] A. Nubiola, I. A. Bonev, Absolute calibration of an ABB IRB 1600 robot using a laser tracker. Robotics and Computer-Integrated Manufacturing, 29, 236-245 (2013)
[9] M. Abderrahim, A. Khamis, S. Garrido, L. Moreno, Accuracy and Calibration Issues of Industrial Manipulators. Industrial Robotics-Programming, Simulation and Applications, 131-146 (2007)
[10] J. Józwik, D. Ostrowski, P. Jarosz, D. Mika, Industrial robot repeatability testing with high speed camera Phantom v2511. Advances in Science and Technology Research Journal, 10, 86-96 (2016)
[11] D. Kumičakova, V. Tlach, M. Cisar. Testing the performance characteristics of manipulating industrial robots. Transactions of the VŠB - Technical University of Ostrava: mechanical series, 62, 39-50 (2016)
[12] A. Şirinterlikçi, M. Tiryakioğlu, A. Bird, A. Harris, K. Kweder, Repeatability and Accuracy of an Industrial Robot: Laboratory Experience for a Design of Experiments Course. Technology Interface Journal, 9 (2009)
[13] Charu C Aggarwal, Neural Networks and Deep Learning. Springer, 2018
[14] Ragav V., Baoxin L., Convolutional Neural Networks in Visual Computing. CRC Press, 2017
[15] A. Nubiola, M. Slamani, I. A. Bonev, A new method for measuring a large set of poses with a single telescoping ballbar. Precision Engineering, 37, 451-460 (2013).

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# Chapter: 58

## Innovative Development in Evacuated Tube Solar Collector

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**ABSTRACT**

Solar energy is the ultimate renewable energy source utilized in evacuated tube solar collectors (ETSC) functioning. The net-zero building concept is widely used in the research and development sector in energy-efficient building technology. In the low-temperature region, a significant portion of the energy is consumed in space heating. Hence as per the present scenario, renewable and sustainable energy plays a vital role in energy savings. Solar space heating systems are associated with solar water heating systems by evacuated tube solar collectors. This review article aims to discuss the recent advancements in evacuated tube solar collectors, considering different essential factors affecting the Performance of ETSC with its wide field of application. This study also discusses the payback period and some challenges of ETSC. A detailed analysis of the various working fluids and nanofluids was carried out to improve the evacuated tube solar collectors' overall performance and efficiency. The present review article emphasizes the recent development and improvement based on experimental, simulation and numerical studies in the last few decades. Eventually, this review presents future ideas that can be implemented to improve the performance of evacuated tube solar collectors.

**KEYWORDS:** Solar Energy, Net-zero building, Evacuated tube, Solar collectors, Nanofluid, Energy Efficiency, Space heating.

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## INTRODUCTION

Renewable energy is critical in reducing dependence on traditional energy sources in which solar energy is widely used. India's solar energy potential is enormous. India's geographical area absorbs about 5,000 trillion kWh of power each year, with most of it receiving 4-7 kWh per square meter every day [1)]. Solar collectors are also utilized to generate hot water in the water storage tank, with significantly higher thermal efficiency than photovoltaic (PV) cells. One of the essential considerations in designing the solar collectors installation is the type of solar collectors[2)]. Solar collectors come in various shapes and sizes, including flat plate collectors, evacuated tube collectors, etc. Because solar radiation is only available during the day, solar energy storage is a significant difficulty in power generation, space heating, and water heating applications. As a result, choosing influentialcollectors is vital for any solar system. During installation, the use of evacuated tube solar panels was confirmed. Evacuated tube collectors show much greater efficiency and effectiveness of solar energy than other collectors for the absorber field [3)]. The evacuated tube solar collector is a device commonly used to supply heat for various purposes such as air heating, water heating, and thermal power plants, among others [4)]. Official figures show that per capita power usage has risen steadily over the previous eight years, from 914 kWh in 2012-13 to 1208 kWh in the most recent fiscal year, a 32 % increase. At India's independence in 1947, demand was only 16 kWh [5)]. Increased use of renewable energy resources is required to meet rising energy demand and the depletion of traditional energy sources [6)]. Solar collectorsform a heat exchanger that converts solar radiation into two types of energy: thermal energy in solar thermal applications and direct electrical power in photovoltaic applications. Solar devices capture solar radiation energy that strikes their surface, convert it to heat, and transport the heat to the working fluid running through them in the case of thermal applications [7)].

Space heating accounts for 32-33% of total energy use in residential and commercial buildings worldwide. Domestic hot water production also uses roughly 24% of residential and 12% of commercial buildings, posing a significant barrier to energy-efficient building design. Fig.1 shows that world energy consumption increases tremendously every ten years based on U. S Energy information [8]. Hence, renewable solar energy plays a significant role in overcoming the energy demand. ETSCs are highly effective, and their performance is based on the solar irradiance of any region.

**Methodology:** This review used a systematic literature review strategy to bring out comprehensive place-based research knowledge on Evacuated tube solar collectors (ETSC) and their advancement. A systematic review focus on its energy efficiency and effectiveness. The recent literature reviews are based on various factors such as design aspects, operating parameters, tracking systems, and using different working fluids to enhance efficiency [2]. Based on research findings and studies of recent advancements in ETSC, few future recommendations have been made for further research after a detailed discussion.

**Evacuated Tube Solar Collectors:** ETSCs are comparatively more effective because of the vacuum in annular space between two concentric glass tubes, eliminating sun-tracking by tabular arrangement and design.

**Evacuated tube solar collectors: Principle of operation:** The evacuated tube solar collectors' main components are the absorber, transparent glass cover, and heating source. ETSC works on the simple principle of 'Black body heat absorption principle' by which the 'black body absorbs the maximum amount of heat because absorptivity of the black body is maximum compared to all other colors' The ETSC in which water or space heating can be possible by using a vacuum tube. The evacuated tube is made up of borosilicate glass in two concentric tubes.

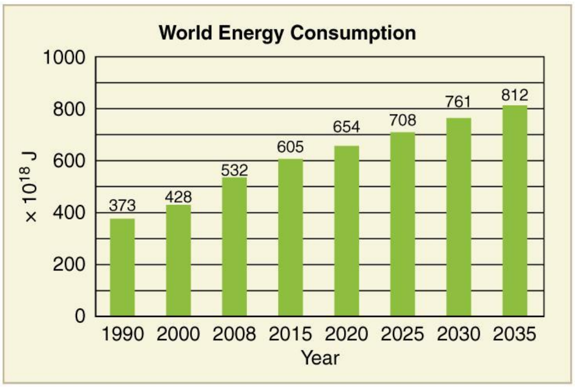


**Fig. 1: Past and projected world energy use [8]**

The vacuum is generated between two concentric tubes. The sketch shows that a special coating is done in the evacuated tube's inner surface vacuum tube, which is the main component that absorbs solar energy. Thermosiphon Systems**:** In this type, water flows through the system, and when water gets warm, it rises as more extraordinary water sinks. The collectorsare installed below the storage tank so that warm water will rise into the tank. These systems do not involve any pump and are more reliable. The absorber is selectively coated to absorb all the global irradiance. Selective coatings have the highest value of absorptivity (>0.95) and negligible emissivity (<0.1).

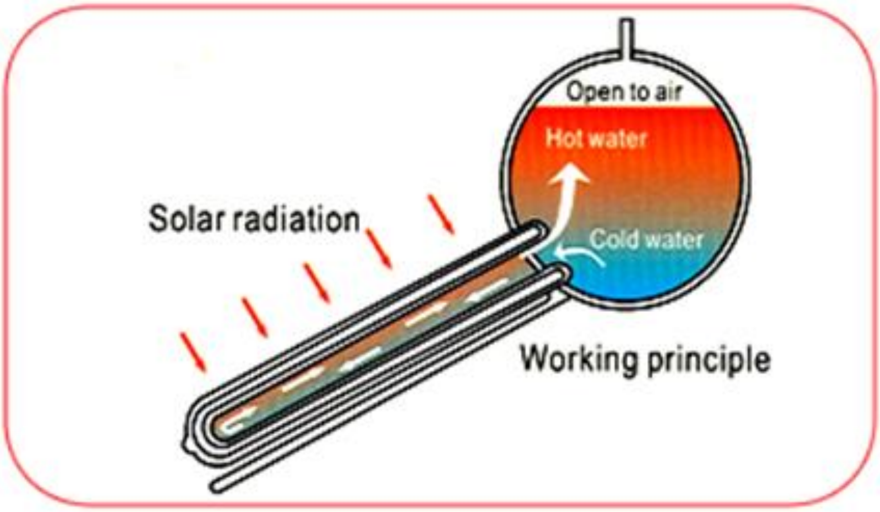


**Fig. 2: Evacuated Tube solar collectors working principle.**

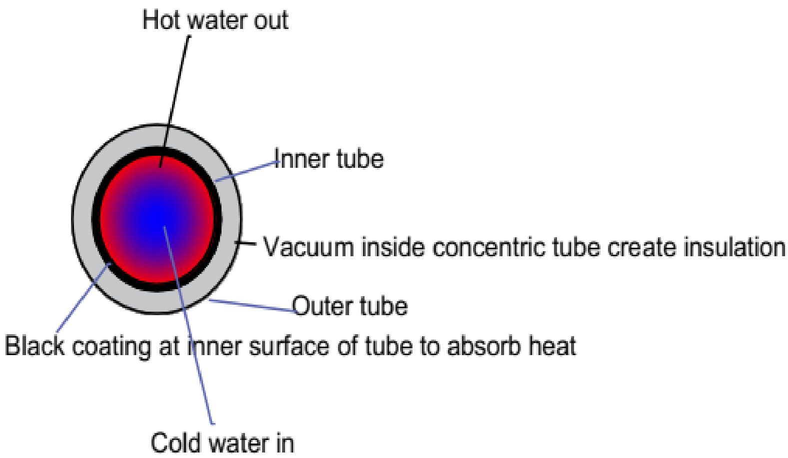


**Fig. 3a: Evacuated tube inner cross-section[9)]**

**Why is an evacuated tube solar collector (ETSC) preferable to another solar collector?**

Generally, FPCis designed for sunny and warm climates, and their performance decreases during cold and cloudy days; as well, it's comparatively costly and less effective than ETSC[10)]. According to many researchers [11)], ETSCs collect direct and diffuse radiations with excellent thermal performances with much higher efficiencies than FPC. ETSC also has convenient installation, maintenance, and transportation facility. Mangal et al. [12)] mentioned that the only energy output in FPC is obtained at a mid-day peak because the sun is perpendicular to the solar collectors at mid-day. Still, in ETSC, due to the cylindrical form of the evacuated tube, sun tracking can be possible the whole day; hence peak solar energy absorption can be possible throughout the day as well because of the vacuum presence inside the evacuated tube envelope of the convective and conductive heat loss inside the evacuated tube reduces and less effected by outside low atmospheric temperature and flow of wind. The other most important factor in selecting the ETSC is that the system does not affect if one or two evacuated tubes are broken. The capacity of hot water production and efficiency might be decreased, but the system will remain in a working position.At the same time, the repair and maintenance work can be carried out without shutting down the complete system, but if any damage occurs in FPC, then the operation has to be shut down, and then only the system can repair ([13)]. An

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ETSC can produce heat quickly, and the heat loss in the tubes during the day is negligible, while heat generation is slow for an FPC, and the heat loss in the collectors and tank is high due to daytime convection [11]. To install ETSC, grouting of the collectors is not mandatory because there is no effect of wind on the collectors because of the open space between two evacuated tubes. Still, grouting is a must in the case of FPC, and there are many limitations during the installation of FPC. As per the industry feedback, the overall performance of ETSC is satisfactory, and many research scopes are available for space heating and cooling application compared to FPC. The most crucial feature of ETSC is that they can operate in cold climate conditions and will not damage at higher altitudes due to freezing of water or snow formation. Energy efficiency is the primary factor in space heating systems in cold regions. A hybrid space heating system combines solar energy and geothermal energy for a space heating system ([14].

**Recent advancements in ETSC based on its classification and modification:** The evacuated tube solar collectorsis mainly classified into three types.

- ETSC with direct flow
- ETSC with U-tube flow
- ETSC with heat pipe flow

ETSC in which cold water is supplied in an insulated manifold, in which hot water is collected at a higher temperature. The manifold is connected with direct flow ETSC. Cold water gets down through an evacuated tube due to higher density, and hot water rises due to the thermosyphon effect. During the day, higher-intensity solar energy radiation strikes the evacuated tube. According to some publications, direct flow ETSC exhibit substantially higher efficiency than the conventional FPC[2] of ETSCs tube inner cross-section, the evacuated tube comprises two concentric tubes in which the inner tube has a selective coating. It absorbs all thermal radiation that passes through, having minimum emissivity[15]. At the same time, the outer tube is exposed to sun radiation. The inner tube absorbs solar radiation that travels through the translucent outer tube. The inner tube gets heated up when sunlight travels through the outer tube. A vacuum is generated to retain the heat, enabling solar radiation to flow through but preventing heat transmission[16].The construction and functioning of evacuated tube collectors vary considerably[17]**.** Several factors can affect the collector's performance, including tube slope, flow velocity, and dust or covering. According to Weiss[18], a collector’s tilt angle of 30° to 75° has no impact on overall Performance.ETSC with a Cu-U-tube layout is commonly utilized to improve thermal efficiency and efficacy using Nanofluid or other working fluids, Evacuated tubes with heat exchangers in the solar dryer increase the heat transfer rate of air, drying the product efficiently with less time.

A review of the performance of an evacuated tube solar collector with a sealed heat Pipe model is generally made of copper to improve the collectors' efficiency. The working fluid is kept at reduced pressure in an evacuated tube with a heat pipe, evaporating in the evaporator portion, and condensation happens at saturated temperature. The low-pressure fluid inside the heat pipe develops a capillary action pressure to pump condensed liquid from the condenser to the evaporator in close-loop circulation[19]. The ETSCs with heat pipe systems with reflectors lower convection losses while increasing exergy efficiency. The thermal oil is poured into the evacuated tube. The bulb temperature and the heating efficiency of the evacuated tube heat pipe have risen when oil is inserted) into the evacuated tube**.**The temperature, heating time, and cooling time are Maximum in case 3, in which the ETSC with heat pipe taken in copper

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foamed metal with oil is used inside the collectors. The heat transfer rate can enhance in the case of an evacuated tube solar collector with a heat pipe using a rectangular absorber plate by increasing the contact surface area of the heat pipe [21]. Further research is recommended from the above review, creating a standard simulation tool in 2020 that can calculate the device output parameters under design conditions and collecting training datasets from pilot projects from which simulation validation and experimental results can obtain. Optimizing the required solar system, including the control system and superstructure operation, improves the system's overall performance parameters[22]. It has been experimentally proved that an evacuated heat pipe collector (ETHPC) performs much better than a traditional flat-plate collectors[23]. The heat pipe comprises copper tubing, and the evaporator, adiabatic, and condenser portions are 1700, 100, and 200 mm long, respectively. A copper plate is finned in the evaporator area to improve solar input[24].The result was obtained by a solar-assisted space heating system based on the following factors. i.e., solar radiation intensity, yearly weather data, number of sunny days per year, and solar collectors area. The increase in the wind velocity contributes to the decrease in both the energy and exergy efficiency of the evacuated tube solar collectors[25]. In the ETSC-by increasing the number of the evacuated tube with the heat pipe increases both absorber surface area and absorbed energy; however, the temperature difference between the working fluid and heat pipe is maximum at the inlet section of the tube, which leads to maximum heat transfer coefficient and subsequently the temperature difference decreases after passing through other tubes. Hence, the rate of heat transfer and increase in temperature reduces due to an increase in the total number of tubes[26]. Heat pipe solar collectors have a high potential regarding both state-of-art. The heat transfer rate can enhance in the case of an evacuated tube solar collector with a heat pipe using a rectangular absorber plate by increasing the contact surface area of the heat pipe, as shown in Fig.4.

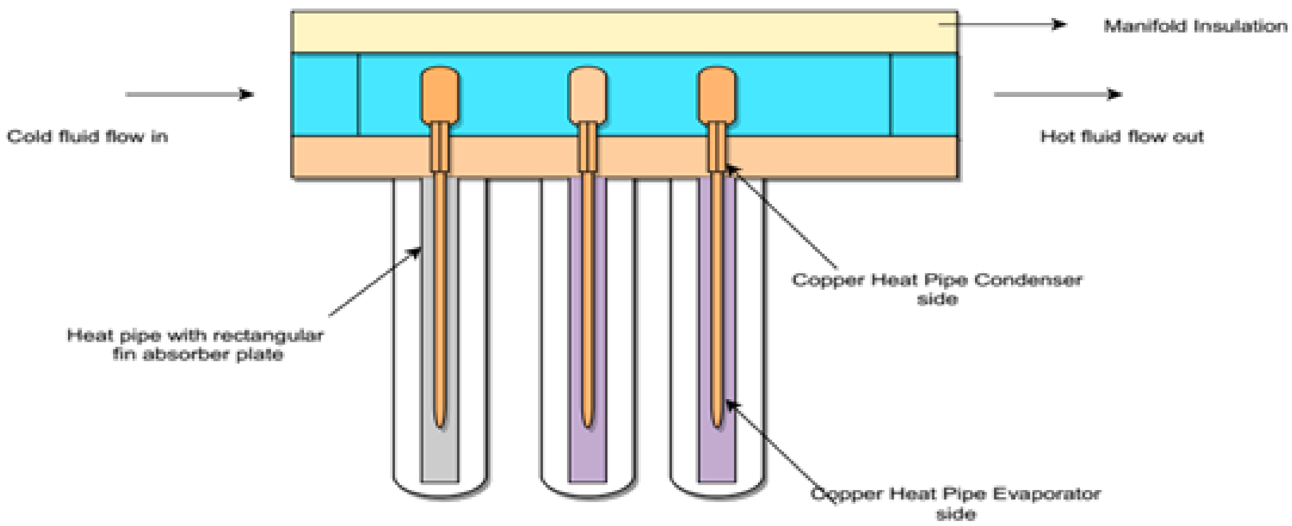


**Fig. 4: Evacuated tube solar collectors with heat pipe with the rectangular fin absorber plate[21]**

The-art collector's development and new collectors concepts and applications. However, they still suffer from several drawbacks[27].

**Factors affecting the Performance of ETSCs:** ETSC Performance can be evaluated using a variety of operating parameters such as the working fluid, or Nanofluid used, angle of incident radiation, collectors inclination angle, type of reflector, mass flow rate, wind velocity, solar

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intensity in Watt/$m^2$, location, the number of sunny days throughout the year, and weather data. The thermal efficiency, optimum temperature obtained, efficacy, and rate of hot water production as a function of time are significant indicators of ETSC performance.

**Effect of working fluids/Nanofluids on the Performance of ETSCs:** In the ETSCs, water is initially used as a working fluid to heat the water; later on, oil and air are the most common working fluids used in solar energy systems. Still, the thermal conductivity of these fluids is relatively low. It was found that adding propylene glycol with water as a working fluid in ETSC with a heat pipe resulted in an increased temperature difference with increased exergy efficiency and thermal efficiency. This CONCLUSION is consistent with the experimental investigations carried out by[28)]. Who studiedto increase the overall performance of an evacuated tube solar collectors with a thermosyphon heat pipe, chloroform, and acetone showing the best results in terms of energy and exergy performance of the thermosyphon heat pipe evacuated tube collectors (THPETC).Evacuated tube solar collectors coupled with solar desalination systems using therminol as a working fluid in evacuated tubes enhance the efficiency and production of freshwater and condensation rate[29)]. Researchers are now looking into new working fluids, such as nanofluids, rather than water and air, to improve collectors' performance. Nanofluids comprise base liquid and nanomaterials with improved thermophysical properties like thermal conductivity, diffusivity, and convective heat transfer coefficients. Nanofluids increase solar collectors' optical characteristics, transmittance, and extinction coefficient and boost heat transfer efficiency. As time passes, the water temperature rises, increasing solar radiation and a maximum temperature of $64^0$ degrees Celsius[30)]. It is possible to enhance the efficiency of evacuated tube collectors by adding a trim concentration level of 1.5 to 2.0 volume by creating a mirror from a part of the inner concave surface of a glass tube. U-tube is installed inside the evacuated tube solar collectors using nanofluids, and it found that the maximum thermal efficiency is achieved with a 4% nanofluid volume concentration[31)]. U-tube solar collectors with aluminum oxide Nanofluid concentration enhance the maximum efficiency by 72.4%[32)]. High temperatures can be achieved by adopting a vacuum between the glass cover and the absorber plate to reduce or eliminate convection losses[33)]. Carbon dioxide as a working fluid is used in evacuated tube solar collectors where the $CO_2$ temperature difference occurs from $35^0$C to $78^0$C and gives a maximum temperature difference of $43^0$C[34)]. Nanofluids are designed to prepare fluids by dispersing nano-sized metal or metal oxide particles dispersed in liquids like water. Nanofluids possess higher thermal conductivity[35)]. The evacuated tube heat pipe solar collectors using $TiO_2$ nanoparticles mixed in distilled water enhanced the efficiency by 16.7% at a flow rate of 2.7 liters per minute. $TiO_2$ nanofluid has a higher temperature difference than water. The presence of $TiO_2$ nanoparticles enhances the thermal properties compared to water. These enhancements increase the capability to transfer heat from the absorber plate to the working fluid. Different Types, sizes, and content in %age of volume fraction of nanoparticles also play a significant role in enhancing the rate of heat transfer, thermal properties of the Nanofluid, overall effectiveness, and efficiency of the evacuated tube solar collectors. Maximum solar collector's efficiency occurs at a 5% volume fraction of Nanofluid in distilled water[36)]. In another paper, the thermal analysis was taken by another nano fluid-like grapheme water (0.2 % Concentration). The reading was obtained for temperatures at the different quantities of fluid capacity in the tank. The maximum temperature increases with decreases in the quantity of Nanofluid.

As well as the reading obtained with and without a reflector at the same condition and with different quantities of the working fluid. The temperature rises with the reflector and increases up $70^0C$[37].ETSC also gives good results at a high flow rate and downward flow direction[38]. The critical properties of carbon dioxide as a working fluid have a high volumetric capacity and higher heat transfer coefficient than other working fluids. They are thermally stable for a wide range of temperatures. Carbon dioxide's other properties are abundant in nature, nonpoisonous, non-flammable, and environment friendly with lower global warming potential. In the study of evacuated tube solar collectors, $CO_2$is a working fluid, and using parabolic collectors or external compound parabolic collectors in both the reflector and the working fluid temperature increases the efficiency of the evacuated tube collectors decreases. At the maximum temperature of $200^0C$, the collectors' efficiency becomes 40%. As well as the main challenge is to maintain high operating pressure inside the collectors[39].In an evacuated tube solar collectors with supercritical $CO_2$ as a working fluid, the results show that the temperature, pressure, and mass flow rate increase with the solar radiation, which is different from those of traditional solar collectors using liquid as the working fluid. The annually-averaged collector's efficiency is above 60.0% in the case of supercritical $CO_2$ as a working fluid, which is much higher than water-based solar collectors[40]. As per the previous study, supercritical carbon dioxide is used as a working used in evacuated tube solar collectors for solar water heating systems in which the heat transfer can take place by natural convection without using the pump. The thermal efficiency can achieve up to 90.4%, which is comparatively higher than other solar water heating systems. In this system, sufficient hot water in summer can produce at $78^0C$[41]. During a typical day of operation, the effects of employing water, ammonia, acetone, methanol, and pentane as working fluids of the built-in heat of the pipe are compared. From an economic and technological standpoint, it has been proven that the performance of a solar water heater can be improved by up to 28% and 50%, respectively[42]. The collectors comprise five evacuated tubes that are filled with regular engine oil. The working fluid is carried through an extra stainless-steel pipe incorporated with the tubes. 5 U-shape twists are formed by bending the steel pipe (through-flow pipe) 5 times. Every U-turn is contained within a single evacuated tube. The number of evacuated tubes should be increased, and the stainless-steel pipe diameter should be raised. At the same time, the length is lowered to improve the system's performance and make it suited for larger loads, e.g., creating superheated steam[43]. The heat gained by the working fluid increases with solar intensity. Heat transfer from the outer glass to the U-type copper or aluminum tube will be higher at higher solar intensity. Subsequently, there will be a higher potential for convective heat transfer between the lower surface of the U tube and the working fluid. The model predictions are compared with experimental data, and a good agreement is observed between them. Aqueous lithium chloride solution ($LiCl$-$H_2O$), water, and air are chosen as working fluids[44].

**Performance analysis of ETSC based on reflector and absorber:** The reflectors and absorbers in the evacuated tube solar collector are essential in enhancing thermal efficiency and optimum temperature range. The research has been carried out to select reflector material and configuration of material in which mirror is considered the best than other reflector materials like white paint or aluminum foil. The flat and zigzag geometry of reflectors also provides the best results[41]. This reflector can focus radiation on an absorber plate inside the tube. External radiation concentrations can also be coupled to an evacuated collector for performance enhancement over the simple[42]. The reflectors are used to enhance the Performance of ETSC. In the case of a reflector, ETSC gives a higher temperature difference and has better thermal efficiency than the case without a reflector[43]. The Performance of ETSC depends on the absorber shape and geometry configuration inside the tube and

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evacuated tube arrangement with the proper angle of solar irradiation. Kim and Seo[44] worked on different absorber shapes with different arrangements of absorber plates. U tube of copper is inserted inside the evacuated tube where fluid flow occurs.Four models were studied based on the absorber's solar irradiation angle and shape. Regarding the beam radiation consideration, overall, model II gave the best performance among all models, and the absorbing area of the tube increases the overall performance of the collector also increases[44].The cheapest and least effective tor is a diffuse reflection with a simple surface. V-trough and cylindrical reflectors are more commonly used because of their superior performance and ease of production. The collector's efficiency has increased by 2% due to improved transmittance from 0.91 to 0.96 and antireflection coatings[46]. The only factors that influence the reflection of beam radiation are the incidence angle and collector geometry[47]. A compound parabolic reflector improves optical efficiency by 66 % at a normal incidence angle[56]. The optical efficiency of a Fresnel lens is reduced by 6.3 % while the thermal efficiency is raised[48]. Thermal efficiency is reduced due to optical and thermal losses.

**Review of performance based on operating parameters:** Various factors affect the performance of evacuated tube solar collectors. Based on the working fluid flowing inside the evacuated tube, some of the critical factors are the mass flow rate of the working fluidOptical properties of the absorber tube materials based on the coating, design of collector geometry and contact surface area, angle of inclination of an evacuated tube, and by application of a reflector to enhance the intensity of the radiation(Kumar et al., 2021). (Gao et al.,2011) examined the effects of thermal flow and mass rate on solar hot water systems with forced circulation. Two types of ETSCs were investigated for the system: water in a glass and U-pipe evacuated collectors. WGETSC and UPETSC were compared in terms of their energy efficiency. UPETSC has a 25–35 percent larger energy storage capacity than WGETSC, according to the comparison. The flow rate and fluid thermal mass impact energy storage and pump operations. A proper mass flow rate is necessary to keep the pump running smoothly and extract energy from the collector promptly and efficiently. It should be mentioned that when the flow rate increases, the performance of energy collecting decreases (El-Nashar,2001).

## Table 1 Previous Research outcomes on different working fluids and types of ETSC:

| **Author** | **Type of Investigations** | **Working Fluid** | Key findings |
|---|---|---|---|
| Areas, C.[54] | Experimental | Water | • In cold climates, the evacuated-tube collectorsperforms b |
| H. Zhang et al. [55] | Experimental | $CO_2$ | • The thermal-hydraulic Performance of $CO_2$ is g influenced by its mass flux, heat flux, operating pressure, and section shape. |
| (X. W. Zhang et al.[56] | Experimental | CO2 | • The results reveal that natural convection may quickly ge supercritical $CO_2$ flow circulation in this solar heater without a d pump.<br>• Up to 90.4 % heat recovery efficiency is achieved, highe most standard solar water heater systems. |
| Heater. [57] | Experimental | $CO_2$ | • The thermosiphon solar water heater of claim 1, wherein c dioxide circulates through the U - shaped tube in the glass tube gravity as the carbon dioxide upon cooling becomes heavier and r to the U - shared tube in the glass tube through the cold manifold. |
| (Yamaguchi et al.[58] | Experimental | $CO_2$ | • Solar heating or water cooling may readily create a natura convection flow of supercritical carbon dioxide. This convective fl collects and transmits heat from solar collectors tubes to water. |
| (X. R. Zhang et al.[59] | Experimental | $CO_2$ | • A Feasibility Study of CO2Based Rankine Cycle power solar energy. The maximum temperature of $CO_2$ can achieve up to C. |

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**Application of ETSC:** The most suitable device for solar thermal applications has been evacuated tubesolar collectors67). The main application of ETSC is either for domestic purposes, for example, in residential homes, or industrial applications, such as in pharmaceuticals, textiles, paper, and leather industries, swimming pools, boiler houses, hospitals, and nursing homes. Some of the applications identified by several researchers include water heating, air drying, air heating, and desalination are just a few of the many uses for ETSCs. The researchers have studied ETSCs, which may be utilized for cooling and heating systems. Evacuated tubes with a heat exchanger in the solar dryer increase the heat transfer rate of air,drying the product efficiently with lesstime.All use of ETSCs in different components of domestic life, namely water heating, roof heating, kitchen, washing machine, space heating, etc. Nowadays, each household consumes a considerable quantity of energy daily. We can install efficient ETSCs with proper hot water storage technologies and proper utilization in cold regions to reduce unit power consumption.

**Challenges and remedies of using ETSCs:** Specific challenges arise after using ETSCs for domestic water heating applications. ETSCs tube is comparatively more efficient than FPC. It becomes pretty hot, reaching the boiling point of water during the hot summer month due to the vacuum inside the tube, leading to overheating and breaking the evacuated tubes. To overcome this common problem, cold water with hot water ensures the temperature and pressure should not exceed the desired limit[68)]. In the extreme winter season, when the surrounding temperature is shallow and snowfall occurs, the snow falls stuck on the evacuated tube, forming the snow layer on the ETSC. This happens because the outer surface of the evacuated tube is not heated. Hence ultimately, the efficiency and effectiveness of ETSCare hampered because the solar energy could not reach to evacuated tube due to snow formation. Hence, we need to remove snow every morning, which is tedious work.Fragility two layers of annealed borosilicate glass are used to construct evacuated tubes, and annealed glass is far more fragile than tempered glass. Glass tubes are easily fractured due to their fragility and can be destroyed by small hail, jostling, or bad handling. As a result, particular caution must be exercised when transporting or handling evacuated tubes[69)].

**Economic considerations of the usage of ETSC:** Evacuated tube solar collectors (ETSCs) have been commercially available for over 20 years. The evacuated tube solar water heater market has recently witnessed a considerable expansion in China, Europe, Japan, and India due to the fast-growing industries of ETSCs. This study attempted to identify the economic advantages of ETSCs over other solar collectors by examining the original manufacturing and installation costs, operating and maintenance costs, and the payback period. According to data from AEE INTEC on cost analysis of various solar thermal collectors and comparisons based on specific cost per meter square ($m^2$) and gross area in $m^2$, ETSCs have a lower specific cost per $m^2$ and a higher gross area than FPC, an air collector, and a parabolic trough collectors[70)]. According to an economic analysis of roof-integrated concrete solar collectors, evacuated tube collectors have a short payback period, which means that the investment cost can be repaid quickly. Evacuated tubes provide environmental benefits by reducing greenhouse gas emissions and air pollution[71)]. The evacuated tube that has been used in ETSCs is the best choice in terms of the minor effects caused during their manufacture. However, from a financial standpoint, it is evident that a more significant expenditure is required to obtain the evacuated tube collectors system. Still, the operation and maintenance cost is comparatively significantly less[72)]. As a result, an ETSC is more cost-effective and affordable in the long run than other solar collectors. Recent large-scale production and deployment of evacuated tubes have

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demonstrated that this technology is mature, with a three-year payback period without subsidies[68)].

**Discussion:** Following a review of ETSC's significant developments based on several points of debate, such as its geometric layout, use of different kinds of the working fluid, Nanofluid, adjustment of operating parameters, use of reflectors, and so on, ETSCs is an example of one of the ideal types of solar collectors which can be operated on medium temperature levels because of shallow thermal losses and since between two concentric glass tube vacuum minimize in conduction and convection losses, but radiation losses exist. Selective coatings that increase absorbance while minimizing emittance can reduce radiation losses. Stationary evacuated tube solar collectors have a temperature range of 50–200 °C, while stationary flat plate solar collectors have 30–80 °C[73)]. The main goal of this review is to show the key aspects that can improve the efficiency of evacuated tube solar collectors. If the convective heat transfer coefficient between the absorber tube and the working fluid is higher, the efficiency of the evacuated tube solar collectors will be higher. Using an effective heat exchanger, ETSCs can be improved by using high thermal conductivity working fluid and nanofluids. The overall performance of ETSCs refers to their efficiency and efficacy, determined by some parameters such as the collector's design, the optical properties of the absorber tube, and the working fluid inside the tube. The previous work done on ETSCs nanofluid is well explained with the help of the table. 2 in which the complete detailed information of Nanofluid with outcomes is explained[74)]. MWCNT, Al2O3, CuO, SiO2, and TiO2 nanoparticles, as well as a mixture of propylene glycol and water as the base fluid, resulted in a 10.5 percent better efficiency, or 66 percent when 0.2 volume percent of MWCNT nanofluid was used. The effect on the thermophysical properties of different nanofluids with varying particle sizes, nanoparticle mass fraction, tube dimensions, and circulation rate can improve ETSC efficiency. Cu–water has the highest thermal recovery efficiency of all the nanofluids[75)].CuO mass concentration significantly impacts heat transport, with a value of 1.2 percent corresponding to the best results. Most refrigerants, as the working fluid of ETSCs, also give excellent results. Moreover, Yurddaş.[74)] found 76% efficiency experimentally using R-134a in a circular design of ETSC. Efficiency can be increased using nano-coatings of high-absorbance materials on the absorber tube. The performance of heat pipe ETC is higher than direct flow ETSC[76)]. A concentric tube inside the absorber tube with phase change material can be investigated experimentally and numerically. More specifically, Chopra et al.[77)] used SA-67 as PCM and found a thermal efficiency of up to 87.8%.

**Nomenclature & Abbreviation**

| | |
|---|---|
| ETSCs | evacuated tube Solar Collectors |
| PV | photovoltaic |
| FPC | flat plate collectors |
| COP | coefficient of performance |
| PV/T | photovoltaic thermal |
| HVAC | heating,ventilation & Air conditioning |
| ETHPSC | evacuated tube heat pipe solar collectors |
| THPETSC | thermosyphon heat pipe evacuated solar tube solarcollectors |

| | |
|---|---|
| WGETSC | water in glass evacuated tube solar collectors |
| UPETSC | U pipe evacuated tube solar collectors |
| NCL | natural circulation loop |
| IMD | Indiameteorological department |
| PCM ` | phase change material |

## REFERENCES


[1] MNRE. (n.d.). Retrieved February 25, 2021, from India, achieved 5th,and has achieved grid parity.

[2] Kumar, A., Said, Z., & Bellos, E. (2021). An up-to-date review on evacuated tube solar collectors. Journal of Thermal Analysis and Calorimetry, 145(6), 2873–2889.

[3] Lazzarin, R. (2020). Heat pumps and solar energy: A review with some insights in the future. International Journal of Refrigeration, 116, 146–160.

[4] Shadab Ahmad, S. A. (2018). Design of Solar Evacuated Tube Collectors for Low-Intensity Thermal Energy. International Journal of Applied Engineering Research, January.

[5] Mallapur Chaitanya. (2021). India's per capita power consumption is rising, but wide variations persist across states. In Money Control (p. 1).

[6] Farhana, K., Kadirgama, K., Rahman, M. M., Ramasamy, D., Noor, M. M., Najafi, G., Samykano, M., & Mahamude, A. S. F. (2019). Improvement in the performance of solar collectors with nanofluids-A state-of-the-art review. Nano-Structures & Nano-Objects, 18, 100276.

[7] Chang, H., Duan, C., Wen, K., Liu, Y., Xiang, C., Wan, Z., He, S., Jing, C., & Shu, S. (2015). A modeling study on the thermal performance of a modified cavity receiver with glass window and secondary reflector. Energy Conversion and Management, 106, 1362–1369.

[8] World Energy Use | Physics. (n.d).

[9] RED SUN,Evacuated tube Collectors Solar Water Heater. (n.d.). Retrieved February 24, 2021, from

[10] Alternate Energy Tutorials. (n.d.). Retrieved February 25, 2021.

[11] Ayompe, L. M., Duffy, A., Mc Keever, M., Conlon, M., & McCormack, S. J. (2011). Comparative field performance study of flat plate and heat pipe evacuated tube collectors (ETCs) for domestic water heating systems in a temperate climate. Energy, 36(5), 3370–3378.

[12] Mangal, D., Lamba, D. K., Gupta, T., & Jhamb, K. (2010). Acknowledgment Of Evacuated Tube Solar Water Heater Over Flat Plate Solar Water Heater. International Journal of Engineering, 4(4), 279–284.

[13] Tang, R., Yang, Y., & Gao, W. (2011). Comparative studies on the thermal performance of water-in-glass evacuated tube solar water heaters with different collectors tilt-angles. Solar Energy, 85(7), 1381–1389.

[14] Xu, W., Liu, C., Li, A., Li, J., & Qiao, B. (2020). Feasibility and performance study on hybrid air source heat pump system for ultra-low energy building in severe cold region of China. Renewable Energy, 146, 2124.

[15] Bermel, P., Lee, J., Joannopoulos, J. D., Celanovic, I., & Soljacie, M. (2012). Selective Solar Absorbers. Annual Review of Heat Transfer, 15(15), 231–254.

[16] Zubriski, S. E., & Dick, K. J. (2012). Measurement of the efficiency of evacuated tube solar collectors under various operating conditions. Journal of Green Building, 7(3), 114–130.

[17] Siva Kumar, S., Kumar, K. M., & Kumar, S. R. S. (2017). Design of Evacuated Tube Solar Collectors with Heat Pipe. Materials Today: Proceedings, 4(14), 12641–12646.

[18] Abo-Elfadl, S., Hassan, H., & El-Dosoky, M. F. (2020). Energy and exergy assessment of integrating reflectors on thermal energy storage of evacuated tube solar collectors-heat pipe system. Solar Energy, 209(June), 470–484.

[19] Abd-Elhady, M. S., Nasreldin, M., & Elsheikh, M. N. (2018). Improving the performance of evacuated tube heat pipe collectors using oil and foamed metals. Ain Shams Engineering Journal, 9(4), 2683–2689.

[20] Kalogirou, S. A. (2016). Nontracking solar collection technologies for solar heating and cooling systems. In Advances in Solar Heating and Cooling. Elsevier Ltd.

[21] Zhang, X., Yang, J., Fan, Y., Zhao, X., Yan, R., Zhao, J., & Myers, S. (2020). Experimental and analytic study of a hybrid solar/biomass rural heating system. Energy, 190, 116392.

[22] Speyer, E. (1965). Solar energy collection with evacuated tubes. Journal of Engineering for Gas Turbines and Power, 87(3), 270–275.

[23] Chun, W., Kang, Y. H., Kwak, H. Y., & Lee, Y. S. (1999). Experimental study of the utilization of heat pipes for solar water heaters. Applied Thermal Engineering, 19(8), 807–817.

[24] Siuta-Olcha, A., Cholewa, T., & Dopieralska-Howoruszko, K. (2020). Experimental studies of thermal performance of an evacuated tube heat pipe solar collectors in Polish climatic conditions. Environmental Science and Pollution Research.

[25] Shafieian, A., Khiadani, M., & Nosrati, A. (2019). Thermal performance of an evacuated tube heat pipe solar water heating system in cold season. Applied Thermal Engineering, 149(August 2018), 644–657.

[26] Ersöz, M. A. (2016). Effects of different working fluid use on the energy and exergy performance for evacuated tube solar collectors with thermosyphon heat pipe. Renewable Energy, 96, 244–256.

[27] Jamar, A., Majid, Z. A. A., Azmi, W. H., Norhafana, M., & Razak, A. A. (2016). A review of water heating system for solar energy applications. International Communications in Heat and Mass Transfer, 76, 178–187.

[28] Bhargva, M., & Yadav, A. (2020). Effect of shading and evaporative cooling of glass cover on the performance of evacuated tube-augmented Solar still. Environment, Development and Sustainability, 22(5), 4125–4143.

[29] Daghigh, R., & Shafieian, A. (2016). Theoretical and experimental analysis of the thermal performance of a solar water heating system with evacuated tube heat pipe collectors. Applied Thermal Engineering, 103, 1219–1227.

[30] Kaya, H., & Arslan, K. (2019). Numerical investigation of efficiency and economic analysis of an evacuated U-tube solar collectors with different nanofluids. Heat and Mass Transfer/Waerme- Und Stoffuebertragung, 55(3), 581–593.

[31] Kim, H., Kim, J., & Cho, H. (2017). Experimental study on performance improvement of U-tube solar collectors depending on nanoparticle size and concentration of Al2O3 Nanofluid. Energy, 118, 1304–1312.

[32] Ghoneim, A. A., Shabana, H. M., Shaaban, M. S., & Mohammedein, A. M. (n.d.). Performance Analysis of Evacuated Tube Collectors in Hot Climate. 8–20.

[33] Abas, N., & Khan, N. (2016). A Thermosyphon driven Solar Water Heater Using CO 2 as Working Fluid. Journal of Applied Environmental and Biological Sciences, 6, 43–54.

[34] Carmichael, L. T., Berry, V., & Sage, B. H. (1963). Thermal Conductivity of Fluids. Ethane. In Journal of Chemical and Engineering Data (Vol. 8, Issue 3, pp. 281–285).

[35] Series, I. O. P. C., & Science, M. (2020). An experimental investigation on the effect of hybrid Nano fluid ( Al + Al 2 O 3 / distilled water ) on the thermal efficiency of evacuated tube solar collectors. 2–9.

[36] Maustafa Mahdi, M., Abed Jaddoa, A., Falih Kadhim, I., & Asmet, W. (2020). Outdoor testing of an evacuated tube closed two phase thermosyphon solar water heater charged with Nanofluid. IOP Conference Series: Materials Science and Engineering, 765(1).

[37] Yadav, A., & Bajpai, V. K. (2013). Comparison of thermal performances of flat plate and evacuated tube solar air collectors at different flow rates: experimental analysis. International Journal of Renewable Energy Technology, 4(2), 107.

[38] Duong, V., & Diaz, G. (2014). Carbon dioxide as working fluid for medium and high-temperature concentrated solar thermal systems. 2(1), 99–115

[39] Zhang, X. R. (2008). An experimental study on evacuated tube solar collectors using supercritical CO 2. 28, 1225–1233

[40] Zhang, X., Niu, X., & Yamaguchi, H. (2018). Study on a supercritical CO 2 solar water heater system induced by the natural circulation. 10(4), 1–15.

[41] Gan, Y. Y., Ong, H. C., Ling, T. C., Zulkifli, N. W. M., Wang, C. T., & Yang, Y. C. (2018). Thermal conductivity optimization and entropy generation analysis of titanium dioxide nanofluid in evacuated tube solar collectors. Applied Thermal Engineering, 145(September), 155–164.

[42] Lecturer, A., & Mohammed, A. A. (2014). ABSTRACT :18(2), 122–132.

[43] Naik, B. K., Varshney, A., Muthukumar, P., & Somayaji, C. (2016). Modeling and Performance Analysis of U Type Evacuated Tube Solar Collectors Using Different Working Fluids. Energy Procedia, 90(December 2015), 227–237.

[44] Alhabeeb, B. A., Kadhim, T. J., Hashim, H. T., & Mohammed, H. N. (2020). Enhancement of the thermal efficiency of the evacuated tubes solar water heater by adding a reflector. International Energy Journal, 20(1), 57–66.

[45] El-nashar, A. M. (1981). Renewable Energy Systems and Desalination. Evacuated Tube Collectors, II.

[46] George, I., & Kalaivanan, R. (2017). Analysis of thermal performance on evacuated tube solar collectors without and with reflector. 55–61.

[47] Kim, Y., & Seo, T. (2007). Thermal performances comparisons of the glass evacuated tube solar collectors with shapes of absorber tube. Renewable Energy, 32(5), 772–795.

[48] El-Nashar, A. M. (2001). The economic feasibility of small MED seawater desalination plants for remote arid areas. Desalination, 134(1–3), 173–186.

[49] Kyekyere, E., Ndiritu, H., Hawi, M., & Mwambe, P. (2021). Performance of Water in Glass Evacuated Tube Solar Water Heater under Kenya Climatic Condition. April.
[50] Essa, M. A., Rofaiel, I. Y., & Ahmed, M. A. (2020). Energy, 206, 118166.
[51] Thippeswamy, L. R., & Kumar Yadav, A. (2020). Heat transfer enhancement using CO2 in a natural circulation loop. Scientific Reports, 10(1), 1–10.
[52] Areas, C. (2020). A Comparative Study on the Performances of Flat Plate and Evacuated Tube Collectors Deployable in Domestic Solar Water Heating Systems in Di ff erent Climate Areas.
[53] Zhang, H., Guo, J., Huai, X., & Cui, X. (2019). Thermodynamic performance analysis of supercritical pressure CO2 in tubes. International Journal of Thermal Sciences, 146(September), 106102.
[54] Zhang, X. W., Niu, X. D., Yamaguchi, H., & Iwamoto, Y. (2018). Study on a supercritical CO2 solar water heater system induced by the natural circulation. Advances in Mechanical Engineering, 10(4), 1–15.
[55] Yamaguchi, H., Sawada, N., Suzuki, H., Ueda, H., & Zhang, X. R. (2010). Journal of Solar Energy Engineering, Transactions of the ASME, 132(1), 0110101–0110106.
[56] Zhang, X. R., Yamaguchi, H., Fujima, K., Enomoto, M., & Sawada, N. (2006). JSME International Journal, Series B: Fluids and Thermal Engineering, 48(3), 540–547.
[57] Shahi, M., Mahmoudi, A. H., & Talebi, F. (2010). International Communications in Heat and Mass Transfer, 37(10), 1535–1545.
[58] Lu, L., Liu, Z. H., & Xiao, H. S. (2011). Thermal performance of an open thermosyphon using nanofluids for high-temperature evacuated tubular solar collectors. Part 1: Indoor experiment. Solar Energy, 85(2), 379–387.
[59] Mahendran, M., Lee, G. C., Sharma, K. V., & Shahrani, A. (2012). Performance of Evacuated Tube Solar Collectors using Water-Based Titanium Oxide Nanofluid. Journal of Mechanical Engineering and Sciences, 3(December), 301–310.
[60] Mahbubul, I. M., Khan, M. M. A., Ibrahim, N. I., Ali, H. M., Al-Sulaiman, F. A., & Saidur, R. (2018). Renewable Energy, 121, 36–44.
[61] Ozsoy, A., & Corumlu, V. (2018). Renewable Energy, 122, 26–34.
[62] Sharafeldin, M. A., & Gróf, G. (2019). Efficiency of evacuated tube solar collectors using WO3/Water nanofluid. Renewable Energy, 134, 453–460.
[63] Mevada, D., Panchal, H., ElDinBastawissi, H. A., Elkelawy, M., Sadashivuni, K., Ponnamma, D., Thakar, N., & Sharshir, S. W. (2019). Applications of evacuated tubes collectors to harness the solar energy: a review. International Journal of Ambient Energy, 0(0), 1–18.
[64] Alternative Energy Tutorials. (2010). Evacuated Tube Collectors for Solar Hot Water System.
[65] Sabiha, M. A., Saidur, R., Mekhilef, S., & Mahian, O. (2015). Progress and latest developments of evacuated tube solar collectors. Renewable and Sustainable Energy Reviews, 51, 1038–1054.
[66] Cost Analysis of Solar Thermal collectors - Efficiency Finder. (n.d.).
[67] Venkatacha, C., Mariam, S. G., & Chimdo Anc, A. (2018). Journal of Applied Sciences, 19(1), 1–8.
[68] Hoffmann, R., Brondani, M., Pappis, F., Friderichs, A., Serafini, S., & Foletto, E. L. (2014). Global Nest Journal, 16(6), 1100–1110.
[69] Kalogirou, S. A. (2004). Solar thermal collectors and applications. In Progress in Energy and Combustion Science (Vol. 30, Issue 3).
[70] Kim, H., Ham, J., Park, C., & Cho, H. (2016). Theoretical investigation of the efficiency of a U-tube solar collectors using various nanofluids. Energy, 94, 497–507.
[71] Yurddaş, A. (2020). Optimization and thermal performance of evacuated tube solar collectors with various nanofluids. International Journal of Heat and Mass Transfer, 152, 119496.
[72] Chopra, K., Tyagi, V. V., Pandey, A. K., & Sari, A. (2018). Applied Energy, 228(May), 351–389.
[73] Chopra, K., Pathak, A. K., Tyagi, V. V, Pandey, A. K., Anand, S., & Sari, A. (2020). Energy Conversion and Management, 203(July 2019), 112205.

# Chapter: 59

# Study of RCD on Industrial Commercial and Residential Electrical Safety: A Hazard Awareness

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**ABSTRACT**

Every human relies on electricity to power the operation and comfort of their businesses and homes. And they expect their electrical installations to be secure, to protect people from the risk of shock or electrocution, and to protect buildings against the risk of electrical fire. Although the municipal laws on electrical health and defensive equipment continue to improve, many risks still remain today. Hence the paper reflects on the real development in the electrical safety industry through innovative engineering technologies covering all sorts of industrial, business, residential safety. Thus, during electrical faults, the paper studies the function and importance of highly sensitive residual current device (RCD) and its defensive techniques. RCD is a protective device that detects the electrical faults and switch off the electricity automatically.

KEYWORDS: electrical shock; fire hazards; electrical safety; RCD

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## INTRODUCTION

Electromechanical devices could create an electrical shock and fire hazards by their own existence. During the construction of these devices one of the most critical aspects is to add effective protection against electric shocks and fire hazards to them. Residual Current Device (RCD) that can be referred to as a life-saving system intended to protect from lethal electric shock if anyone hit something live, like a bare cable. In addition, which can provide electronic fire safety. RCDs provide a specific degree of security that regular circuit breakers and fuses can't do. For example, when mowing the grass, you cut through the cable and inadvertently hit the uncovered active wires, or a defective device overheats allowing electrical current to spill to earth. The electrical current flowing through circuits is tracked by the residual device for securing it. During the tracking process if electricity is detected flowing in unexpected direction, automatically RCD can turn off the particular circuit reducing the risk of serious injury and death.

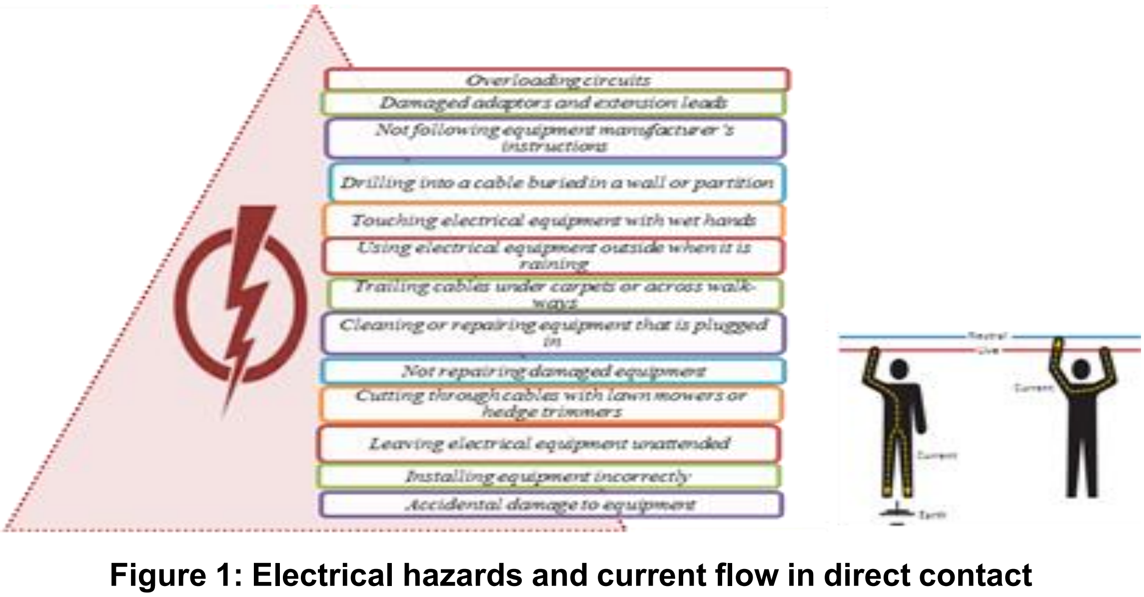


**Figure 1: Electrical hazards and current flow in direct contact**

Electrical devices like television, battery chargers, toasters, computers, electrical cookers, washing machines used to draw electrical power. In a house electrical installation comprised

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of three components (i) fuse or circuit breakers in main switch, (ii) lighting point and the permanent wiring to the power, and (iii) related power outlets, lights, switches on load side. However, there are certain possible dangers mentioned in Fig 1, even the fuse and circuit breakers are installed to the residential load.

**Significance of electric shock protection for human life safety:** The influence of electric shock on human body is complex, as they depend on both the time it flows and the current value. Ventricular fibrillation is the key reason people die from electric shock when the heart fails its usual pulse of contraction. The electric could happen directly, when direct contact with bare conductor or when contacting the equipment with leakage current. For instance, a current may be felt in the body of as small as 0.5 mA (0.0005 A), but usually the affected person will not be shocked. Currents between 0.5 mA and 10 mA are likely to be uncomfortable, triggering involuntary muscle contractions, but typically do not have any harmful effect. A 10 mA current (0.01 A) is considered the let-go threshold. When current is greater than this, it is not being possible to loosen the grip on an electrically active device. Currents that last for a long time between about 10 mA and 50 mA may cause severe breathing trouble, disrupt heart function, and muscle contractions. Considerable currents of more than 50 mA (0.05 A) can results burns, breathing problems, cardiac arrest and damages to tissue. With the size and length of the current the probability of this occurring increases. Alternating current (a.c.) is high risky than direct current (d.c.) because it affects the heart's natural rhythm more often.

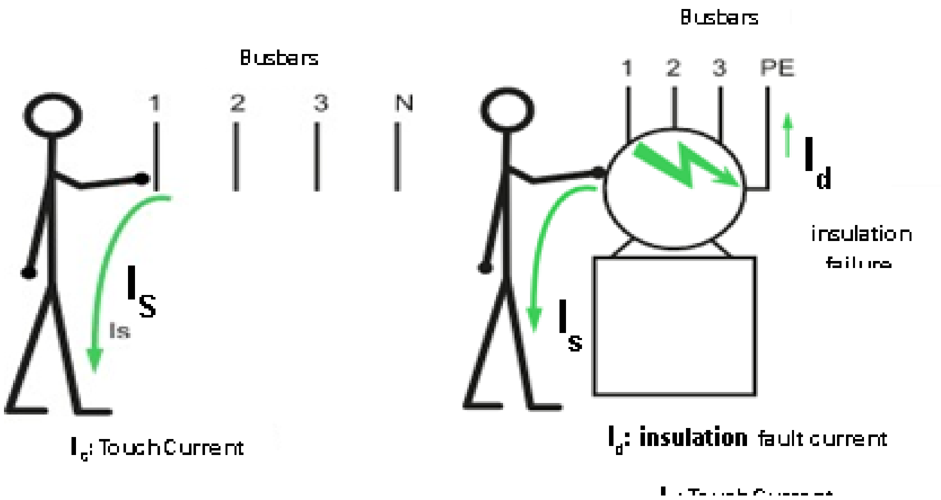


**Figure 2. Effect of electric shock during direct and indirect contact**

**Necessity of preventing electrical faults and fire hazards:** Electric fires in cables and connections are caused by electric arcs, earth leakage current, overloads and short circuits. Two types of faults are possible to occur within the electrical circuit. First if a live component comes in contact with the earthed metal works causes earth fault. It usually happens if a washing machine motor fails with insulation failure. Second, when a live conductor comes in contact with the neutral conductor may leads to short circuit current. These faults should be quickly detected and terminated because it may cause drastic heating and damages the electrical installation will result in set fire. The country wise registered accident data with their current are shown in Figure 3.

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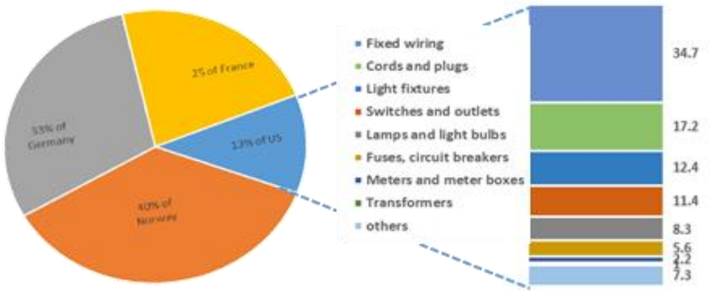


**Figure 3: Properties of electrical fires and causes of electrical distribution.**

Every year in Europe 2,000,000 fires are registered, causing more than 4,000 deaths, and 70,000 people are hospitalized because of serious injuries. On average, buildings account for 90 percent of fires in the EU. Electricity is a source of domestic fires which is reported quite frequently in [3]. Every year there are 280000 electrical fires in homes [4]. An electrical installation organization [4] reported the electrical fires proportions of different countries based up on the region and the investigative methods; 13 percent in the United States, 25 percent in France, 33 percent in Germany and 40 percent in Norway. In addition, according to the National Fire Protection Association's new statistics [5]; 41200 home structure fires are only due to 'electrical delivery' each year. Earlier figures compiled by FEMA [6] revealed very similar results: the fifth-ranking cause of fires was electrical distribution, the fourth-ranking cause of fire deaths and the second-ranking cause of property damage. The proportions of electrical fires and the causes of electrical distribution are depicted in Figure 3 and the preventive methods are imparted in Figure 4.

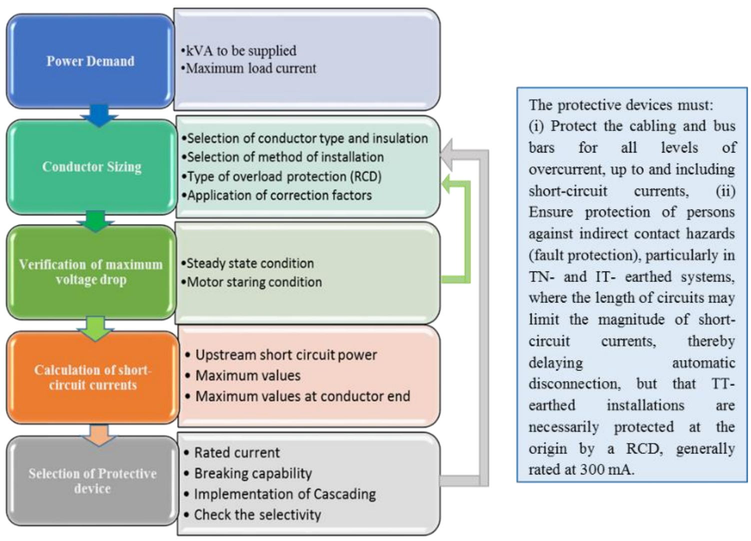


**Figure 4: Flow chart of selection of over current protective device**

**Fault protection devices for Electrical Hazards:** In general, there are various types of the safety devices used in electrical and electronic circuits. Among these, safety devices used to avoid electrical hazards are fuses and circuit breakers, residual current circuit breaker (RCCB), residual current circuit breaker with overload protection (RCCBO), earth leakage circuit breaker (ELCB), and residual current device (RCD).

**Fuses and circuit-breakers*:*** Contrary to common opinion, the fuse in an appliance socket is not intended to protect the device from overload but to protect the flexible wire that provides it from overheating in the event of failure (i.e. short circuit or earth failure). It should be consistent about what and not what a wire fuse does. If a device develops a fault the following problems

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may happens: A current that is too big causes the fuse to melt, (ii) prevents current flow, (iii) prevents flex overheating and causes fire, (iv) prevents further damage to the equipment. An integrated electromagnetic trip switch could secure the device itself. Consequently, as a result of direct contact, fuses and circuit breakers cannot provide protection against the very tiny electrical currents that pass through the body to earth. Residual current devices can afford this safety as defined in this technical article provided they have been selected correctly.

**Residual current circuit breaker (RCCB):** It is a mechanized switch together with the tripping feature of residual current connected in it. Essentially, it can only sever the circuit when leakage current to the earth. But, short circuit fault or over current cannot be detected by the RCCBs they need to be attached to a fuse or MCB (Miniature Circuit Breaker) in line. RCCBs usually have a break up power and fault-making of 1 kA. This means that if it is a fault to Earth they can accommodate a 1 kA fault on their own. The Wiring Laws allow other tools to provide protection for a line to neutral short circuits and overloads. The system used for protection against short circuits could boost the RCCB's short circuit rating when working together. RCCBs provide protection against earth leakage but a big point to bear in mind when installing them it should always be mounted in combination with a properly designed SCPD (Short Circuit Protective System).

**Residual current circuit breaker with overload protection (RCBO):** It is also a residual current system with a built-in MCB. RCBO is equivalent to residual current circuit breaker and MCB. Residual current circuit breaker together with overload protection have a significant act in (i) short circuit current and overload protection, (ii) earth fault current protection. The RCBO can be used in each one of the circuit, so that if fault occur in one circuit it does not affect the subsequent circuits.

**Earth leakage circuit breaker (ELCB):** This circuit breaker is mainly designed mainly for industrial requirement. It allows the selectivity between different circuit breakers through adjusting the threshold of tripping delay and residual current. Its main function is to protect from ground breaker fault and works with combination with circuit breaker. ELCB follows the IEC 62020, standard which focus on monitoring and isolation of the network. It also shields human lives from electric shocks. The primary usage is for the manufactures who need the tripping time in the production chain.

**Residual current device (RCD):** An additional direct contact protection is provided by RCD. It measures the current size of the neutral and live conductors. Also the circuit of the residual current device is design to easily detachable following the size of the threshold size. The RCDs reacts within 0.04 seconds and it is rated 30mA. If anyone touches the RCD circuit directly one do experience the nonlethal electric shock.

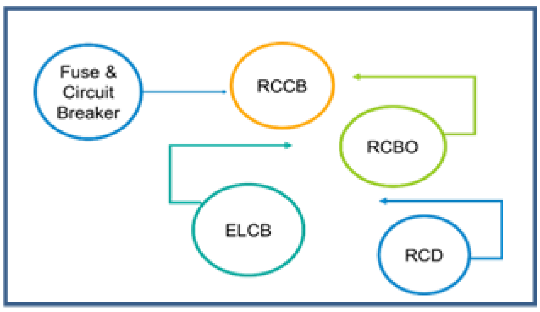


**Figure 5: Different types of protection devices**

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**Critical review on high sensitivity residual current device (RCD):** High sensitive residual current device uses residual current for its operation at rated 30 mA or less, if offers many protections against the electrical hazards from interaction with live parts. Different reasons to fall in fault is considered which includes (i) improper maintenance, (ii) abrasion and bending of connecting leads (iii) insulation fault (natural tear and wear) (iv) carelessness (v) water immersion and (vi) unintentional touching. This rapid tripping device identify the residual currents to the earth and detach the power supply automatically in order to protect human or animal lives. RCD devices calculates the residual current and identify the difference in the input current and output current leaving the system with earthed source. To provide the rapid security, it follows the IEC 61008 and IEC 61009 standard. Therefore, it offers extra protection where standard protection entails failures like human error, damaged or old insulation etc. It can interrupt the current even in the device failure and terms as ultimate protection device. For instance, in the case of greenhouse possibility of proportion of electrocutions is high, wherein the people are in contact with earth. A low track of resistance can be deployed by damp ground for the passage of electric shock through the body. In other way, RCD can be attached with the fuse box to have in the existing system. Moreover, there are plug-in RCDs available that are cost-effective, and can literally save lives. Residual current instruments (RCDs) are usually used to protect against over direct and indirect interactions.

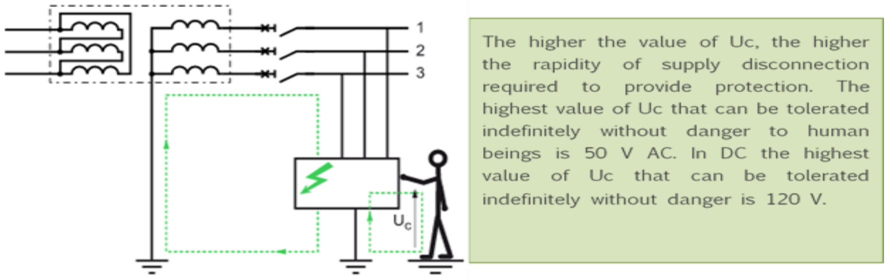


**Figure 6:** Illustration of dangerous touch voltage Uc

**Types of RCDs:** An appropriate safety device with a suitable level of sensitivity should be introduced and applied to identify a line to earth fault and insulation fault which may leads to fire hazard or electrical shock. The operating algorithm of the protective system depends on the power network, special signals, detection of nonlinear sinusoidal alternating earth faulty current, DC current, distorted voltages, current comprising component of low frequency system, detection of an arc failure, higher order harmonics, power electronic converter circuits. The international standards consider the following types of RCDs in accordance of their sensitivity and the shape of waveform AC-type: only intended for residual sinusoidal currents of 50/60 Hz,

**A-type:** intended for waveforms similar to AC-type RCDs and residual DC-pulsing currents with a smooth DC portion up to 6 mA;

**F-type:** designed for waveforms, the same as for A-type RCDs (but the smooth DC portion can be increased up to 10 mA) and mixed-frequency residual currents; the RCD must be provided from one single phase.

**B-type:** designed for residual currents: designed for sinusoidal waveforms up to 1000 Hz, pulsating DC, smooth DC, and also mixed frequency. It can be concluded that nowadays A-type RCDs are the most common RCDs used in low voltage systems.

**Selectivity of residual current device:** Selectivity of residual current device is accomplished

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either by delaying time or by splitting circuits which are then separately or jointly protected, or by combining the two methods together. Such selectivity protects any RCD tripping, rather than the one instantly upstream of a fault detection. Withthe device presently offered, selectivity at different distribution levels is achievable, systems for automated disconnection in case of indirect contact danger are placed on distribution panel boards andon security of electrical appliances, along with added safety against direct interaction hazards.

## CONCLUSION

Electrical devices are frequently handled with currents and voltages which is inherently harmful to animals, humans and structures. Those dangers can be caused by physical interaction, overloading, short circuiting, and loss of component, or impact of heat or moisture. An RCD can sense lowcurrents of leakage that can pass through a person's body. The paper has studied on RCD for electricalsafety as well electrical hazards and its causes that are also described in detail. Moreover, during electrical faults, the paper studies the function and importance of highly sensitive residual current device (RCD) and its defensive techniques. This residual current device is a protective device, whichdetect the electrical faults and switch off the electricity automatically. The ensuing possible dangers have to be eliminated by precautionary planning and architecture combined with fault analysis and detection system. Therefore, the study helps the readers to understand the importance of electrical safety and give awareness about the electrical hazards.

## REFERENCES

[1] IEC. IEC 61140:2016. Protection Against Electric Shock–Common Aspects for Installation and Equipment; International Electro technical Commission: Geneva, Switzerland, 2016.

[2] CENELEC. HD 60364-4-41:2017. Low-Voltage Electrical Installations–Part 4-41: Protection for Safety–Protection Against Electric Shock; European Committee for Electro technical Standardization: Brussels, Belgium, 2017.

[3] IEC. IEC TS 60479-1:2016 Effects of Current On Human Beings and Livestock. Part 1: General Aspects; International Electro technical Commission: Geneva, Switzerland, 2016.

[4] Marty Ahrens “Home structure fired” from Nation home protection association issued October 2019

[5] V.Babrauskas at the 7th international Fire & Materials conference, 2001, San Francisco, USA, pp39-Proceedings are available from the publisher, Interscience Communications, UK

[6] Liu, Y.; Xie, X.; Hu, Y.; Qian, Y.; Sheng, G.; Jiang, X. A novel transient fault current sensor based on the PCB Rogowski coil for overhead transmission lines. Sensors 2016, 16, 742.

[7] Granizo, R.; Blánquez, F.R.; Rebollo, E.; Platero, C.A. A novel ground fault non-directional selective protection method for ungrounded distribution networks. Energies 2015, 8, 1291–1316.

[8] Bao, G.; Gao, X.; Jiang, R.; Huang, K. A novel differential high-frequency current transformer sensor for series arc fault detection. Sensors 2019, 19, 3649.

[9] Yang, K.; Zhang, R.; Chen, S.; Zhang, F.; Yang, J.; Zhang, X. Series arc fault detection algorithm based on autoregressive bispectrum analysis. Algorithms 2015, 8, 929–950.

[10] Sułowicz, M.; Ludwinek, K.; Tulicki, J.; Depczyn´ski, W.; Nowakowski, Ł. Practical adaptation of a low-cost voltage transducer with an open feedback loop for precise measurement of distorted voltages. Sensors 2019, 19, 1071.

[11] Rabcan, J.; Levashenko, V.; Zaitseva, E.; Kvassay, M.; Subbotin, S. Application of fuzzy decision tree for signal classification. IEEE Trans. Ind. Inf. 2019, 15, 5425–5434.

[12] Czapp, S. The impact of DC earth fault current shape on tripping of residual current devices. Elektronika ir Elektrotechnika 2008, 4, 9–12.

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# Chapter: 60

# Artificial Intelligence Application in Mechanical Engineering

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**ABSTRACT**

With the development of computer technology, the application of artificial intelligence technology is more and more extensive. This paper summarizes artificial intelligence technology, including its development process, and composition. What's more, the concept of mechanical and electronic engineering is introduced and the relationship between mechanical and electronic engineering and artificial intelligence technology is analysed. Finally, the development of artificial intelligence in mechanical fault diagnosis is summarized. Taking the fault diagnosis of the hot forging press as an example to illustrate the specific application of artificial intelligence in mechanical engineering.

**KEYWORDS:** artificial intelligence, mechanical and electrical engineering, machine learning, neural network, fault diagnosis.

## INTRODUCTION

Artificial intelligence is an emerging technology science that studies and develops the theory, technology and application systems for simulating and extending human intelligence, involving disciplines such as psychology, cognitive science, thinking science, information science, systems science and bioscience. Artificial intelligence is in fact the simulation of the process of data interaction of human thinking, hoping to understand the essence of human intelligence and then produce a smart machine, this intelligent machine can be the same as human thinking to respond and deal with the problem [1]. With the continuous progress of science and technology, mechanical engineering is also constantly evolving and changing, from traditional mechanical engineering to electronic mechanical engineering. And its level of automation and intellectualization has continuous improvement, it went into a new stage of development, thus, the combination of artificial intelligence technology and mechanical and electronic engineering has become a hotspot.

Artificial intelligence technology is applied under the premise of the development of computer technology, which improved computer technology through the analysis of it to achieve the realization of intelligent technology. When Intelligent technology is applied in mechanical and electrical engineering, it mainly achieved the automation control of mechanical engineering, the applications of artificial intelligence in mechanical and electrical engineering is not only the use of computer technology but also combined with information technology, psychology, linguistics and other knowledge [2]. The purpose of this paper is to report the composition and development of artificial intelligence, as well as the relationship between artificial intelligence and mechanical and electronic engineering. Most importantly, it aims to study how artificial intelligence is applied in the field of mechanical and electrical engineering.

### The Research Direction of Artificial Intelligence:

**Machine Learning:** Machine Learning (ML), which mainly focuses on how the computer simulates human learning behaviour, reorganizes the existing knowledge structure with the knowledge and skills learned and continuously improves its performance. Machine learning is the core of artificial intelligence, and it is the only way for computers to have their own intelligence. At present, machine learning is used in all areas of artificial intelligence but cannot be used for deductive reasoning [3].

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**Expert System:** Expert system (ES) is another important branch of artificial intelligence research [4]. It will explore the general way of thinking about the use of specialized knowledge to solve specific problems. ES will make the theoretical research of artificial intelligence into practical application; an expert system can be seen as a kind of specialized knowledge of computer intelligent program systems, it can use expertise and experience provided by experts in specific areas and the use of reasoning techniques in artificial intelligence to solve and simulate complex problems that can often be solved by experts. A basic expert system consists of a knowledge base, database, reasoning machine, interpretation mechanism, knowledge acquisition and user interface, as shown in Figure 1.

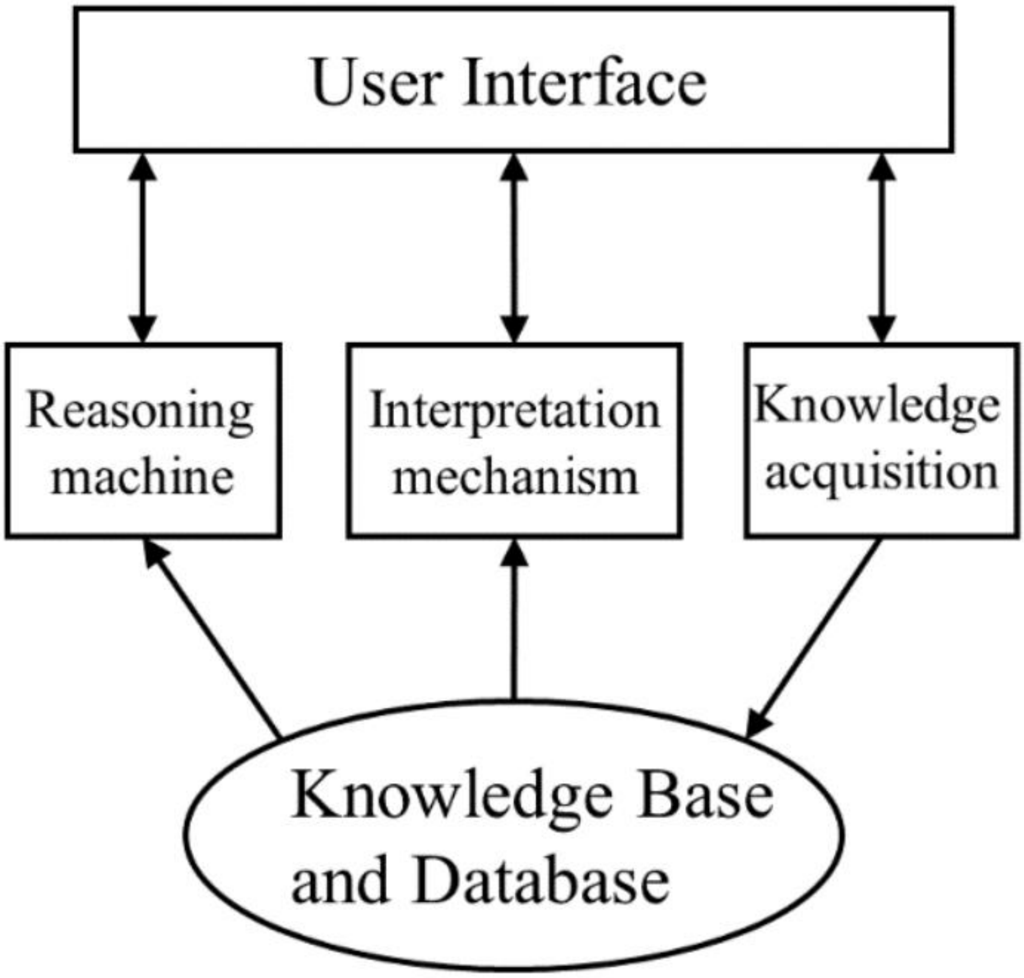


**Fig. 1 The basic structure of the expert system**

**Pattern Recognition:** Pattern recognition research mainly includes two aspects: one is the method of perception of the object, which belongs to the understanding of the scientific category; the other one is to achieve pattern recognition with the computer under the condition of the task of the case is determined. The former is the research content of physiologists, psychologists, biologists and neurophysiologists. The latter has been systematically researched by the efforts of mathematicians, informatics experts and computer science workers, and has been applied in text recognition, voice recognition, fingerprint identification, remote sensing and medical diagnosis, etc., it has greatly facilitated people's lives.

**Neural Network:** Artificial Neural Network (ANN) is an arithmetic model obtained by ABSTRACTing the human neural network from the perspective of information processing. It is composed of a large number of neurons connected with each other. Each neuron represents a specific output function, called an excitation function. The connection between each of the two neurons represents a weighting through the connected signal, called the weight. When the neural network connection mode, weight and incentive function change, the network output also will change [5].

**Deep Learning:** The concept of deep learning comes from artificial neural network research, belonging to a new field of machine learning [6]. Depth learning refers to artificial intelligence beginning to learn, train, self-mastery concepts, and recognize sounds, images and other data from untagged data. This approach is closer to the human brain. Deep learning is mainly to build a deep structure to learn multi-level representation, not specifically referring to a machine learning algorithm or model, but a technology.

**The Concept of Mechanical and Electronic Engineering:** Mechanical and electrical engineering is a science and technology covering all kinds of science, the core of which is mechanical electronics, combined with related knowledge of information technology and intelligent network. The theory of these disciplines has been widely used in mechanical and electrical engineering. In the design of mechanical and electrical engineering, it is necessary to integrate computer technology, network technology and mechanical-related technology, combining the different mechanical components to improve the design. Although the knowledge is very complex in the design of mechanical and electronic engineering, the design is relatively simple, the structure is not complicated and has good performance. Mechanical and electronic engineering has high efficiency in, small size when it went to production, which replaced the traditional machinery [7].

**The Relationship between Artificial Intelligence and Mechanical and Electronic Engineering:** With the rapid development of electronic information, mechanical and electronic engineering as a basic discipline has been widely used in our life. But mechanical and electronic engineering also has shortcomings, such as the unstable system, the reason for the problem is the imperfect factor of the electronic information system. Artificial intelligence itself can quickly transfer information and timely process it, which can effectively make up for this shortcoming. In the process of input and output in mechanical and electronic engineering, the electronic information system will face a lot of difficulties and resistance, if the input information is too complex, the electronic information system is likely to make a mistake, and then you need to manually solve the problem. If you can combine the two features, you can solve the problems and shortcomings of mechanical and electrical engineering.

**Application of Artificial Intelligence in Mechanical Engineering:** At present, artificial intelligence technology is often used in the diagnosis of mechanical engineering failure [8-10]. In general, artificial intelligence-based fault diagnosis techniques include rule-based reasoning (RBR), case-based reasoning (CBR), and fault-based tree fault diagnosis.

Based on the basic composition and basic principle of the traditional expert system, a mechanical fault diagnosis expert system based on RBR and CBR reasoning is constructed. The overall structure is shown in Figure 2. The system includes a maneuver case database, fault diagnosis rule database, fault diagnosis database, fault reasoning machine, knowledge processing, the fault diagnosis process interpreter, learning system and expert system man-machine interface.

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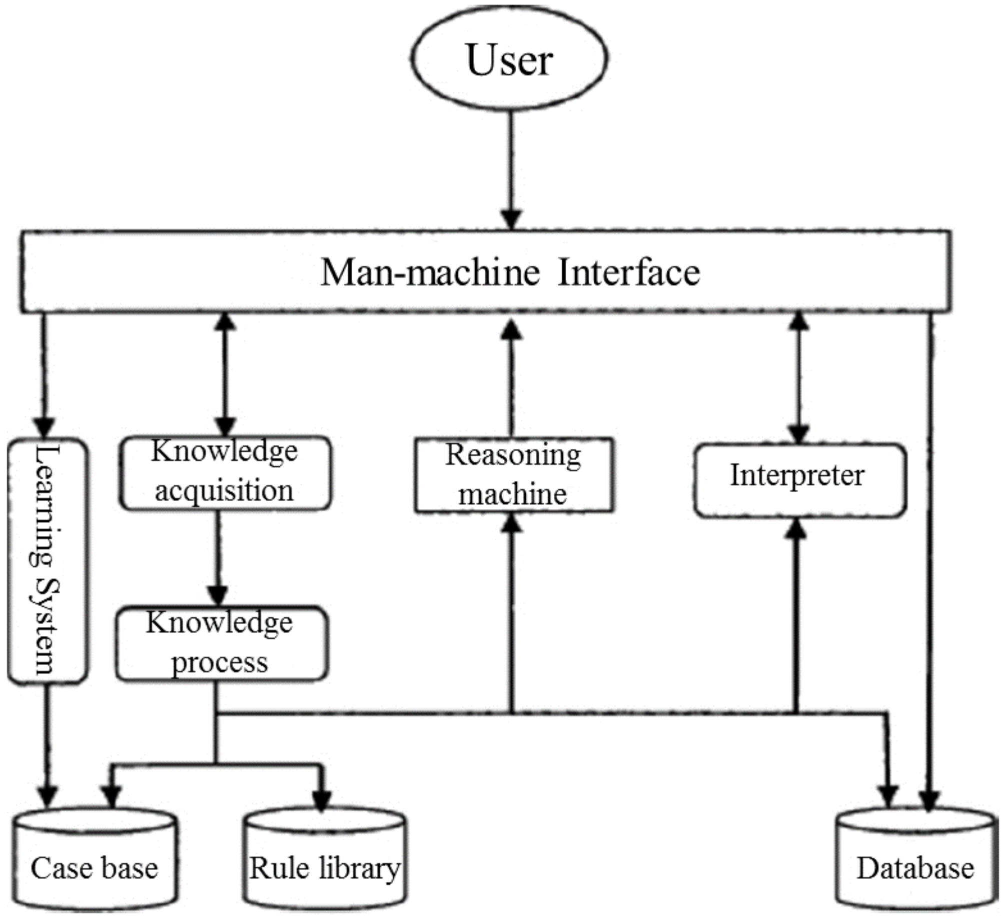


**Fig. 2 The overall structure of the system**

The basic working process of the diagnosis system is: Firstly, the user inputs the online data monitored by the machine through the man-machine interface. Secondly, the reasoning machine activates the corresponding rules to obtain diagnostic results according to the positive reasoning mechanism, it will provide diagnostic expert advice, and then retrieve the case in the database through a certain algorithm, subsequently, get the most similar case, calculate the similarity according to the historical case, and complete the mechanical fault diagnosis with high efficiency. Finally, it will further improve the expert diagnosis system by adding new cases.

**Intelligent Diagnostic System for Rotating Machinery:** From the situation of fault diagnosis of mechanical equipment, during the development of several years, the theory and method of fault diagnosis technology of rotating machinery have been improved day by day. In practical application, it has achieved great economic benefits. In this paper, the fan diagnosis system is used as an example, in fact, it is the universal integrated neural network diagnosis system in the fan fault diagnosis application. The system is composed of two parts: a fan and a motor. According to the type of monitoring parameters, the main system can be divided into five subsystems: vibration, temperature, noise, oil and performance, in which the fault diagnosis and decision system is the core of the whole intelligent system.

**Intelligent Diagnosis System for Reciprocating Machinery:** Because the reciprocating machinery has a set of high-speed reciprocating motion qualities, its kinematics and dynamic morphology is much more complex than the rotating machinery, fault diagnosis is more difficult. The research on failure mechanisms and diagnostic methods of research not enough. The diesel engine is a typical reciprocating machine; an integrated neural network diagnosis

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system is actually a universal integrated neural network diagnostic system in the applications of diesel engine fault diagnosis.

Diesel engine failure can be divided into performance failure and mechanical failure. The diagnosis of performance faults can be achieved using a sub-neural network, with performance parameters as input, such as power, speed, cylinder pressure, water temperature and so on. The mechanical fault is diagnosed by two sub-neural networks and the integrated neural network the diagnosis system is formed by using the commonly used vibrio acoustic (VA) signal and oil analysis information as input.

**Application of Fault Diagnosis to Hot Film Forging Press:** In the process of production of hot forging presses, it will produce some common serious problems, such as the slider stopping outside the location of the top dead center, a stuffy car, the main motor current being too high, and lubrication failure. There are many reasons for these failures, and the fault diagnosis method of the hot forging press can be combined with rule reasoning and case reasoning [11].

The fault diagnosis of the production process of the hot forging press is based on the rule reasoning and the case reasoning. The system carries out the relevant rule reasoning and case reasoning according to the case in the case library and establishes the number of failures. And the nearest neighbor algorithm is used to analyses the similarity of case matching. The algorithm is as follows:

$$sim(X,A) = \sum_{i=1}^{n} w_i sim_i(f_i^X, f_i^A) / \sum_{i=1}^{n} w_i$$

Where $w_i$ is the weight of the $i^{th}$ attribute, $f_i^x$ represents the value of the $i^{th}$ attribute of the fault X, $f_i^A$ presents the value of the $i^{th}$ attribute of ase A, $sim_i(f_i^X, f_i^A)$ similarity of the fault X and the retrieval case A, $\sum_{=1}^{n} w_i = 1$ .Different types of aribute values, the calculation method of $sim_i(f_i^X, f_i^A)$ is not the same:

The value of the attribute of the string type is calculated by the TF-IDF method. The similarityis expressed by the cosine of the angle of the weight vector, which is shown in Equations (2) and (3)

$$w_i = f_i * \lg(\frac{N}{N_j + 1}),$$

$$sim(X,A) = \frac{\sum_{j-1}^{t}\left[f_{xj} * \lg\left(\frac{N_x}{N_{xj}+1}\right)\right][f_{aj} * \lg(\frac{N_A}{N_{Aj}+1})]}{\sqrt{\sum_{j-1}^{t}\left[f_{Xj} * \lg\left(\frac{N_x}{N_{Xj}+1}\right)\right]^2}\sqrt{\sum_{j-1}^{t}[f_{Aj} * \lg\left(\frac{N_A}{N_{Aj}+1}\right)]^2}}$$

Where, j represents the attribute of string type, j =1,---,t, $f_{Xj}$ and $f_{Aj}$ is the frequency of thefault; N, NX and NA represent the total number of string type attributes in the case; Nj, NXj and NAjrepresent the number of occurrences of a string type attribute in the case.

For the value type attribute is the range of [a,b], the calculation of $sim_i(f_i^X, f_i^A)$ is asfollows:

$$\boldsymbol{sim_i(f_i^X, f_i^A) = 1 - \frac{|f_i^X, f_i^A|}{b-a}; \; f_i^X, f_i^A \in [a,b]}$$

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The results of case matching are listed in the similarity degree from large too small. The design engineer uses the larger similarity fault diagnosis to design scheme and sets a similarity threshold δto improve the diagnosis efficiency.

## CONCLUSION

This paper reviews the composition and development of artificial intelligence, as well as the relationship between artificial intelligence and mechanical and electrical engineering. It also summarizes the relevant applications in the field of mechanical engineering. Theoretical and practical research shows that intelligent technology has been widely used in all aspects of mechanical systems, coupled with the discovery of knowledge and distributed artificial intelligence and other computer technology, which makes artificial intelligence more effective in the mechanical system and other areas. Because of the increasingly fierce competition in the machinery industry, the hybrid intelligent design, monitoring, control, diagnosis system based on fuzzy logic, neural network, expert system, will be a new research hotspot in order to improve the level of its intelligent control. These applications have very promising prospects.

## REFERENCES

[1] P Norvig, SJ Russell. Artificial intelligence: a modern approach [J]. Applied Mechanics & Materials, 2003, 263 (5): 2829-2833.

[2] RA Brooks. Intelligence without representation [J]. Artificial Intelligence, 1991, 47 (1–3): 139-159.

[3] DE Goldberg, JH Holland. Genetic algorithms and machine learning [J]. Machine Learning, 19883 (2): 95-99.

[4] B Chandrasekaran. Generic tasks in knowledge-based reasoning: High-level building blocks for expert system design [J]. IEEE Expert, 1986, 1 (3): 23-30.

[5] MH Hassoun. Fundamentals of artificial neural networks [J]. Proceedings of the IEEE, 1996, 84 (6): 906.

[6] Y Lecun, Y Bengio, G Hinton. Deep learning [J]. Nature, 2015, 521 (7553): 436-444.

[7] W Bolton. Mechatronics electronic control systems in mechanical and electrical engineering [J]. Fish Physiology & Biochemistry, 2009, 35 (3): 385-398.

[8] H Yang, J Mathew, L Ma. Intelligent diagnosis of rotating machinery faults - A review [M]. Pattern Recognition & Data Mining, 2002

[9] LB Jack, AK Nandi. Fault detection using support vector machines and artificial neural networks, augmented by genetic algorithms [J]. Mechanical Systems & Signal Processing, 2002, 16 (2-3):373-390.

[10] A Siddique, GS Yadava, B Singh. Applications of artificial intelligence techniques for induction machine stator fault diagnostics: review [J]. IEEE International Symposium on Diagnostics for Electric Machines, 2003, 49 (3): 29-34.

[11] WH Wen. Application of artificial intelligence technology in mechanical and electronic engineering [J]. Automation and instrumentation, 2016, 2: 96-97.

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# Chapter: 61

# Reduction in Cooling Capacity of the Room by Earth Air Tunnel Heat Exchanger

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**ABSTRACT**

In this work, we have developed an earth air tunnel heat exchanger (EATHE) model in Ansys fluent and obtained results. The case study has been selected where the outlet of the EATHE is supplied in the room. The room has an air conditioner that operates in the vapor compression refrigeration cycle. Initially, the outlet of the EATHE is supplied in the room. In this work, CFD model EATHE has been used for analysis in cooling mode using ANSYS Fluent 16.5. The EATHE model consists of 23 m length of spiral mild steel pipe. The diameter of pipe is 0.15 m and thickness of mild steel pipes is 0.005 m the and velocities of air 2 m/s. The case study was taken for the small room and reduction in cooling load was calculated. Initially cooling capacity of the room is found to be ___ based on the outlet condition of 47.6°C DBT and Relative humidity in Bikaner region, Rajasthan, India. Air from the EATHE is passed into this room and reduction in cooling capacity of the room is found to be___%. This or compression refrigeration cycle will result in reduction in electricity consumption of the vapor compression refrigeration cycle.

**KEYWORDS:** Thermal conductivity, CFD, Temperature, Velocity, Earth Air Tunnel Heat Exchanger.

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## INTRODUCTION

The current world scenario facing energy crisis because of deplete in fossil fuels, so we are in need to find the alternative sources of energy which can satisfy the future energy needs. Non-conventional sources of energy are better alternatives which can be found abundantly on earth [1]. Air-conditioning are the commonly used households and industrial appliances for cooling. The common working fluids used in these devices are CFCs are hazardous to human beings and which depletes the ozone layer of the atmosphere. Alternative refrigerants are developed by the scientists in order to overcome the problems associated with the energy consumption, environmental pollution and performance [2, 3]. In this regard one of the alternative is EATHE. EATHE are modern device in which tubes are buried under the earth at 1.5m to 2.5 m. the temperature will remain constant at this depth and it is equal to annual average temperature. The constant temperature will remain lower in summer and it can be utilized for the cooling, similarly it can be utilized for heating in winter conditions. EATHE is made up of metallic, concrete or plastic tubes which is buried under the earth which cann utilize the heat capacities of the earth for heating and cooling conditions. EATHE are used as a source in the winter and sink in the summer. EATHE can be effectively used as a cooling system if the cooling load requirements are met or else it can assist the cooling systems by saving the enormous amount of energy. Many researchers have find out that EATHE can reduce the energy consumption enormously and it can be used for building heating and cooling conditions [4–6]. The important factors which affect the performance of EATHE system are surface condition, temperature and moisture [7]. The classification of the site for EATHE is based on the geological properties. It also depends on the physical, thermal properties, depth of water, depth of bed rock etc. [8–16].Kabashnikov et al. [17] they investigated mathematical and numerical model for EATHE. This model shows the temperature variation in terms of Fortier integral. This model is presented for 2m depth for the number of tubesKumar et al. [18] Calculated performance of the system without air-conditioning. He developed the numerical model in which the temperature of the outlet is reduced to $9.75^{0}$C and he takes the length of the EATHE as 20 m.

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Jens pfafferott [19] In this study, first behavior of temperature is plotted over the time and characteristics lines the second energy gain in is drawn on standardized graph and third parametric model is provide to calculate the efficiency. M. De Paepe and A. Janssensh [20] Investigated the thermo hydraulic performance of the EATHE. One dimensional analysis was used to design the parameters of EATHE. They derived the relation for the pressure drop and linking the pressure drop with the thermal effectiveness of the tube. They developed the relation which gives optimal thermal effectiveness with least pressure drop which is accepted.

Ghosal et al. [21]investigate the thermal modelling of the recirculated EATHE. All year round performance was studied for the effectiveness of the EATHE located d\in IIT Delhi India. Performance was based on the thermal loading level and COP for summer and winter day in ayear of 2002. Results shows that temperature was 6-7 °C more in winter and 3-4°C less in summer compared to the green house operating without recirculated EATHE.Ghosal et al. [22] Investigated thermal performance of ground air collector and EATHE. He found there is a 2-3 °C increase in temperature in winter. EATHE and ground air collector are found to be more effective than EATHE with the similar length of the pipe in winter conditions. Anticipated and experimental temperatures of greenhouse air in models developed for EATHE and ground air collector are in good agreement Tiwari et al. [23] investigate annual thermal performance of greenhouse with an earth-air heat exchanger In this paper thermal model given by Cihoshal and Tiwari has been validated by the round year experimental work at the IIT Delhi, India. Correlation coefficient and the root-mean-square percentage deviation have been computed for the each month for validation of thermal model. The values are 0.99% and 4.24% for greenhouse temperature with an earth to air heals exchanger in the month of January. The experimental work is validated to the thermal model developed by the Ghoshal and Tiwari. The temperature of greenhouse increases and decreases by the 8°C and 4°C in summer and in winter due to use of an earth air tunnel heat exchanger. Earth air tunnel heat exchanger is more effective in summer than winter, because of the higher temperature prevailing in greenhouse in summer. Kumar et al. [24] Investigate heating and cooling potential of an earth air heat exchanger using artificial neural network. In this paper used the concept of artificial neural network and design tool to propose a computer design tool that can help designer to evaluate any aspect of the earth air heat exchanger and the behavior of final configuration. This study focuses mostly on those aspects related to passive heating or cooling performance of building. Two models have developed for deterministic and intelligent. In this work we have simulated the EATHE in ANSYS Fluent 14.5 and the results are validated with the experimental data and it shows and good agreement. Case study has been selected in which room of known size is taken for study and outlet air from the heat exchanger is passed into this room. The percentage decrease in cooling load is calculate and there is good decrease in the electricity consumption and increase in the performance.

## METHODOLOGY

The computational fluid dynamic (CFD) are a powerful method to study heat and mass transfer from many years. CFD codes are structured around numerical algorithms that can tackle fluid flow problems. CFD provides the numerical solutions of partial differential equations witch governing airflow and heat transfer in a discretised form. The complicated fluid flow and the heat transfer processes involved in any heat exchanger can be examined by CFD software, FLUENT 14.5. The CFD codes in FLUENT contain three main elements as shown in fig.2.

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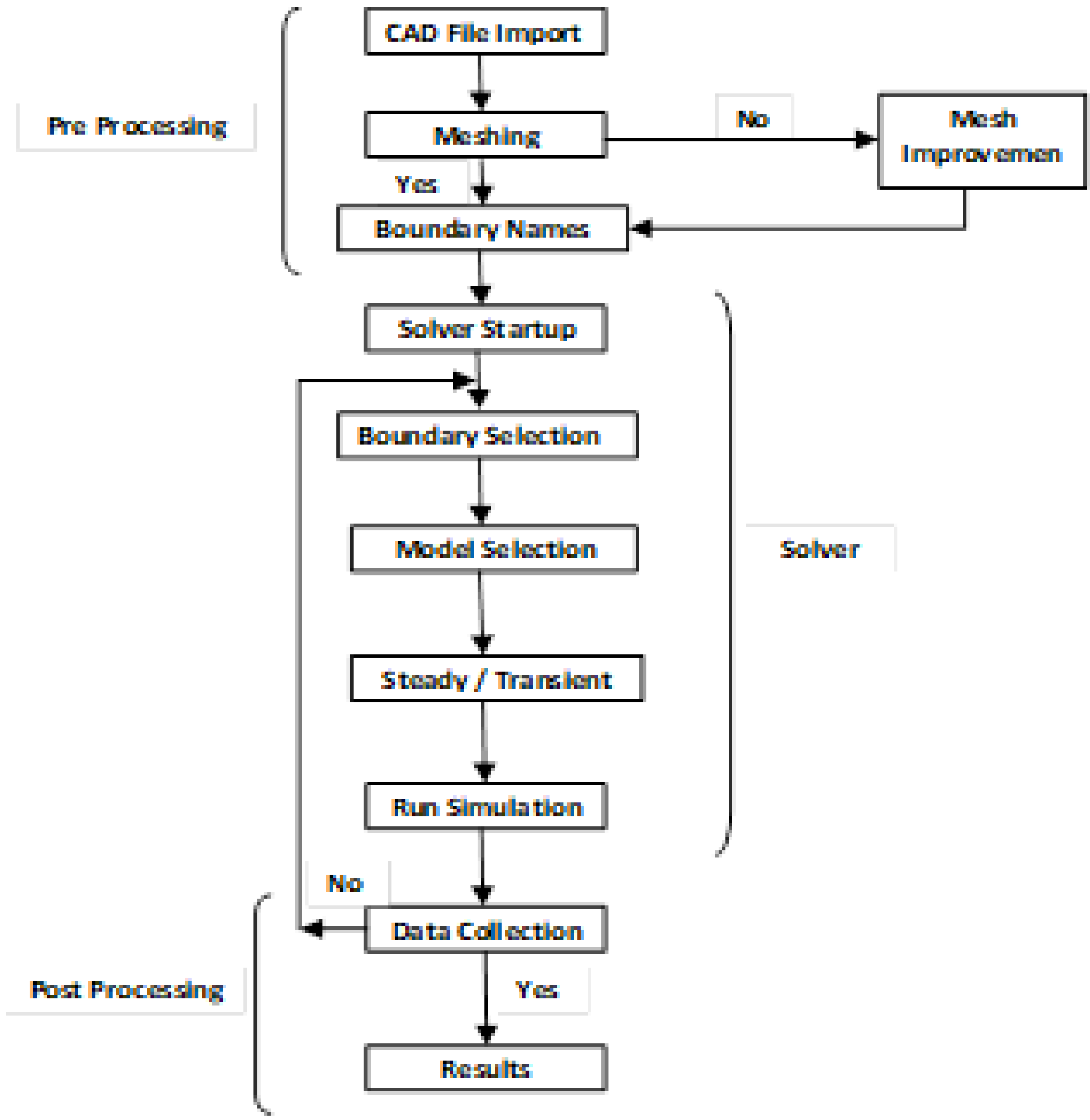


**Fig.1 Flow Chart of CFD Methodology**

(i) Pre-processor

(ii) Solver

(iii) Post-processor.

Pre-processor are consists of input of a flow problem to a CFD program by means of definition of geometry of the region of interest. The CFD domain generating grid to subdivision of fluid domain. The domain is dividing into a number of sub domains. The sub-domains are a grid (or mesh) of cells (or control volumes or elements), with or touch the domain boundary.

Solver uses finite control volume method for solving the governing equations of the fluid flow and heat transfer. Post-processor shows results of the simulations using vector plots, contour plots, graphs, animations, etc.

The present CFD EATHE model is prepared by using CATIA P3 V5R14. The CATIA is very important tool for preparing geometry. Since EATHE model is of cylindrical shape are considering the three parts via outer, middle and, inner which are the material of soil, steel pipe and air (fluid) which is shown in fig 3.

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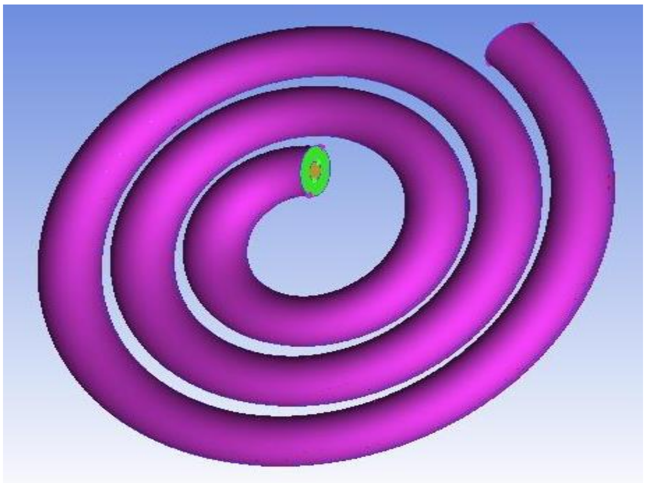

**Fig. 2 EATHE Model**

The next step in pre-processing stage is generation of mesh to be used in the ANSYS FLUENT. ANSYS ICEM is used for generating the mesh of the geometry. The tetrahedral meshing is used for mesh the EATHE model. Since our geometry is quarter third part, so the symmetry is created for the meshing. Since air enters from the one end of the pipe this is the 'inlet' and leave from 'outlet' created in the model which is shown in fig4.

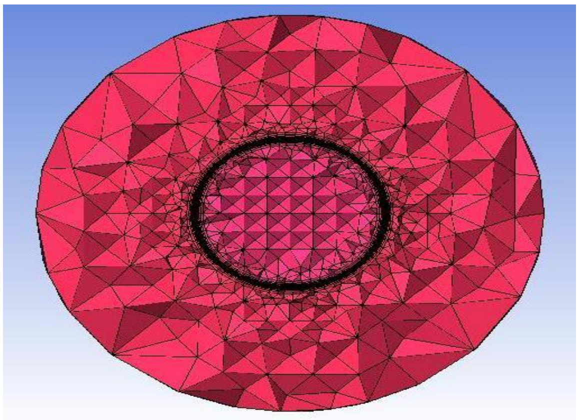

**Fig. 3 Meshing of EATHE**

The environment temperature of Bikaner which is used as the inlet temperature of the EATHE analysis model, during the summer Maximum temperature is 47.6 $^0$C.

**Case study:** A room was selected whose size is 30m by length, 5m by width and 4m by height in which one light and fan was installed. The room has an one window. In this room the total cooling load was calculated using standard procedure and reduction in cooling load was calculated when we use EATHE. Inside condition was assumed to be 25 $^0$C and 50% relative humidity. This assumption is based on the human comfort condition from ASHRAE handbook. Outside condition was taken as 43 $^0$C dry bulb temperature and 24 $^0$C wet bulb temperature for Bikaner region, Rajasthan, India. Corresponding values for the calculations are calculated from the standard psychometric chart. Total cooling load was calculated by summing up sensible heat and latent heat. For sensible heat, heat transfer through walls, roof, floor, infiltration load and glass are considered. For latent heat heat transfer through person and infiltration load are considered. Initially the total cooling load was calculated and then percentage reduction in cooling load was calculated by inserting EATHE pipe in this room. The length of EATHE is 23.42m and its diameter is 0.15 m. the EATHE is buried inside the ground

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at 3m depth. EATHE is validated using experimental data's. Output of the EATHE is supplied into the room and the reduction in cooling capacity of the room is calculated by calculations.

**Data analysis**

- External Heat Gain
- Cooling Load Due to Conduction Heat Gain through the Walls (north & south sides)

**Material of the wall**: The wall is made of a concrete block, rectangular core sand and gravel aggregate with cement plaster sand aggregate in both sides Solar heat Gain through Glass. When the sun's ray strikes a pane of glass, a small amount of energy is reflected, glass absorbs some energy with consequent rise in temperature, but greater part of the energy striking the surface passes through the glass. The solar heat gain inside the conditioned space through glass is given by:

$Q_{glass}$ = Radiation transmitted + Inward Flow of Absorbed + Conduction Heat Gain Through Glass

Solar Radiation = Solar Heat Gain + Conduction

**Heat Gain by the wall:** Solar Heat Gain due to Conduction through Wall Since there is a direct solar radiation on this side of the wall the cooling load gain through this wall is considered differently from the other walls. The cooling load due to conduction through this wall is given by

Q = UA*CLTDc

Calculation of the quantity of air infiltrated, There are two methods for calculating the quantity of air infiltrated:

Air change method and

Crack method

For this particular case the air change method is used, it is based upon the average number of air changes/hr. expected in the air conditioning space.

Infiltration, Qi = [H*L*W*G]/60 (m/min)

**Door Infiltration:** In addition to the above infiltration, door infiltration must be considered. It is calculated using the following equation:

Door infiltration (m/min) = [Door opening per hour*factor from table]/60

Assumption: -Neglect wall infiltration

-public building

**Load due to Outside Air:** The load due to the outside air will be both sensible as well as latent, and can be calculated as follows:

OASH = 20.43*Qm (To-Ti)

OALH = 50*Qm (Wo-Wi) W

Where: OASH =outside air sensible heat

OALH = outside air latent heat

**Internal Heat Gains:** The heat gain components that contribute to internal heat gains are:

- Light and
- People (occupants)

Internal heat gain due to Light. Light generates sensible heat by the conversion of the electric power input into heat.

The cooling load due to heat gain from lighting is ql = W*Ful*Fsa

Where, ql = heat gain W

W = total light wattage

Ful = light use factor

Fsa = light special allowance factor

**Internal Heat Gain due to Occupants:** Occupants give out both sensible and latent heat:

Sensible: qs = no of occupants*Sens. H.G*CLF

Latent: ql = no of occupants* Lat. H.G

Where, Sens. H.G = sensible heat gain

Lat. H.G =latent heat gain

CLF =cooling load factor for people

**The Mass Flow Rate of Air:** The mass flow rate of air required to cool the total load is determined by:

qs = ma Cpa (Tin-Tx)

Where, qs = total sensible heat of the room, W

Cpa = specific heat of moist air 1.0246KJ/KgK

Tin = design indoor condition temperature, $^{o}$c

Tx = air temperature at the outlet of the wetted surface, $^{o}$c

**Volumetric Flow Rate of Air:** The volumetric flow rate of air can be obtained from the mass flow rate.

Qa = ma/ρa

where Qa = volumetric flow rate of air

$\rho_a$ = density of air

**Specific Humidity of supplied Air:** The specific humidity of the supply air can be found from the latent heat balance.

$q_l = m_a C_{pw} (W_{in}-W_s)$

ma = mass flow rate of air

Wi = specific humidity of room air

Ws = specific humidity of supply air

Cpw = latent heat of evaporation

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The percentage reduction was found to be around ____%. The below table shows the cooling load calculated without EATHE and with EATHE.

| EXTERNAL HEAT GAIN | | Sensible(W) | Latent(W) |
|---|---|---|---|
| Wall (conduction) | Q= UAT | 1463.93 | ---- |
| Door (conduction) | Qd = UAT | 30.13 | ---- |
| Roof (conduction) | QR = UAT | 70.44 | ---- |

## RESULTS AND DISCUSSION

**Validation of Model to Experimental Data:** The CFD based EATHE model is validated by taking observations of an actual EATHE fabricated at Ajmer (Western India) as shown in fig.6 The experimental observations was taken on March 12, 2009 and repeated on April 08, 2009 at Ajmer. The experiment flow of air is made through the material of PVC and steel pipes separately. The two horizontal cylindrical pipes of 0.15 m inner diameter with the buried length of 23.42 m made up of PVC and mild steel pipes and buried at a depth of 2.7 m in a flat land with dry soil. The two pipes viz. PVC and steel are connected to common intake and outlet manifold for air passage. The observations were taken for flow velocities 2 m/s.

**Table 3 Physical and Thermal Parameters Used in CFD model**

| S. No. | Material | K (w/m K) | Density (kg/m3) | $C_p$ (j/kg K) |
|---|---|---|---|---|
| 1 | Air | 0.0242 | 1.225 | 1006 |
| 2 | Soil | 0.52 | 2050 | 1840 |
| 3 | Steel | 54 | 7833 | 465 |
| 4 | Sandy Loam Soil | 1.2 | 2215 | 1260 |

Table 4 shows the validation of simulated temperatures with experimental results. The variation in simulation and experimental results are 7.06% of experimental results. This variation may be occur due to variation in the coefficient of friction of the engineering material which is used in simulation and experiment, irregularities such as joints in experimental set-upand improper insulation at the risers of experimental set-up.

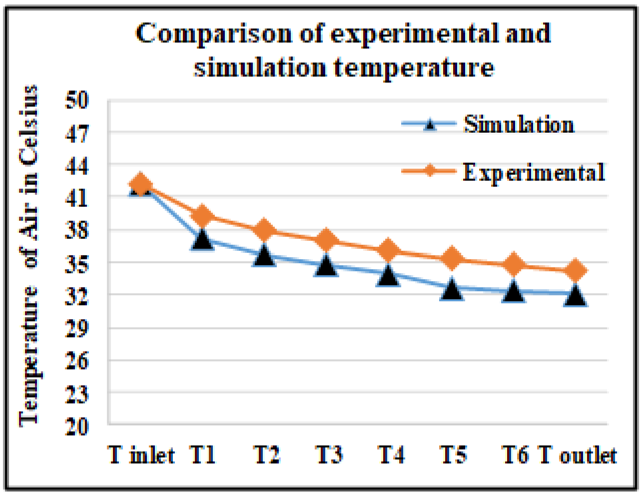


**Fig. 4 Graph of validation**

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**Performance of spiral pipe Earth Air Tunnel Heat Exchanger:** Fluid flow analysis of earth air tunnel heat exchanger (EATHE) is evaluated by using CFD fluent model. In this project simulation of EATHE has been carried out to determine temperature of air under steady state conditions by keeping the soil surrounding pipe of the EATHE at constant temperature of 300 K. The Fluid flow analysis system has considered outer surface of soil with 250 mm thickness. In this study the EATHE is design for Bikaner region and the heist temperature of Bikaner region is consider for inlet temperature of EATHE is 320.6 K in summer season.

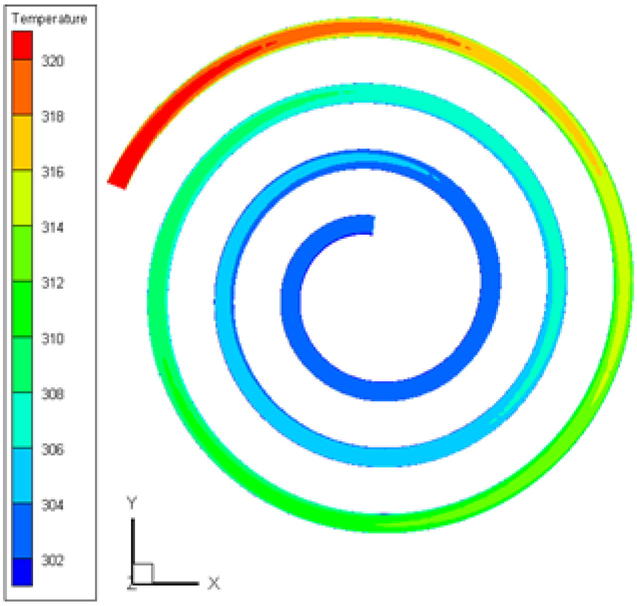


**Fig.7 contour plot of temperature distribution in spiral pipe EATHE.**

When the velocity of air (3 m/s) performs at 23.42 m length of earth air tunnel heat exchange and the inlet temperature of is 320.6 K, so the outlet temperature of earth air tunnel heat exchanger is 301.77 K which is given in table 5. Fig. 7 shows the contour Plot of temperature distribution in air. The read red color denotes maximum temperature range and blue color shows the minimum temperature range.

**Table 5 Outlet Temperature for spiral pipe EATHE**

| S. No. | Temperature Sensor | Length (m) | Outlet temperature of EATHE (K) |
|---|---|---|---|
| 1 | $T_{inlet}$ | 0.00 | 320.60 |
| 2 | $T_1$ | 3.34 | 315.04 |
| 3 | $T_2$ | 6.69 | 312.02 |
| 4 | $T_3$ | 10.03 | 309.78 |
| 5 | $T_4$ | 13.38 | 306.29 |
| 6 | $T_5$ | 16.72 | 304.42 |
| 7 | $T_6$ | 20.07 | 302.85 |
| 8 | $T_{outlet}$ | 23.42 | 301.77 |

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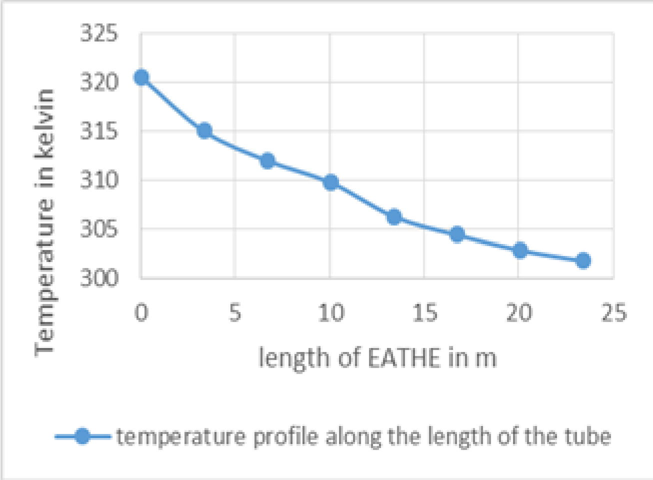


## CONCLUSION

In this project simulation of EATHE has been carried out to determine temperature of air under steady state conditions by keeping the soil surrounding pipe of the EATHE at constant temperature of 300 K. The solution of governing equation have been given us the temperature profile of fluid which is air with different length of pipe and different velocity of air. In this study the EATHE is design for Bikaner region and the heist temperature in summer is considered for inlet temperature of EATHE. The heist temperature of Bikaner is 320.6 K. It has finally concluded that the above results obtained from the EATHE 3-D CFD Fluent analysis model for cooling is carried out for hot and dry climate of Bikaner region western part of Rajasthan, India. The performance of EATHE at 23 m length and 3m/s velocity of spiral pipe have performed. The temperature fall from 320.6 K to 305.11 K.

## REFERENCES

[1] T. S. Bisoniya, A. Kumar, and P. Baredar, “Experimental and analytical studies of earth-air heat exchanger (EAHE) systems in India: a review,” Renewable and Sustainable Energy Reviews, vol. 19, pp. 238–246, 2013.
[2] V. Bansal, R. Misra, G. D. Agrawal, and J. Mathur, “Performance analysis of earth-pipe-air heat exchanger for winter heating,” Energy and Buildings, vol. 41, no. 11, pp. 1151–1154, 2009.
[3] V. Bansal, R. Misra, G. D. Agrawal, and J. Mathur, “Performance analysis of earth-pipe-air heat exchanger for summer cooling,” Energy and Buildings, vol. 42, no. 5, pp. 645–648, 2010.
[4] N. K. Bansal, M. S. Sodha, and S. S. Bharadwaj, “Performance of Earth-air tunnel system,” International Journal of Energy Research, vol. 7, no. 4, pp. 333–345, 1983. S. S. Bharadwaj and N. K. Bansal, “Temperature distribution inside ground for various surface conditions,” Building and Environment, vol. 16, no. 3, pp. 183–192, 1981.
[5] M. Santamouris, A. Argiriou, and M. Vallindras, “Design and operation of a low energy consumption passive solar agricultural greenhouse,” Solar energy, vol. 52, no. 5, pp. 371–378, 1994.
[6] R. Kumar, S. C. Kaushik, and S. N. Garg, “Heating and cooling potential of an earth-to-air heat exchanger using artificial neural network,” Renewable Energy, vol. 31, no. 8, pp. 1139–1155, 2006.
[7] S. Milun, T. Kilić, and O. Bego, “Measurement of soil thermal properties by spherical probe,” IEEE Transactions on Instrumentation and Measurement, vol. 54, no. 3, pp. 1219–1226, 2005.
[8] M. S. Kersten, “Laboratory research for the determination of the thermal properties of soils,” Bulletin No. 28, Engineering Experiment Station, University of Minnesota, Minneapolis, Minn, USA, 1949.
[9] D. A. de Vries, “Thermal properties of soils,” in Physics of Plant Environment, W. R. van Wijk, Ed., North-Holland, Amsterdam, The Netherlands, 1963.
[10] D. A. de Vries, “Heat transfer in soils,” in Heat and Mass Transfer in the Biosphere, D. A. de Vries and N. H. Afgan, Eds., pp. 5–28, Scripta Book, Washington, Wash, USA, 1975.
[11] D. Hillel, INTRODUCTION to Soil Physics, Academic Press, San Diego, Calif, USA, 1982.
[12] D. L. Nofziger, “Soil temperature changes with time and depth: theory,”
[13] B. R. Becker, A. Misra, and B. A. Fricke, “Development of correlations for soil thermal conductivity,” International Communications in Heat and Mass Transfer, vol. 19, no. 1, pp. 59–68, 1992.

ISBN: 978-81-961781-9-2

[14] Y. Chen, M. Shi, and X. Li, "Experimental investigation on heat, moisture and salt transfer in soil," International Communications in Heat and Mass Transfer, vol. 33, no. 9, pp. 1122–1129, 2006.

[15] M. Z. Yu, X. F. Peng, X. D. Li, and Z. H. Fang, "A simplified model for measuring thermal properties of deep ground soil," Experimental Heat Transfer, vol. 17, no. 2, pp. 119–130, 2004.

[16] V. P. Kabashnikov, "Analytical and numerical investigation of the characteristics of a soil heat exchanger for ventilation systems," vol. 45, pp. 2407–2418, 2002.

[17] R. Kumar, S. Ramesh, and S. C. Kaushik, "Performance evaluation and energy conservation potential of earth–air–tunnel system coupled with non-air-conditioned building," *Build. Environ.*, vol. 38, no. 6, pp. 807–813, Jun. 2003.

[18] 2003 Evaluation of earth-to-air heat exchangers with a standardised method to calculate energy efficiency.pdf." .

[19] M. De Paepe and A. Janssens, "Thermo-hydraulic design of earth-air heat exchangers," *Energy Build.*, vol. 35, no. 4, pp. 389–397, May 2003. exchanger_ an experimental validation.pdf." .

[20] M. K. Ghosal, G. N. Tiwari, D. K. Das, and K. P. Pandey, "Modeling and comparative thermal performance of ground air collector and earth air heat exchanger for heating of greenhouse," *Energy Build.*, vol. 37, no. 6, pp. 613–621, Jun. 2005.

[21] G. N. Tiwari, M. A. Akhtar, A. Shukla, and M. E. Khan, "Annual thermal performance of greenhouse with an earth – air heat exchanger : An experimental validation," vol. 31, pp. 2432–2446, 2006.

[22] R. Kumar, S. C. Kaushik, and S. N. Garg, "Heating and cooling potential of an earth-to-air heat exchanger using artificial neural network," *Renew. Energy*, vol. 31, no. 8, pp. 1139–1155, Jul. 2006.

[23] M. K. Ghosal and G. N. Tiwari, "Modeling and parametric studies for thermal performance of an earth to air heat exchanger integrated with a greenhouse," vol. 47, pp. 1779–1798, 2006.

[24] F. Al-Ajmi, D. L. Loveday, and V. I. Hanby, "The cooling potential of earth–air heat exchangers for domestic buildings in a desert climate," *Build. Environ.*, vol. 41, no. 3, pp. 235–244, Mar. 2006.

# Chapter: 62

# Sustainability and the Potential of Solar Energy Sources: A Review

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**ABSTRACT**

Solar energy sources are considered clean, have little influence on the environment, and can be sustained for a predictable future in light of social, economic, and environmental demands. Solar energy mainly manifests as heat and light. The environment transforms and absorbs heat and sunlight in a variety of ways. By replacing non-renewable energy sources, renewable energy technologies offer a great chance to mitigate greenhouse gas emissions and slow global warming. Solar energy can be utilized in various applications like water heating, air heating, space heating, solar cookers, solar drier, etc.

**KEYWORDS:** Solar Energy; Renewable Energy; Global warming; Green House; Solar Drier.

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## INTRODUCTION

The measurement and comparison of the environmental effects of human activity on various products is necessary for sustainable development [1]. The usage of fossil fuels is rising substantially, along with increased living standards, developing countries' industrialization, and global population growth. It has long been understood that this excessive use of fossil fuels hurts the environment, increases health concerns and the threat of global climate change, and accelerates the rate at which fossil fuel stocks are depleting [2]. Society is gradually looking for more manageable creation techniques, squander minimization, decreased air contamination from vehicles, circulated energy age, protection of local woods, and decreased ozone-depleting substance outflows [3]. Expanding utilization of petroleum derivatives to satisfy our current energy needs and caution over the energy emergency have produced a resurgence of interest in elevating sustainable choices to meet the fostering scene's developing energy needs [4,5]. The unnecessary utilization of petroleum products has caused unnatural climate change via carbon dioxide; hence, sustainable advancement of solar energy is enthusiastically required [6].In this paper, the endeavor has been made to determine the extent of sustainable power contraptions to meet energy necessities and the relief capability of ozone-depleting substances, primarily carbon dioxide.

**Solar energy application:** Changes towards ecological upgrades are turning out to be all the more politically satisfactory worldwide, particularly in created nations. Society is gradually moving towards looking for more practical; taking everything into account sun oriented nuclear power is the most bountiful one and is accessible in both immediate as well as roundabout structures. The Sun radiates energy at a pace of 3.8 × 1023 kW, of which roughly 1.8 × 1014 kW is caught by the Earth [7]. There is an immense extension to use accessible sun-based energy for warm applications, for example, cooking, water warming, crop drying, etc. Sun-powered cooking is the most immediate and advantageous utilization of sun-oriented energy. Sun-oriented energy is a promising choice for being one of the leading energy hotspots for cooking [8-10]. Different sorts of sun-oriented cookers are accessible; the box-type, sun-based cooker (Fig. 2) is broadly utilized from one side of the planet to the other. A review was led in Costa Rica and on the planet overall, and afterward, looked at the benefits and restrictions of sun-powered broilers with traditional kindling and electric ovens. The restitution time of a typical hot box type sun-powered stove, regardless of whether utilized 6-8 months per year, is around 12-14 months, generally 16.8 million tons of kindling can be saved, and the emanation of 38.4 million tons of carbon dioxide each year can likewise be forestalled [11]. Sun-oriented water radiator of homegrown size, reasonably fulfilling the more significant part of the heated water needs of a group of four people, offers critical security to the climate and ought to be utilized at whatever point conceivable to accomplish a practical future [12].

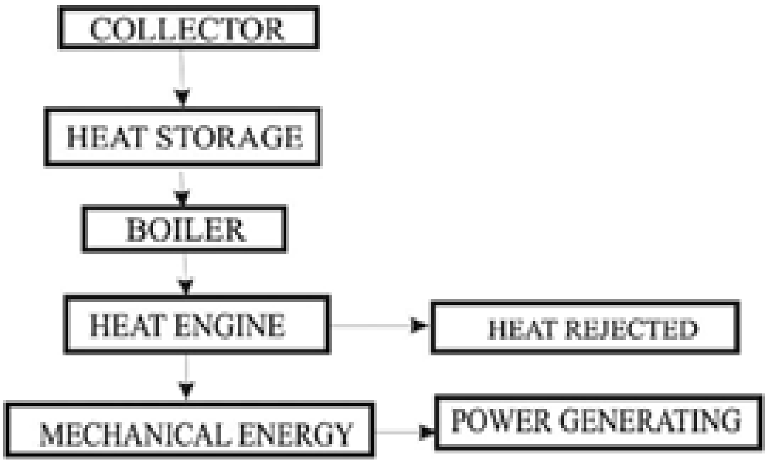


**Fig.1 Schematic Diagram of the solar thermal system**

Solar energy is a crucial source of energy. Solar irradiation is abundant in many rural locations where electricity is unavailable, so using solar energy to create electricity is a viable option. A solar thermal electricity generation system that converts solar energy into electricity using solar thermal conversion, essentially collected Solar energy is transformed to electricity using various technologies of heat-to-electricity conversion devices [14,15]. The solar panel is the primary element of any solar thermal system Collector. Specifically, designed heat exchangers called solar energy collectors convert solar radiation energy into internal energy It is feasible to build a sustainable future [13].

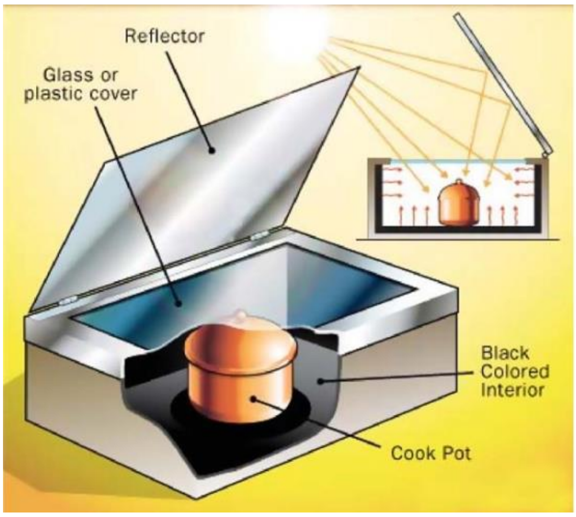


**Fig.2 Box-type Solar cooker [11]**

In the last many years, energy-related issues are turning out to be, to an ever-increasing extent, significant and include the best utilization of assets, the ecological effect because of the discharge of toxins, and the utilization of customary energy assets [16]. Direct sun-powered energy transformation to power is ordinarily done utilizing photovoltaic cells, which utilize the photovoltaic (PV) impact. PV impact relies upon the communication of photons with energy equivalent to, or more than, the band-hole of PV materials. Some of the misfortunes because of the band-hole restrictions are tried not to by flow semiconductors of various band-holes. [17]. PV modules create power straightforwardly from light without emanations, commotion, or vibration. Daylight is free, yet power age cost is outstandingly high, even though costs are beginning to descend. Sun-oriented energy has low energy thickness: PV modules require a huge surface region for limited quantities of energy age [18].

**Fig.3 Evacuated tube solar water heater [19]**

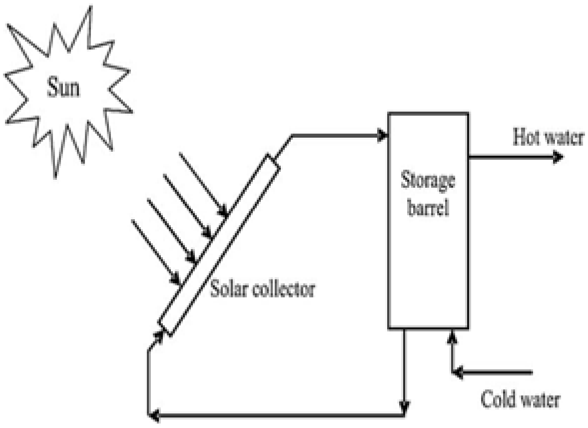


**Fig.4 Layout of domestic solar water heater [13]**

A domestic-sized solar water heater that can provide most of the hot water needs for a household of four offers excellent environmental protection and should be used whenever possible. A substitute that can prepare fruits and vegetables by national and international standards while using zero energy is solar-drying technology. It reduces energy use, saves time, takes up less space, and enhances product quality.

## CONCLUSION

A comprehensive literature survey of significant renewable energy gadgets for domestic and industrial applications such as solar water heaters, solar cookers, and dryers, the review gives an overview of the development and scope of solar energy mitigation for clean and sustainable development. Solar drying of agricultural produce has good potential for energy conservation in developing nations. The improved cookstoves provide a better kitchen environment for rural women and improve their health standards. At the same time, it also reduces the fuel collection burden for them. The paper explicitly points out the greenhouse gas emission mitigation potential depending on the use and availability of renewable energy sources and the fuel it replaces.

## REFERENCES

[1] Dincer I. Environmental Issues. I. Energy Utilization. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects 2001;23(1):69–81.
[2] Farhad S, Saffar-Avval M, Younessi-Sinaki. Efficient design of feedwater heaters network in steam power plants using pinch technology and exergy analysis. International Journal of Energy Research 2008;32:1–11
[3] Sims REH. Bioenergy to mitigate for climate change and meet the needs of society, the economy and the environment. Mitigation and Adaptation Strategies for Global Change 2003;8:349–70
[4] Youm I, Sarr J, Sall M, Kane MM. Renewable energy activities in Senegal: a review. Renewable and Sustainable Energy Reviews 2000;4(1):75–89.
[5] Horst GH, Hovorka AJ. Fuelwood: the “other” renewable energy source for Africa? Biomass and Bioenergy 2009;33:1605–16.
[6] Hall DO, Mynick HE, Williams RH. Cooling the greenhouse with bioenergy. Nature 1991;353:11–2
[7] Thirugnanasambandam M, Iniyan S, Goic R. A review of solar thermal technologies. Renewable and Sustainable Energy Reviews 2010;14:312–22.
[8] Biermann E, Grupp M, Palmer R. Solar cooker acceptance in South Africa: results of a comparative field-test. Solar Energy 1999;66(6):401–7.
[9] Tucker M. Can solar cooking save the forests? Ecological Economics 1999;31:77–89.
[10] Wentzel M, Pouris A. The development impact of solar cookers: a review of solar cooking impact research in South Africa. Energy Policy 2007;35(3):1909–19.
[11] Nandwani SS. Solar cookers cheap technology with high ecological benefits. Ecological Economics 1996;17:73–81.
[12] Layton J. How solar cooking works. 03 February 2009. HowStuffWorks.com.
[13] Kalogirou S. Thermal performance, economic and environmental life cycle analysis of thermosiphon solar water heaters. Solar Energy 2009;83:39–48
[14] Xiaowu W, Ben H. Exergy analysis of domestic-scale solar water heaters. Renewable and Sustainable Energy Reviews 2005;9:638–45
[15] Xiao C, Luo H, Tang R, Zhong H. Solar thermal utilization in China. Renewable Energy 2004;29:1549–56.
[16] Mills D. Advances in solar thermal electricity technology. Solar Energy 2004;76:19–31.
[17] Stoppato A. Life cycle assessment of photovoltaic electricity generation. Energy 2008;33:224–32.
[18] Goswami DY, Vijayaraghavan S, Lu S, Tamm G. New and emerging developments in solar energy. Solar Energy 2004;76:33–43.
[19] Topcu YI, Ulengin F. Energy for the future: an integrated decision aid for the case of Turkey. Energy 2004;29:137–54.
[20] Thermal Analysis of an Evacuated Tube Solar Collector using a One-end Stainless Steel Manifold for Air Heating Applications under Diverse Operational Conditions Gaurav Verma, Saifullah Zaphar1,* , Chandrashekara M , “EVERGREEN Joint Journal of Novel Carbon Resource Sciences & Green Asia Strategy, Vol. 10, Issue 02, pp897-911, June 2023

# Chapter: 63

# To Develop a Smart HVAC System Using a Building Energy Management System

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**ABSTRACT**

The modern smart building offers software solution and sensing the surrounding environment. However, this will be allowed management easily for leaders that are providing better control and optimize heating, ventilation, and air conditioning (HVAC) ،as well as this is consider from the important topics in mechanical engineering modern application.

## INTRODUCTION

Heating, ventilation, and air conditioning (HVAC) is the use of various technologies to Control the temperature, humidity, and purity of the air in an enclosed space. Its goal is to provide thermal comfort and acceptable indoor air quality. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. "Refrigeration" is sometimes added to the field's abbreviation as HVAC&R or HVACR, or "ventilation" is dropped, as in HACR (as in the designation of HACR-rated circuit breakers).

## PROBLEM

As there is a more & more increment in energy consumption. There in a need to develop a system which is Energy eff. & could also conserve energy. Building Energy Management System (BEMS), based on computer or for controlling, Monitoring & then, optimization of energy consumption. In the same manner we can use HVAC as a smart HVAC system.

## SOLUTION

There are two types

- VRF
- VAV

**VRF: - VRF (VARIABLE REFRIGERENT FLOW) SYSTEM IN HVAC:** Japanese company named Daikin first invented this. Daikin called this VRV (1982).

1. This is multi split type air conditioning because with one outdoor we can use multiple indoor unit.

2. In this technology cooling/heating is adjusted by adjusting refrigerant flow and which is achieve by changing the speed of compressor.

3. Advantages- less energy consumption, takes very less space.

4. The front runner company who are selling VRF are Daikin, Samsung, Voltas, Hitachi etc.

5. we can connect 60 IDU (Indoor unit) with 1 outdoor unit (ODU).

COMPRESSOR USING IN THIS SYSTEM:

1. Digital scroll compressor.

2. Inverter scroll compressor.

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REFRIGERENT:

410A or 407C

PIPE LENGTH LIMIT:

150 meters (connection between IDU and ODU)

POWER SAVING:

30% to 40%

**VRF SYSTEM COMPONENTS:**

- 2 Compressor (Digital Scroll And Inverter Scroll)
- Accumulator
- 2 Oil Separator
- Condenser
- Electronic Expansion Valve.

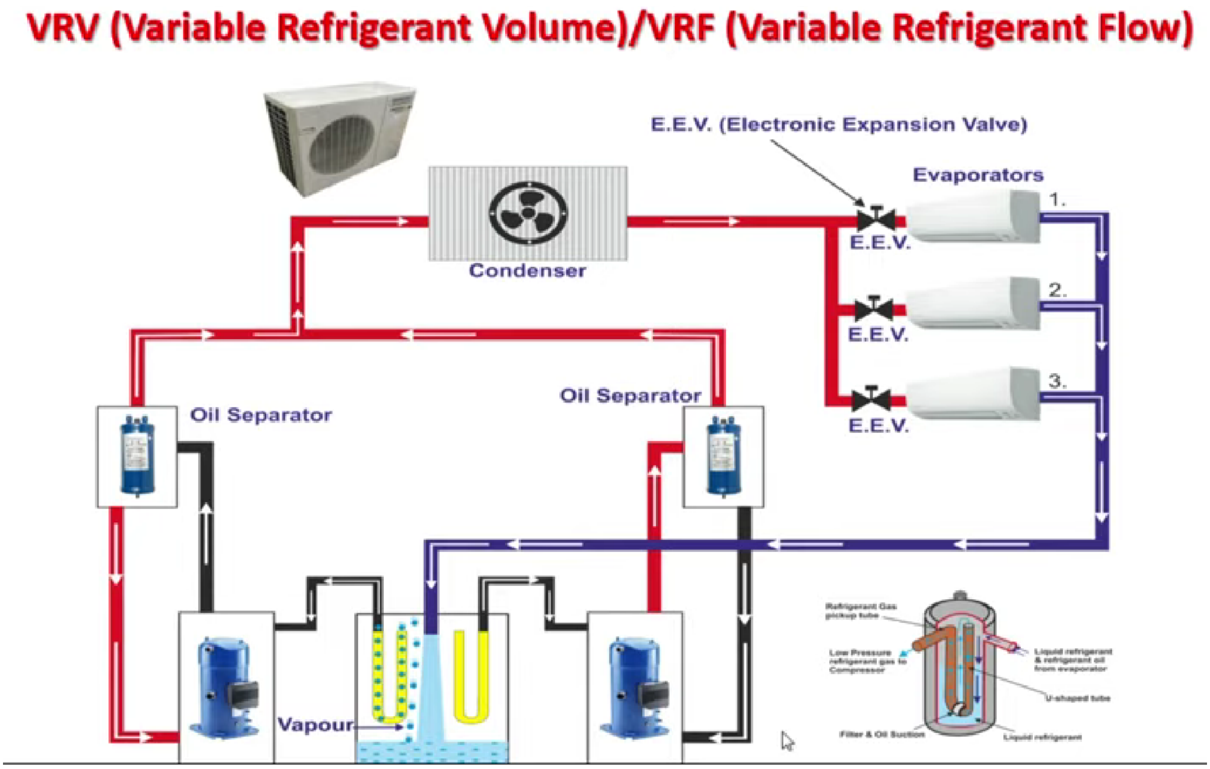


**Figure 5 VRV Variable Refrigerant Volume**

**VAV:** Variable air volume (VAV) systems enable energy-efficient HVAC system distribution by optimizing the amount and temperature of distributed air. VAV systems supply air at a variable temperature and airflow rate from an air handling unit (AHU). VAV systems use flow control to efficiently condition each building zone while maintaining required minimum flow rates.

There are two major classifications of VAV boxes or terminals—

- Pressure Dependent
- Pressure Independent.

Some features of a VAV system include the following:

- Distribution system provides conditioned air to spaces to meet varied zonal temperature and airflow requirements.

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- Variable frequency drive-based air distribution system can reduce supply fan energy use.
- Supply-air temperature reset capability allows adjustment and reset of the primary delivery temperature with the potential for savings at the chiller or heating source.

There are several different types of VAV and terminal boxes. The most common include:

- Single duct terminal VAV box
- Fan-powered terminal VAV box
- Dual ducted terminal VAV box
- Induction terminal VAV box

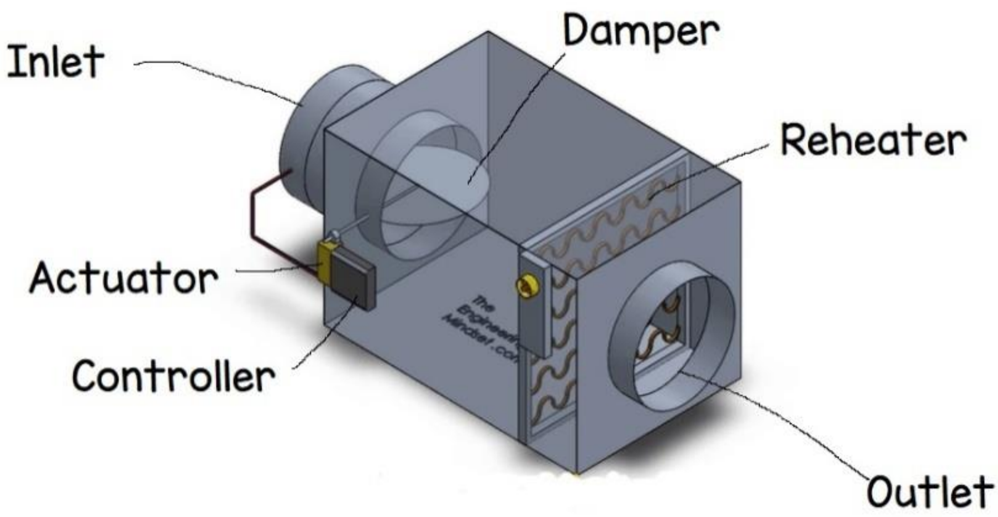


**Figure 6 Duct Outlet**

**VAV SYSTEM COMPONENTS**

- Chiller/Condensing Unit
- Furnace Air Handler
- Main Duct
- Branch Ducts
- VavBoxes
- Diffusers
- Thermostats.

**Advantages:** The advantages of PLC controlled VAV systems over older version of VAV systems include more precise temperature control, reduced compressor wear, lower energy consumption by system fans, less fan noise, additional passive dehumidification, and negligible amount of manual work needed. Air distribution system can reduce supply fan energy use. Supply-air temperature reset capability allows adjustment and reset of the primary delivery temperature with the potential for savings at the chiller or heating source.

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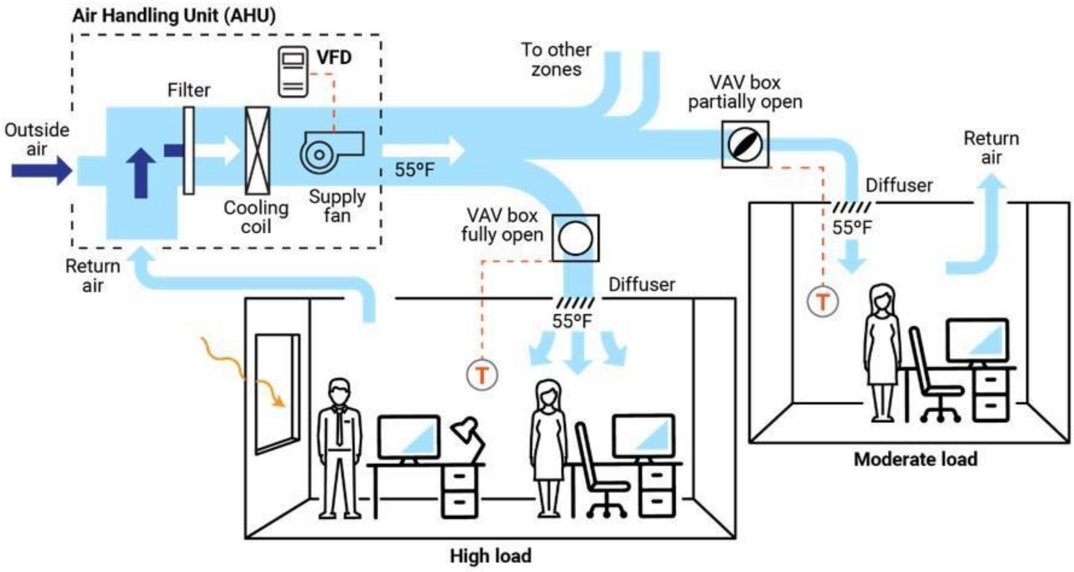


**Figure 7 VAV System in HVAC**

**Requirement for a Smart HVAC System:**

**Sensors:** A sensor is a device, module, machine or a subsystem that detects events or changes in its environment and send the information to other electronics, frequently a computer processor. Sensors are always use with another electronic device. Types of sensors used in HVAC

- Oxygen Sensor
- Temperature Sensor
- Carbon Sensor
- Pressure Sensor
- Humidity Sensor
- Indoor Air Quality Sensor
- Occupancy Sensors
- Room Sensors

**Air Handling Unit (AHU):** An air handler, or air handling unit (often abbreviated to AHU), is a device used to regulate and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system. An air handler is usually a large metal box containing a blower, heating or cooling elements, filter racks or Chambers, sound attenuators, and dampers. Air handlers usually connect to a ductwork. Ventilation system that distributes the conditioned air through the building and returns it to the AHU. Sometimes AHUs discharge (supply) and admit (return) air directly to and from the space served without ductwork. Some AHU components shown are:

- Supply Duct
- Fan Compartment
- Vibration Isolator ('Flex Joint')
- Heating And/or Cooling Coil
- Filter Compartment
- Mixed (Recirculated + Outside) Air Duct

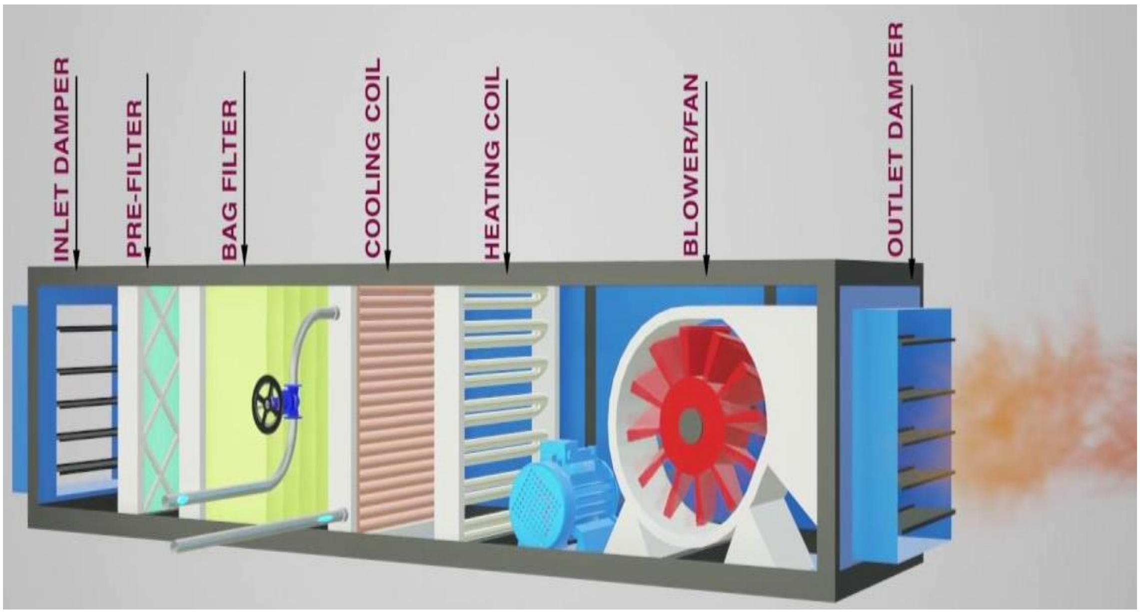


**Figure 8 Air Handling Unit**

**EC Fans:** An electronically commutated (EC) fan design delivers the combined benefits of AC and DC Fans. The EC fan's power comes from a brushless DC motor, but it offers the control that AC induction fans have over the fan rotor through a printed circuit board. The electronically commutated fan's DC motor has the advantage of a variable speed control built in. An AC electrical supply powers the EC fan, but the on-board electronics convert the power to DC before reaching the motor. The secondary magnetic field generated by the permanent magnets makes EC fan motors considerably more efficient than AC induction motors.

**Introduction to PLC:** A programmable logic controller (PLC) is a specialized computer used to control machines and process.It uses a programmable memory to store instructions.

- **Functions of plc:** It include on/Off control, timing, counting, sequencing, arithmetic, and data handling.

The biggest differences are that a PLC can perform discrete and continuous functions that a PC cannot do, and a PLC is much better suited to rough industrial environments. A PLC can be thought of as a ‘ruggedized’ digital computer that manages the electromechanical processes of an industrial environment.

**Types of PLC:** There are two types of PLC,

- **Fixed/Integrated/Compact PLC: -** This type of PLC is most commonly called the Fixed I/O PLC. Fixed I/O” actually stands for Fixed “Input/ Output”. When you buy Compact PLCs, you will notice that the input section and the output sections of the PLC are integrated into the microcontroller itself.
- **Modular PLC: -** The modular PLC is a type that allows multiple expansions of the PLC system through the use of modules, hence the term “modular”. Modules give the programmable logic controller additional features like increased number of I/O units, and they are usually easier to use because each component is independent of each other.

## BLOCK DIAGRAM OF PLC

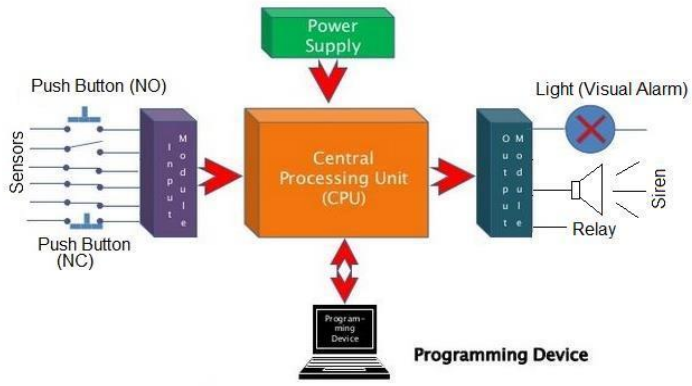


**Figure 9 BLOCK DIAGRAM OF PLC**

1. **CPU MODULE: -**A CPU model consists of central processor and its memory. The processor accepts input data from various sensing devices, executes the stored user program, and sends appropriate output commands to control devices.
2. **INPUT /OUTPUT MODULE: -**The input and output module of PLC are used to connect the connectors and actuators to the system to sense the parameters such as temperature, pressure, and flow.
3. **POWER SUPPLY: -** It's needed to convert mains A.C voltage to low D.C voltage (Normally Internal). In large PLC systems, this power supply power does not normally supply power to the field devices.

**PROGRAMMING DEVICE: -** A personal computer (PC) is the most commonly used programming devices. The software allows users to create, edit, document, store and troubleshoot programs.

## LADDER LOGIC

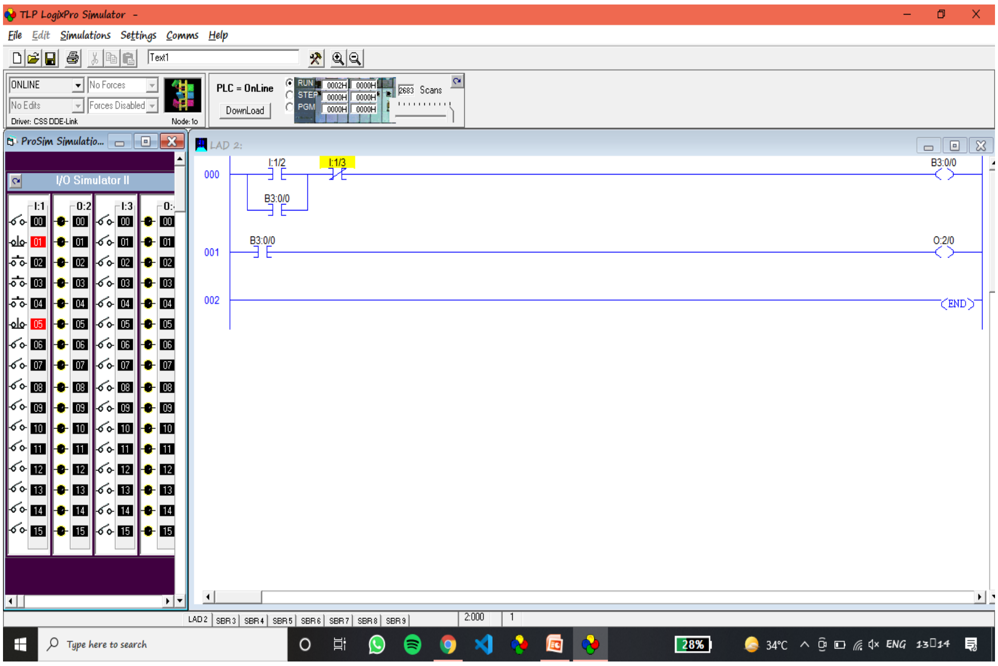


**Figure 10 Ladder Logic**

- LADDER LOGIC was created as the first PLC programming language.

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- Ladder Logic is labeled as such because the software is laid out in shape of a ladder.
- On the left side, ladder logic instructions are set as conditions, while the ones on the right side are instructions that are triggered if the conditions are met. Each rung of the ladder spans from left to right and is executed from top to bottom by the PLC
- The controller is designed in modular form so that sub assemblies could be removed easily for replacement or repair.
- The control system needs the capability to pass data collection to a control system.

The system used to program the controller is simple, So that it can be easily understood by plant personnel.

## CONCLUSION

Mechanical Engineering is a hot topic for modern applications. One of these areas is heating and cooling system at design modern building. Therefore, engineering spends money and time to configure HVAC system with all of these efforts still build suffer from a shortage of services. For this, we design a modern system that has the ability to predicate heating and cooling system for any building. However, this will arrange this HVAC system automatically without any human interaction. On the other side, machine learning makes the proposed more efficient by sensing all surrounding environment. In this case, the building will provide by HVAC automatically. According to the testing/ evaluating system of the proposed system, we can easily notice that intelligent HVAC can adopt with modern building with acceptance results. In future directions, this proposed system will be tested with other data set to confirm its efficacy. Hence, this dataset will be employed with other artificial tools, such as deep learning, neural networks and nearest neighbor.

## REFERENCE

[1] https://www.researchgate.net/publication/355162742_Intelligent_HVAC_Systems_for_Smart_Modern_Building
[2] https://theengineeringmindset.com/air-handling-units-explained
[3] https://www.dspaininc.com/air-conditioning/vrv-vrf
[4] https://www-conditionedairsolutions-com.
[5] https://www.youtube.com/watch?v=ZxmvvZuzxhA&ab_channel=Engineering%26Automation
[6] https://en.wikipedia.org/wiki/Sensor
[7] https://www.youtube.com/watch?v=HBmOyeWtpHg&ab_channel=TheEngineeringMindset

# Chapter: 64

# Creation of Cam Instrument Worked Mallet

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**ABSTRACT**

In numerous enterprises utilized fluctuates kinds of machines and instruments to perform various sorts of activities. For example, producing, pounding, cutting and so on. In any case, various issues to face, for example, low power supply, less labor and furthermore weighty works work force and so on, this task connects with activities performed by this can be accomplished by either utilizing elective engine power or physically by proportion of the pivot the head lower appended to the shaft and pounding activity can be run naturally to utilize AC engine, chain drive (or) bolt drive, chain, lead representative is likewise accommodated speed control purposes so reasonable speed can be accomplished when no electrical power supply the cam worked mallet can be utilized physically by basically turning the hand switch. Likewise, the giving is basic and kept up with is simple.

**KEYWORDS:** Cam profile, electric motor, shell bearings, shaft, pulley, belt.

## INTRODUCTION

In numerous businesses utilized changes sorts of machines and instruments to perform various kinds of activities. For example, producing, pounding, and cutting and so on. Yet, various issues to face, for example, low power supply, less labor supply and furthermore weighty works work force and so on. Producing is the most well-known process in mechanical designing and is likewise a business choice for the overwhelming majority individuals in India. The smithies deal with issues like inaccessibility of laborers and high machine cost and less pay and so on. The development cam worked hammer gadget which can be utilized for multi-reason activities by either naturally or physically. It is fundamentally utilized for pounding of work piece. It can likewise be utilized for different purposes, for example, punching, fashioning, and bowing, and so on. This advance cam worked hammer is exceptionally fundamental for doing number of such tasks like pounding, riveting, pounding of bigger work piece and cutting of metal.

As in fashioning industry, the temperature of manufacturing activity is especially higher and it is extremely challenging to do manual pounding over the producing metal by physically or hand and furthermore there is generally a gamble while taking care of such kind of high temperature base metals or wok piece. So advance cam worked hammer ignores this kind of issues in industry. The size of machine is smaller and simple to worked &less talented is required the machine keeps up with is likewise less. Different sort of tasks to act in a similar machine and time utilization of the activity performed. Weighty work isn't expected to play out the activities and less contamination and less power is taken. This model machine is generally utilized in limited scope ventures and for the most part producing hammers. The wrench worked pounding machine is the pounding machine in which the interpretation movement to the mallet is given utilizing wrench system. The wrench is joined to the engine, an interfacing bar interfacing the wrench end and outrageous tip of mallet pole.

At the point when engine turns, the wrench gives responding movement to the sledge bar which is turned in center. The possibly burden of the machine was when size of the article exposed to manufacturing changes; jerks are made which can break the wrench or wrench and associating bar joints. Consequently, to wipe out this restriction of machine we chose to execute cam system to give the responding movement to the mallet bar. The Cam Worked

Manual Pounding Machine is utilized in producing of light to medium positions. The motivation behind the machine is to give an answer for producing laborers to make manufacturing helpful, less troublesome and prevalent. At present this industrialization and the quick development in it have permitted the rich and affluent makers to excel however the neighborhood level smithies are exceptionally impacted by this development. It additionally helps in decreasing warming cycles since it finishes the manufacturing of given object quicker than by ordinary technique for hand fashioning to support their creation and work on the nature of the produced parts. The machine comprises of a cam so intended to give influence movement at ordinary spans. A chain and sprocket is joined to cam and the cam is pivoted utilizing legs as one does cycling. This grants turning movement to cam and sledge goes all over. The speed of the effect cycles can be handily constrained by controlling velocity of accelerating.

## METHODOLOGY AND MATERIALS

During literature survey we found various research papers in which we found various methods which are been used to provide strong impact force to the work piece and our aim is to take that review for using as guidance of make “Cam mechanism operated hammer machine”.

- Selection of material
- Estimating the cost
- Buy all materials Process the planning
- Assemble all the parts

**Working Principle:** The long shaft associated with orientation on the two sides of the casing. This pole is appended to the snail type cam on it and it is created horizontal movement from the turning shaft. We interface the opposite finish of mallet to this associating pole through a mid-swinging game plan to accomplish wanted hammer movement with enough force. What's more, the shaft is associated with handle it is use to move the shaft and movement is communicated to that cam and it is raised a ruckus around town support pole the sledge goes all over the activity is performed. The speed is relying up upon the development of the handle to move. What's more, it is additionally worked by utilize electric engine. To utilize electric engine the functioning productivity is improved to analyze the handle development.

**FABRICATION OF FRAME:**

List of parts to assemble the body frame:

1) Iron pipe (square pipe)
2) 1inch wheel
3) Bearing (dodge bearing)
4) Mild steel shaft
5) Snail type cam
6) Hammer.

The specifications of iron pipe: Thickness of the pipe - 2mm

2mm iron pipe is used to construct the body of the machine.

The specifications of wheel: Dimensions of the 1inch wheel- 3mmthickness and $2^{1/2}$inch width

The specifications of dodge bearing: Ball bearings are used to provide smooth and less friction motion in rotary applications and thediameter is 25mm.

Snail type cam: The base circle diameter is 60mm and outer diameter is 70mm and center shaft diameter is 24mm, the snail type cam produces a required sudden impact used for forging operation. The value of theimpact force is depending upon the height of fall of

hammer.
Hammer specifications: The weight of the hammer is 2lb and the length is 75mm.

## CALCULATION

Impact (F) = W/L Where,
Impact (F) = Impact force generated in Newton;
W= Work done by free falling weight in Joules; L=recoil displacement after impact in meters.
Kinetic energy & Potential energy attained by weight Kinetic Energy = ½ $mv^2$.
Potential Energy = mgh Where,
m = Mass of free-falling weight in kg
V = Velocity attained by free falling weight in m/s g = Acceleration due to gravity in $m/s^2$ h = Height of free fall of weight in meter
Required impact force for forging is approximately 100N to 200N.
Calculations for impact force developed by 1.25 kg hammer: For hand forging, required impact force is approximately 100 to 200 N.
Using conservation of energy theorem, we calculate impact force and energy of free-falling object. Considering,
m= 1.3 kg,
h= 0.5m (1.2 ft) (drop height)
V= √2gh = √2*9.81*0.5= 3.13 m/s
P.E = m gh
K. E= 0 Impact velocity= √2gh
K.E = ½ $mv^2$ P.E = 0
P. E= m gh = 1.25 X 9.81 X 0.5= 6.131 J
K. E= ½ $mv^2$= 0.5 X 1.25 X 9.79= 6.119 J
Considering recoil distance= 0.1m by work energy theorem,
W= ½ $mv^2$ (final) – ½ $mv^2$ (initial) W= ½ X 71.3X 9.79= 6.119 J
W= F X L
F= W/L = 6.119/0.3 = 2.03 N.

Hence impact force of 2.03 N is developed.

**Test Results:** The path is taken with the assistance of a neighborhood metal forger on weed snare. In the wake of finishing the test, we reasoned that our machine was much viable and simple to work likewise it saved time. The natural substance is of 25cm long and 5mm in thickness. The metal forgers need to lessen the thickness up to 2mm. The experimental outcomes are as per the following displayed in Table no 1.

**Table -1 test results**

| Parameter | With a Hand | With a Machine |
|---|---|---|
| No. of strokes | 45 | 28 |
| Time | 45sec | 28sec |
| Reduction in thickness | 3mm | 3mm |

## CONCLUSION

Subsequent to surveying a lot of arrangement and enhancing every one we were effective in planning and creating a pounding machine that would function according to our expectations

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in given set of conditions and climate. The arrangement functioned admirably in fashioning light parts significantly quicker when contrasted with hand manufacturing with great quality and less imperfections. The decrease of weariness of specialist has been the greatest result of our venture.

## FUTURE SCOPE OF THE WORK:

The machine can be intended for modern tasks performed. A similar plan can be utilized to change over the machine as a multipurpose. The machine can be made to be controlled by an electric engine or manual exertion. The exploration work serves to comprehend various techniques appropriately. The exploration work helps in better comprehension of various tasks associated with fashioning process. The examination work focuses on plan in light of low spending plan for limited scope enterprises.

## REFERENCES

[1] L.Lumpa, M Gagnon, S Munteon "WATER HAMMER OVERPRESSURE IN THE HYDRAULIC PASSAGES OF HYDROPOWER PLANTS EQUIPPED WITH FRANCIS TURBINE". IOP publications pg.no: 1 to 10, 2022.

[2] Chinmay Joshi, Prajaktap. Desai, Swatnil S. Jadhav, OmkarPatil "CAM OPERATED, PADDLE DRIVEN HAMMERING MACHINE". IJIRT international journal of innovative in technology volume-9, ISSN: 2349-6002, . pg.no: 1681 to 1684, June 2022.

[3] F.Fail, Edwin I. Ekwue, DeodatC.Dacham "DENSITY-MOISTURE RELATIONS OF SOME TRINIDAD SOILS DETERMINED USING a HAMMER-TYPE VIBRATORY COMPACTOR" Research gate the journals of the association of professional engineering o Trinidad and Tobago volume-49, ISSN 1000 7924, pg.no: 47 to 54, April 2021.

[4] Pramshanker. R. Tiwai "AUTOMATION BY CAM IN PUNCHING PRESS MACHINE". Semanticscholar (semanticscholar.org) pg.no: 1 to 10, May 2021.

[5] Nishankhadka, Aakash, Bansnet, GaurabDhungina, Dr. Mahesh Chandra luintel "DESIGN AND FABRICATION OF DE- HUSKING MACHINE USING CAM FOLLOWER MECHANISM FOR PROSO (CHEENO), FOX-TAIL (KAGUNO) MILLET." RECAST research center or applied science and technology pg.no: 1 to 13. November 2020.

[6] CanjunLi ,WenhaoZeng, DaweiXu and yong "KINEMATICS SIMULATION OF THE CAM MECHANISM OF THE ZIPPER MACHINE". Research gate (researchgate.net) IOP publishing,

[7] Sonal Vijay Akshay Kailas Kharat, Hemant Suresh Yeole "CAM OPERATED PUNCHING MACHINE". IRJET international journal of innovative in technology Volume-6, ISSN: 2395-0056, pg.no: 585 to 588, Sep 2019.

[8] Manojkumar, Jay Govindyadav, Manjetyadav "DESIGN AND FABRICATION OF PORTABLE HAMMERING MACHINE". IJRSEM international journals of research in engineering science and management, volume-2, ISSN – 2581-5792, pg.no: 1024 to 1027, May 2019.

[9] Rahul kumar et.al "DESIGN & FABRICATION OF AUTOMATED PORTABLE HAMMERING MACHINE" JETIR journal of emerging technology and innovate research, volume-6, ISSN – 2349- 516, March 2019.

[10] Sagarmakvana et.al "SURFACE MODIFICATION BY MACHINE HAMMERS PEENING AND BURNISHING" IJSRD international journals for scientific research and development and volume-6, ISSN- 2321-0613, 2018.

[11] S.patil, Dayanefhwar B. patil, Shashikant B. khandagali "CAM OPERATED SUGARCANE BUD CUTTING MACHINE". IRJET International research journals of engineering and technologyand volume-5. ISSN- 2395-0056, pg.no: 140 to 147, Oct 2018.

[12] Sager Makvana, Kalpesharjanbhairam "MODIFICATION AND FABRICATION OF SIMPLE POWER HAMMER MACHINE".IJSRD international journals for scientific research and development, volume-6, ISSN-2321-0613., Feb 2018.

[13] Sri HartatiMufadbikhah, EdySuryono "MULTIFUNCTION HAMMER MILL MACHINE DESIGN AND ASSEMBLING TO DESTROY AN AGRICULTURAL WASTES" Research gate advances in engineering research, Volume-175. pg.no: 101 to 104, janavary2018.

[14] Herongjin, Youwei Cui, Zunging "CAM CUTTING MECHANISM WITH OSCILLATING FOLLOWER FOR PC STEEL BARS" SAGE Sage publications advances in mechanical engineering volume-9(12), pg.no: 1 to 7, sep 2017.

[15] Kalyan Mandal Chandrakant Ghormare, Adhijeet Swas “ADVANCE CAM OPERATED HAMMER”. IJESC International journals o engineering science and computing, volume-7, pg.no: 6003 to 6004, March 2017.
[16] Lin Man, Changjiangzhou, Bohu, siyuchen “DESIGN AND ANALYSIS OF HIGH-SPEED CAM MECHANISM USING FOURIER SERIES”. Science Direct (sciencedirect.com) volume-104, pg.no:118 to 129, May 2016.
[17] V.schulze, F. Bleicher, P.Groche, YB. Guo “SURFACE MODIFICATION BY MACHINE HAMMERS PEENING AND BURNISHING”. Elsevier, science director, pg.no: 809 to 832, May, 2016.
[18] H.Tanaka, K.hoshino,N.asakawa “DEVELOPMENT OF A CAM SYSTEM WITH LINEAR SERVO MOTOR FOR AUTOMATION OF METAL HAMMERING”. scientiice.net, Tran’s tech publications and key engineering materials volume-625, pg.no: 360 to 365, March 2015.
[19] Nasri “DEVELOPMENT AND TESTING OF A HAMMER MILL”. Research gate International journals o engineering science and technology, volume-2., ISSN: 0975-546, pg.no: 124 to 130, 2010.
[20] Johan, Berglund, magnusliliengren “ON FINISHING OF PRESSING DIE SURFACES USING MACHINE HAMMER PEENING”. Springer (springer-London limited), pg.no: 115 to 121 may 2010.

# Chapter: 65

## Wireless Charging of Electric Vehicle While Driving

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**ABSTRACT**

The point of this examination is to plan and foster a unique remote power move framework for electric vehicle charging utilizing inductive remote power move (IWPT) innovation. The proposed framework will empower remote charging of EVs while they are moving, taking out the requirement for incessant stops for battery charging. The exploration plans to accomplish high power move proficiency, wellbeing, and insignificant electromagnetic impedance (EMI) while keeping up with similarity with existing charging framework.

**KEYWORDS:** inductive remote power move (IWPT), Electromagnetic interference (EMI), charging infrastructure, EVs, Mutual inductance.

### INTRODUCTION

Electric vehicles (EVs) are turning out to be progressively famous for of transportation, yet the requirement for proficient and helpful charging techniques stays a test. Inductive remote power move (IWPT) is a promising innovation that can possibly reform how electric vehicles are charged. This innovation works by moving power remotely between two curls, an essential loop and an optional loop, that are isolated by a little air hole. The utilization of IWPT for dynamic charging of electric vehicles, while they are moving, might actually conquer a portion of the impediments related with module charging. In any case, this innovation presents a few specialized provokes that should be tended to, like high power move proficiency, wellbeing, and electromagnetic obstruction. This paper gives a far-reaching survey of the present status of examination on powerful charging of electric vehicles by IWPT, including the different methodologies that have been proposed, specialized difficulties, and expected applications.

**Overview of Inductive Wireless Power Transfer:** IWPT depends on the guideline of attractive enlistment, where an attractive field produced by a rotating current moving through an essential loop prompts an ongoing in an optional curl found close by. The effectiveness of IWPT relies upon a few elements, including the distance between the curls, the size and state of the loops, and the recurrence of the rotating current.

**Resonant Inductive Power Transfer:** It is the most proficient cycle for WPT in the static technique where the beneficiary loop is in the focused situation over the transmitter curl. However, in the event that we consider dynamic charging, the recipient curl is portable and can scarcely gather the attractive transition from the transmitter loop. Consequently a capacitor is utilized on the transmitter side and as well as on the collector side known as a remuneration organization to resounding the transmitter curl and the recipient loop.

**Dynamic Charging of Electric Vehicles:** Dynamic charging of electric vehicles utilizing IWPT can be accomplished through a few methodologies. One methodology is to implant essential loops in the street, and optional curls in the EV. As the EV rolls over the essential curls, power is remotely moved to the auxiliary loops, charging the battery. Another methodology is to utilize above links to move capacity to the EV, like how trains and cable cars are controlled. This approach requires the establishment of above links and a component to interface and separate the EV from the links as it moves along the street. In this paper we are concentrating on way to deal with implant essential curls in street and auxiliary loop in the EV.

### LITERATURE REVIEW

This section contains the current and laid out hypothesis and exploration in this report range.

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This will give a setting for work which is to be finished. This will make sense of the profundity of the framework. Survey of writing gives a clearness and better comprehension of the investigation/adventure. A writing review addresses an investigation of beforehand existing material on the subject of the report. This writing overview will coherently make sense of this framework. A few examinations have been led to explore the possibility of remote charging of EVs while driving. A concentrate by Gao et al. (2019) proposed a unique remote power move framework for electric transports in view of inductive power move. The framework comprised of a charging cushion out and about and a pickup curls on the lower part of the transport. The outcomes demonstrated the way that the framework could accomplish a power move productivity of more than 90%, making it a promising answer for remote charging of EVs while driving. One more concentrate by Zhang et al. (2021) proposed a unique remote charging framework for electric vehicles in view of resounding attractive coupling. The framework comprised of a charging cushion out and about and a pickup loop on the vehicle. The outcomes demonstrated the way that the framework could accomplish a power move effectiveness of 95%, making it a promising answer for remote charging of EVs while driving. A concentrate by Wang et al. (2020) proposed a clever remote power move framework for EVs in view of attractive reverberation coupling. The framework comprised of a charging cushion out and about and a pickup loop on the vehicle. The outcomes demonstrated the way that the framework could accomplish a power move effectiveness of 97%, making it a promising answer for remote charging of EVs while driving. A concentrate by Lee et al. (2020) proposed a remote charging framework for electric transports in view of attractive reverberation coupling. The framework comprised of a charging cushion out and about and a pickup curls on the lower part of the transport. The outcomes demonstrated the way that the framework could accomplish a power move productivity of 95%, making it a promising answer for remote charging of EVs while driving.

## FACTORS AFFECTING IWPT

**Coil Design**: Loop is a significant piece of an electromagnetic framing framework. Its plan relies upon the state of the work piece and its application. In the current work, impact of different boundaries of curl configuration like inward breadth (ID), external measurement (OD), viable number of turns (η), and link association on execution of loop have been laid out. Its presentation has been evaluated concerning change in inductance, opposition, and thusly on the ongoing heartbeat and disfigurement of cylinder. The variety of inductance and obstruction of the loop as for change in ID, OD, η, and link association have been resolved tentatively and broke down.

**Air gap:** Air hole is a significant part of planning an inductive remote power move (IWPT) framework, as the distance between the essential and auxiliary curls can influence the power move proficiency and security of the framework. The air hole alludes to the distance between the two loops, and is normally estimated in millimeters or centimeters. The power move proficiency of an IWPT framework diminishes as the air hole between the essential and auxiliary curls increments. This is on the grounds that the attractive field produced by the essential curl debilitates as it goes through the air hole, bringing about a more vulnerable prompted current in the optional loop. In this way, limiting the air hole is significant for expanding the power move productivity of the framework.

Nonetheless, lessening the air hole an excessive amount of can likewise have security suggestions. The attractive field created by the essential loop might possibly represent a danger to people and creatures on the off chance that they are presented to it. Consequently,

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the air hole should be sufficiently enormous to guarantee that the attractive field strength is underneath the suggested security limits. Ascertaining the ideal air hole for an IWPT framework includes adjusting the compromise between power move productivity and security. The ideal air hole will rely upon a few variables, for example, the recurrence and power level of the essential curl, the size and direction of the loops, and the necessary power move proficiency.

**Frequency:** The frequency of the power source used in IWPT for EV charging can affect the efficiency of the charging process. This is because the frequency of the power source determines the frequency of the alternating magnetic field that is used to transfer power from the charging pad to the EV. If the frequency of the power source is too low, the efficiency of the charging process may be reduced, as the magnetic field may not be strong enough to transfer power efficiently. On the other hand, if the frequency of the power source is too high, there may be issues with electromagnetic interference (EMI), which can affect the operation of other electronic devices and potentially pose a safety risk. Therefore, the design of the charging system must take into account the frequency of the power source and the specific requirements of the charging application. In general, most IWPT systems for EV charging operate at frequencies in the range of 85 kHz to 200 kHz, which is high enough to achieve good efficiency while minimizing the risk of EMI.

**Losses in the process:** Inductive Remote Power Move (IWPT) for EV charging includes the exchange of electrical energy remotely through an attractive field, and there are different wellsprings of misfortunes simultaneously. The primary wellsprings of misfortunes in IWPT charging of EV include:

**Resistance misfortunes**: These misfortunes happen in the charging framework's conveyors, for example, the charging curl and links, and are brought about by the progression of electrical flow through these materials.

**Eddy current misfortunes**: These misfortunes happen in metallic articles that are available nearby the charging framework, like the EV skeleton or close by structures. These items can go about as optional curls and produce whirlpool flows, which thus make an attractive field that goes against the essential field, bringing about power misfortune.

**Coupling misfortunes**: These misfortunes happen because of the flawed coupling between the charging cushion and the EV beneficiary loop, bringing about a decrease in how much influence moved between the two curls.

**Parasitic misfortunes**: These misfortunes happen because of different factors like radiation misfortunes, misfortunes in the control gadgets, and misfortunes in the rectifier hardware. To limit these misfortunes, IWPT frameworks for EV charging are ought to be plan with an emphasis on enhancing the coupling between the charging cushion and the recipient curl, limiting obstruction in the guides, involving fitting materials for the attractive center, and executing productive rectifier hardware to change over the air conditioner influence got to DC influence for charging the EV battery.

## TECHNICAL CHALLENGES

Dynamic charging of electric vehicles utilizing IWPT presents a few specialized moves that should be tended to. One of the primary difficulties is the requirement for high power move proficiency. To accomplish effective power move, the essential and auxiliary curls should be painstakingly planned and situated to limit misfortunes. This can be testing, especially for moving vehicles where the position and direction of the curls can change quickly. Another test is wellbeing. The powerful levels utilized for dynamic charging might possibly represent a

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danger to people and creatures. To address this, security frameworks should be integrated into the charging foundation to guarantee that power is possibly moved when it is protected to do as such. Electromagnetic obstruction (EMI) is one more test that should be tended to. The high-recurrence attractive fields utilized for power move might possibly slow down touchy electronic hardware, like pacemakers and correspondence frameworks. To address this, safeguarding and separating strategies should be utilized to limit EMI.

## EXPECTED OUTCOMES

The proposed research expects to foster a unique remote power move framework that can charge EVs while they are moving, taking out the requirement for incessant battery charging stops. The normal results of this exploration are: plan and improvement of a unique remote power move framework for EV charging utilizing IWPT innovation. Exhibition of the achievability of the proposed framework as far as power move effectiveness, security, and similarity with existing charging foundation. Commitment to the headway of IWPT innovation for EV charging applications. Potential to lessen the carbon impression related with EV charging and increment the reception of EVs.

## POTENTIAL APPLICATIONS

Dynamic charging of electric vehicles using IWPT has several potential applications, including public transportation, such as buses and trams, and personal transportation, such as cars and motorcycles. The technology could also be used in industrial applications, such as material handling equipment and automated guided vehicles.

## CONCLUSION

The proposed research aims to study about a dynamic wireless power transfer system for EV charging using IWPT technology, which has the potential to revolutionize the way EVs are charged. The research aims to study high power transfer efficiency, safety, and minimal EMI while maintaining compatibility with existing charging infrastructure. The proposed work has the potential to contribute to the advancement of IWPT technology for EV charging applications, reduce the carbon footprint associated with EV charging, and increase the adoption of EVs.

## REFERENCES

[1] M. Bozchalooi, A. Ghosh, and R. K. Rajashekara, IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 7, no. 1, pp. 295-309, Mar. 2019.
[2] X. Zhang, W. Liu, S. Jiang, and X. Wang, "A review of inductive power transfer for electric vehicles: Prospects and challenges," Applied Energy, vol. 219, pp. 280-297, Jun. 2018.
[3] R. A. H. Ribeiro, T. C. Green, and M. R. H. Kim, "Dynamic wireless power transfer for electric vehicles: A review of the technology and its applications," IEEE Transactions on Power Electronics, vol. 33, no. 3, pp. 2043-2059, Mar. 2018.
[4] N. K. Sonti, A. Kurs, and M. Soljacic, "Wireless power transfer for electric vehicle charging," IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 3, no. 1, pp. 4-17, Mar. 2015.
[5] S. Y. R. Hui, J. Zhang, and C. K. Lee, "Wireless power transfer for electric vehicle applications," IEEE Transactions on Industrial Electronics, vol. 60, no. 7, pp. 2428-2438, Jul. 2013.
[6] K. M. Smedley, T. C. Green, and R. J. Stenton, "Inductive power transfer for electric vehicles: A review," IET Power Electronics, vol. 5, no. 1, pp. 3-13, Jan. 2012.

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# Chapter: 66

# Barkhausen Noise Analysis of Different Shaped Sample of Mild Steel

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**ABSTRACT**

Barkhausen noise analysis is a non-destructive technique which is based on magnetic properties of the material which is a fast technique for material characterization and testing of surface integrity. This method can be integrated into the manufacturing environment such as grinding shaping etc for online testing of produced parts or working machine parts. Due to the shape of the test sample, the BNA the barkhausen noise signal may get affected and that can fluctuate the results. Hence the aim of this research work is to present the experimental investigation of how varying the shape of the test sample can affect the results of the material characterization by the magnetic Barkhausen Noise method. The measurements were made on five samples of the ground and annealed sample to examine the effect of microstructural changes as well. First, all samples of base metal were cut into different sizes and later, all samples were subjected to heat-treatment process annealing. The results concerning magnetic Barkhausen noise were discussed in terms of RMS values, the shape of Barkhausen noise profiles, the position of the peak values and mathematical analysis of barkhausen data obtained from the test performed. In this study, the HL and BN of the mild steel sample were experimentally measured by varying the frequency, MFI, and waveform using magnetic Barkhausen noise analyzer. Barkhausen noise analysis frequency was applied from 20 Hz, 30Hz, 40Hz, 50 Hz at 800 Oe constant and MFI varies from 250 Oe, 500Oe, 750Oe, 1000 Oe at a constant magnetizing frequency of 25 Hz. For hysteresis loop analysis sinusoidal waveform was applied at a magnetizing frequency of 0.1 Hz to 0.4 Hz at 500 Oe constant magnetic field intensity, t, and 150Oe, 300Oe, 400Oe, 600Oe magnetic field intensity at 0.1 Hz constant magnetizing frequency. The result for magnetic Barkhausen noise of the base sample and the annealed sample of mild steel of different thickness and size were observed by graphical variation with frequency and MFI.

## 1. INTRODUCTION

**1.1Background:** Properties of material (especially mechanical) depend on its chemical composition, crystal structure defects, shape, etc. Thus the study of these parameters and the relation between these and the property of the material is necessary. Material characterization refers to the processes that are used to determine material properties and structure. It is a fundamental process in the field of material science and engineering, without which no specific understanding of materials could be achieved. There is various kind of material characterization methods/technique can be classified into two categories [1-2].

1. NDT (non-destructive testing)
2. Destructive testing

The term “non-destructive testing” (NDT) is used for material testing methods that can be applied without compromising the usefulness of the material. Tests can be applied to materials, parts, assemblies or structures. Most non-destructive methods are indirect, producing an estimation of the quality, strength or serviceability of the tested object. Destructive methods can also be applied to material testing. It is, however, the tested object is lost in such a testing scheme and thus cannot be applied to objects that are later used in service. Non-destructive methods offer many advantages to the industry. These advantages mainly fall into four categories: increased productivity, increased serviceability, safety and identification of materials. There is a wide variety of non-destructive testing methods utilizing different physical phenomena. Test methods can be divided into visual, pressure and leak, penetrant, thermal, radiography, acoustic, magnetic, etc. Conventional testing methods such as Optical

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microscope, Scanning electron microscope (SEM), X-ray diffraction (XRD) and hardness measurement are time-consuming and cannot be used for online testing [3].

But these methods are very time consuming and expensive. In opposite to these time-consuming laboratory methods, Magnetic barkhausen noise turns out to be the best alternative. It is a fast, reliable and practical method to detect mass production volume. It is a very important tool for non-destructive characterization [4-6] of ferromagnetic materials. Barkhausen noise analysis is one such non-destructive technique which is based on magnetic properties of the material which is fast and can be integrated into the manufacturing environment for online testing of produced parts or working machine parts etc.

Barkhausen Noise was discovered in 1919 by H. Barkhausen when he wound a ferromagnetic specimen with a wire and hooked it to an external speaker. He found that by changing the magnetic field around the specimen, he could induce a rushing sound in the speaker. This rushing sound was the result of many small abrupt changes in magnetic flux that was occurring within the confines of the coil. These step variations in magnetic flux occur randomly and are what is commonly known as Barkhausn Noise. It is an advanced material characterization technique which has many advantages over other NDT's.

## 1.2 BARKHAUSEN NOISE BACKGROUND

**1.2.1Magnetism:** Magnetism is a complex phenomenon. It is caused by and affects electric currents. These electric currents can be of any scale, down to the scale of electron spin, as this can also be seen as moving electric charges and thus as an electric current. In order to understand the background of using magnetic properties to evaluate the microstructure, some aspects of magnetism are explained in this chapter, starting with the most important definitions, related to this topic.

**1.2.2 Ferromagnetism:** When a material is kept in an external magnetic field it can respond in many ways. Some materials have a tendency to repel the flux line from their core and as a result, it experiences a small force of repulsion from the magnetic field, such materials are known as diamagnetic materials. While some materials show the tendency to concentrate the flux lines to their core, as a result, it experiences attraction force from the external magnetic field, these materials are classified as paramagnetic materials. Ferromagnetism is based on the extent of attraction force they experience from the external field. The force that occurs in diamagnetic and paramagnetic materials are much weaker, and materials exhibiting such behavior do not spontaneously produce their own magnetic field. While ferromagnetic materials show strong attraction towards the external field and are easily magnetized in the external field. In general, language when we say the material is magnetic, we usually mean it exhibits ferromagnetic behavior.

**1.2.3 Magnetic field (H):** One of the most fundamental ideas in magnetism is the concept of the Magnetic Field. A magnetic field can be produced by a permanent magnet. In a permanent magnet, there are the orbital motions and spins of electrons within the permanent magnet material which lead to a magnetization within the material and a magnetic field outside. A magnetic field can also be produced whenever there is an electrical charge in motion This can be due to an electrical current flowing in a conductor for example, as was first discovered by Oersted in 1819 [1]. The strength of this field is proportional to the current that is passed through the field winding in the sensing device or sensor. In the commercial Barkhausen Noise products, this is a common system parameter setting or control, which is used to control the field winding current. Often this term will be used to refer to the magnetizing current, which is

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the current that is used to generate the time-varying external magnetic field around the inspection specimen.

**1.2.4 Excitation Field:** The excitation field term refers to the magnetic field that is used to excite, or influence, the ferromagnetic specimen. This excitation causes emission of Barkhausen Noise as the field is changing from one polarity maximum to the other. This field has to change with time to cause the Barkhausen emission to occur.

**1.2.5 Magnetic Domains:** Magnetic domains are commonly discussed in the articles pertaining to Barkhausen Noise technology. A domain is a region in a ferromagnetic material that is defined by a magnetic polarity boundary. As an external field is applied to the material, the boundary of the magnetic domain will transform towards an equilibrium position. The transition of this domain shift is semi-predictable and is commonly a single part of a series of changes at once. The effect within a material can be described as an avalanche, which is usually the term used in the technical literature.

**1.2.6 Irreversibility:** With magnetic types of inspection and phenomenon, there is an aspect that one frequently encounters. The aspect of irreversibility is displayed in a ferromagnetic material's inability to return to the original magnetic state. In other words, once a ferromagnetic material has been placed in a magnetic field and taken from the field, there will remain in the material some amount of residual magnetism. This characteristic occurs on the order of the individual magnetic domains within a material, thus causing a very unrepeatable transition when the magnetic field is changing within a material.

**1.2.7 Magnetic Hysteresis:** When the magnetic field applied to ferromagnetic materials is cycled in time, the magnetization does not trace its initial path, resulting in magnetic hysteresis. This hysteretic behavior is related to the influence of the applied magnetic field on magnetic moments which are aligned in particular crystallographic directions in different regions in the material. Such regions are known as magnetic domains and the crystallographic directions in which the moments align are called easy magnetization directions.

In neighboring domains, the moments within each domain are aligned along with different directions as seen in Fig. 1.1 (Top). The interfaces between adjacent domains (called the domain wall) can be a few hundred atomic layers thick or even a few atoms (based on the material) and the orientations of the moments change progressively within these layers from that of one domain to that of another.

When an external magnetic field is applied to a ferromagnetic material, as in Fig. 1.1 (Bottom), at magnetic field strengths sufficient to move the domains past any pinning sites, the magnetic moments within each domain then switch to crystallographic easy directions closest to their orientation. With sufficient field to overcome the anisotropy energy, they switch to the direction of the applied magnetic field to attain a state of minimum energy [Jiles and Atherton (1986); Bertotti (1998)]. During the magnetization process, the domains oriented in the direction of the external field (favorably oriented domains) grow at the expense of neighboring less favorably oriented ones, which shrink.

The presence of imperfections or defects within the material serve as a source of lag during magnetization by acting as pinning sites to the domain walls. At sufficiently high magnetic field strengths, all domains will become oriented to the direction of the applied field. A sufficiently strong magnetic field can even reorient the magnetic moments oriented along the favorable crystallographic direction in the direction of the applied magnetic field. Beyond this, no further magnetization is possible, and the material is then said to be saturated. If the direction of the magnetic field is reversed, the magnetic moments realign along the favorable crystallographic direction thereby reducing the magnetization mainly because this reduces the total energy of

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the system. The hysteresis loop is illustrated in Fig. 1.2. The imperfections and impurities in the material affect the shape of the hysteresis loop. Magnetocrystalline anisotropy also influences the hysteresis loop because it affects the ability of domain walls to align along the field direction.

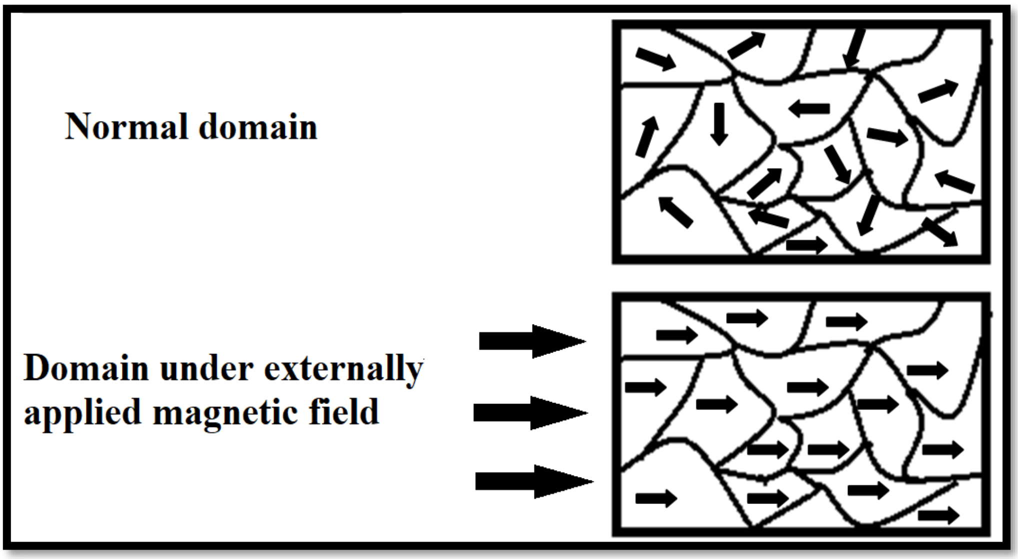


**Figure 1.1: Schematic illustration of magnetic domains within grains. The arrows represent the magnetic moments which are randomly oriented before magnetization (top) and are oriented along the direction of the external magnetic field (bottom)**

For ferromagnetic materials, the hysteresis process can be described mathematically. If an external magnetic field, H, is applied to a ferromagnetic material with relative permeability of free space, μo, the magnetic induction, B, within the material is:

**$B = \mu o(M + H)$**

Where M is the magnetization of the ferromagnetic material. On the microscopic level, the hysteresis process can be divided into the following processes. In a demagnetized state, the magnetic moments are randomly oriented such that the net magnetization is zero. At saturation, all the magnetic moments align in the direction of the applied magnetic field. The magnetization which remains after removal of the externally applied magnetic field is known as the remanent magnetization as observed in Fig. 1.2

The magnetic field when the net magnetization is zero is known as the coercive field as seen in Fig. 1.2 Describing the hysteresis loop allows for predicting the magnetic properties such as the coercivity or remanence for magnetic materials and in turn, allows for improving their performance in devices. Historically, several models have been proposed to predict this hysteresis behavior. Some earlier work suggested a frictional force responsible for hysteresis and others considered hysteresis as a byproduct of the interactions between the magnetic moments [Jiles and Atherton (1986)].

It is now understood that both of these physical phenomena contribute to hysteresis. The apparently smooth nature of the hysteresis loop is attributed to a frictional force opposing the change in magnetization. This is due to the pinning of domain walls by defects in specimens which cause an opposing force resisting changes in magnetization. The mutual interactions between the magnetic domains are also contributing factors.

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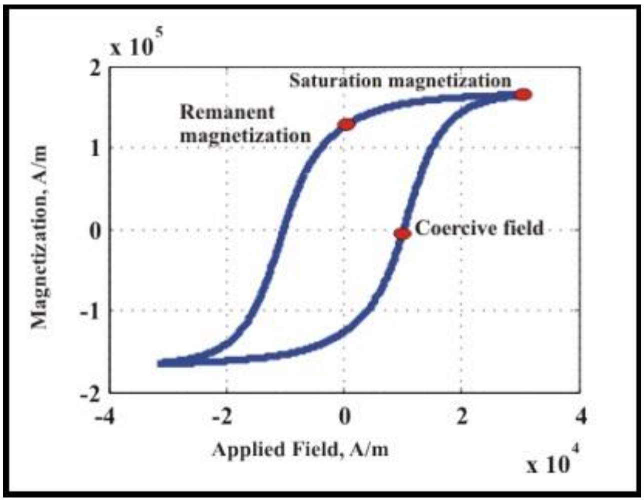


**Figure 1.2: Illustration of the magnetization process**

**1.2 Mechanism of Barkhausen Noise Analysis (BNA):** Barkhausen Noise Analysis (BNA) method, is based on a concept of inductive measurement of a noise-like signal, generated when a magnetic field is applied to ferromagnetic materials. ferromagnetic materials consist of small magnetic regions resembling individual bar magnets called domains. Each domain is magnetized along a certain crystallographic easy direction of magnetization. Domains are separated from one another by boundaries known as domain walls or bloch walls. Under the externally applied magnetic field domains with the direction close to the applied magnetic field (fig 1.1) get increased in their size which leads to the magnetization of the specimen. If an AC magnetic field is applied it will cause domain walls to move back and forth, this is known as barkhausen jump and can be recorded in the form of BN signals. Barkhausen noise has a power spectrum starting from the magnetizing frequency and extending beyond 2 MHz in most materials. It is exponentially damped as a function of distance it has traveled inside the material. This is primarily due to the eddy current damping.

**1.3 Factors affecting the Noise signal:**

**1.3.1 Frequency:** The frequency of the AC voltage applied to the magnetizing coil, which determines the penetration depth. The sensor is sensitive to greater depths if a lower frequency is used. High frequencies induce eddy currents that damp the signal as already explained. Higher frequency also causes vibration due to magnetostriction.

**1.3.2 Applied magnetic field intensity:** The sensor varies the amount of electrical current passing through the magnetizing coil, and therefore the strength of the external magnetic field. The field should be strong enough that the hysteresis loop is relatively large, but not so strong that it saturates the sample.

**1.3.3 Material properties:** Different materials react differently to an applied magnetic field. As the part material changes, so does its hardness, grain size, magnetic permeability, etc.

**1.3.4 Chemical composition:** At high machining speeds, the chemical composition has been shown to be the same as the bulk material, most likely because the carbon does not have time to diffuse. In contrast, at lower machining speeds significant cementite presence was found in white layers. These differences are explained by the occurrence of phase transformation at higher machining speeds.

**1.3.5 Grain size:** Grain boundaries may impede the movement of domain walls, and therefore change the shape of the hysteresis curve. The Barkhausen effect is also responsive to the

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location, size, and type of carbide precipitates. Typically this is assumed to be aliased with other factors, especially the material type and hardness.

**1.3.6 Texture/Surface finish:** The surface finish is usually neglected because it is similar enough for each of the parts to be considered approximately the same.

**1.3.7 Inclusions:** Inclusions affect the sensor response because they have different properties than the bulk material. Inclusions may affect the overall permeability, hysteresis loss, and coercivity of the material.

**1.3.8 Thickness of test sample:** The limitation of BNA is it can only be used to detect changes in the very near to the surface region of the material. The depth of penetration can be governed by the same skin depth equation of the electromagnetic field.

$$\delta = \frac{1}{\sqrt{\pi f \sigma_m \mu_o \mu_r}}$$

Where, $\delta$ - depth of penetration in material

f - Excitation frequency

$\sigma_m$ - conductivity of material

$\mu_o$ - permeability of vacuum

$\mu_r$ - relative permeability of the material

**1.4 Signal analysis:** A typical Barkhausen noise signal of 3 cycle (6 brust) is shown in Fig 1.3. the figure cosists two half, the upper half show the raw data obtain from measurement and the lower half show the filtered signal. Usually, some feature is calculated from this signal and then compared with studied material properties.

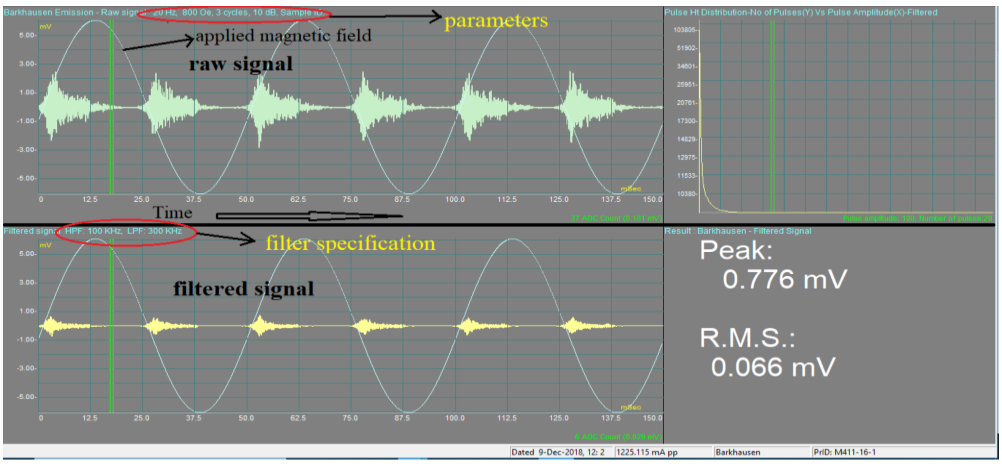


**Figure 1.3: Output display of BN test on Megastar techno four.**

The root-mean-squared (RMS) value of the signal is the most usual one. It has been used, for example, in (Lindgren &Lepisto 2002) and (O'Sullivan,2003).Also the signal can be plotted and the properties of the curve can be analyze. The fig1.4 shows the graph between rms in milli volt and time in milli second. the black hached line shows the actual variation of rms and the red smooth line show the best fit polynomial. The properties of this polynomial such as skewness, kurtosis, Area under the curve can be calculated and then compared with the material properties.

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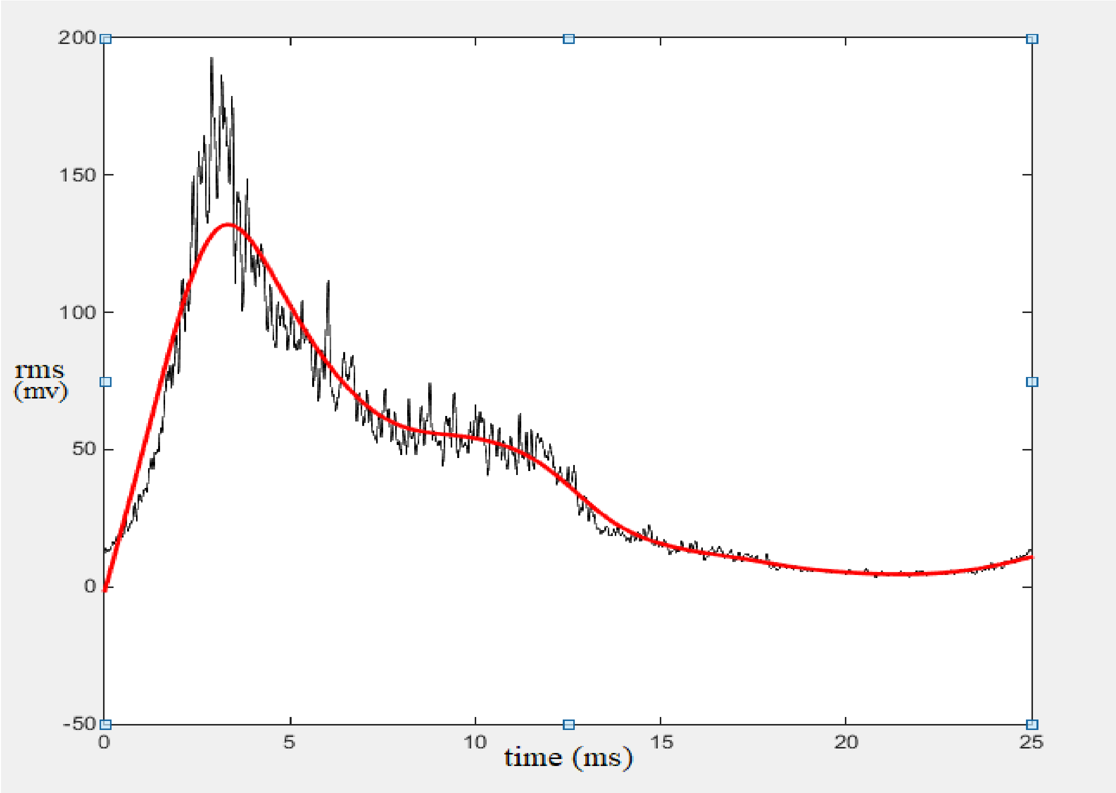


**Figure 1.4: variation of RMS VS time for a rectangular sample at 800 Oe magnetic field intensity and 20 Hz excitation frequency.**

**1.5 Barkhausen Noise Analysis - the Applications:** Many common surface treatments such as grinding, shot peening, carburizing and induction hardening involve some modification of both stress and microstructure and can be readily detected using the method. Various dynamic processes such as creep and fatigue similarly involve changes in stress and microstructure and can also be monitored with BNA. Practical applications of the BNA can be broadly divided into three categories:

- Evaluation of residual stresses; provided microstructural variables can be reasonably controlled.
- Evaluation of microstructural changes; provided level of stress can be reasonably controlled.
- Testing of the following surface defects, processes and surface treatments that may involve changes in both stresses and microstructure.
- Detection of grinding defects and grinding process control.
- Detecting surface defects through Cr-coating.
- Evaluation of shot-peening effect in steel.
- Measurement of residual surface stresses in steel mill rolls and steel sheet.

**INSTRUMENTATION**

**3.1 Experimental set-up:** The measurements of barkhausen noise were carried out on the Magstar system supplied by Technofour, India. The apparatus is shown in fig 3.1.It mainly consists of an AC power supply, a control unit, a sensor/probe, and a display unit. The probe (fig 3.2) consists with U shape magnetizing yoke to to generate magnetic field inside the test sample with the help of alternating current from power supply. A pick up coil at the center was used to gather the signal generated as magnetic response of the work material.

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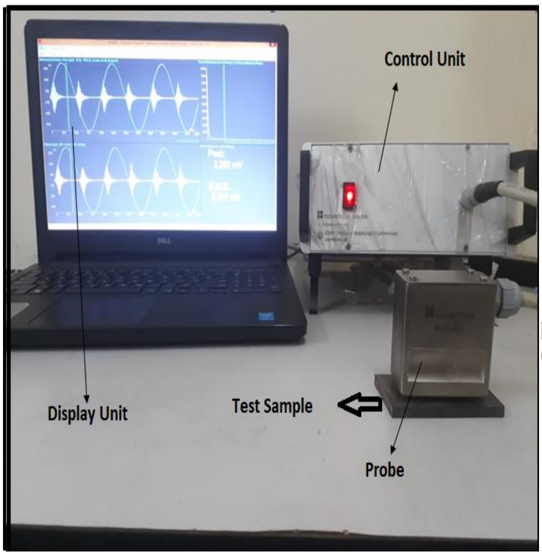


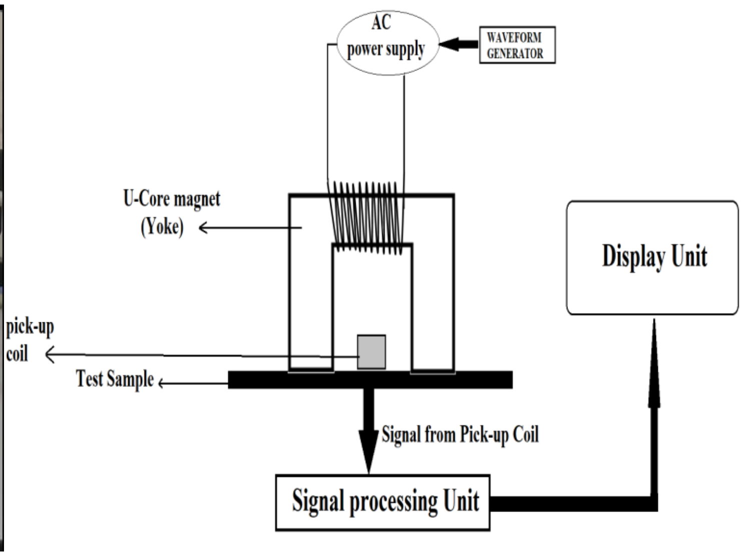


(a (b)

**Figure 3.1 (a) experimental setup (b) schematic diagram**

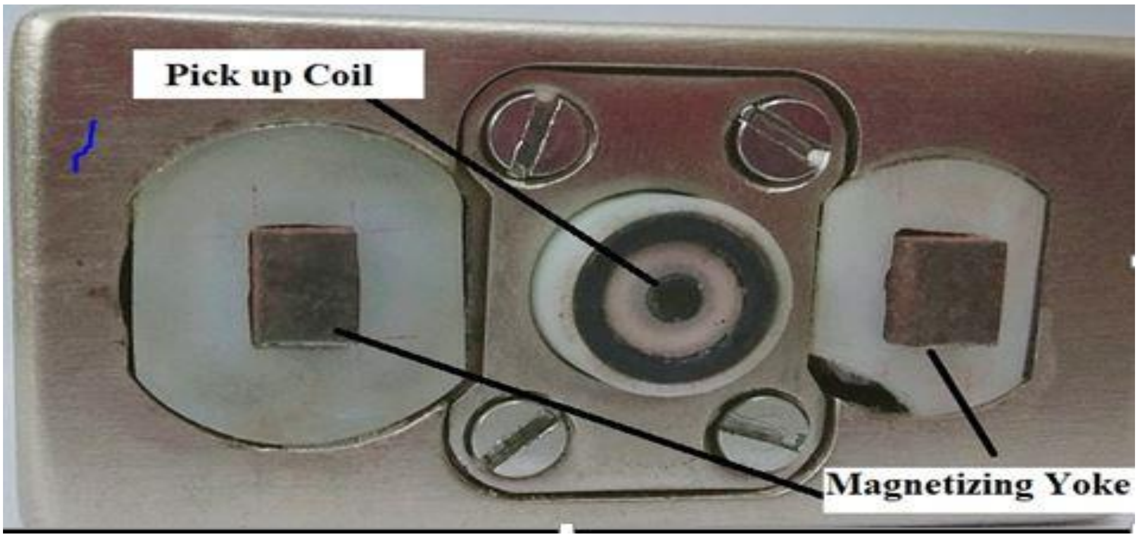


**Figure 3.2: Bottom view of probe**

**3.2 Material selection:** The unhardened low carbon steel has very good magnetic properties. It is widely used in the automobile industry, pipes and pressure vessel, etc. hence it covers a wide spectrum of application. For experiment five sample was prepared from hot rolled IS-2062 steel sheet of 1.54 mm thickness. The chemical composition of the of the material are given in table 3.1.

**Table 3. 1: Chemical composition of IS-2062 steel**

| Element | C | Si | Mn | P | S | Cr | Fe |
|---|---|---|---|---|---|---|---|
| Wt % | 0.17 | 0.045 | 0.32 | 0.007 | 0.013 | 0.3 | Rest |

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**3.3 Sample preparation:** The shape of the sample and their respective dimensions are shown in fig 3.2. Since the objective was to study the effect of shape of the sample hence the dimensions were chosen such that the total volume of each sample remains equal. The sample were cut with help of CNC milling. Surface contamination such as dust, oil, corrosion etc affects the formation of hysteresis loop to avoid such problem test sample were cleaned using emery paper with successively fine mesh girt of 120, 320,400 and 600 to make the surface of sample scale free.

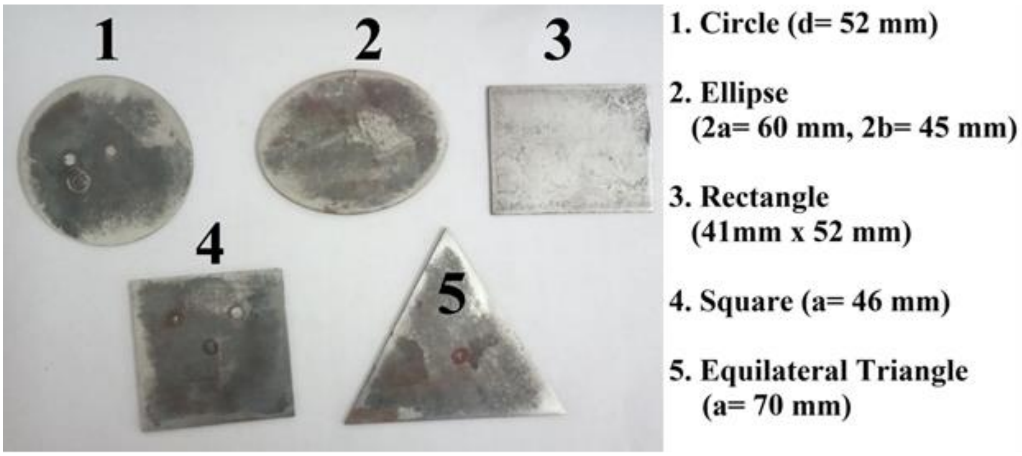


**Figure 3.3: Sample used in the experiment.**

**3.3.2 Annealing of sample:** Annealing was carried out in pit type electric furnace in which sample were first placed into the furnace at 850ºC temperature and then holding them at constant temperature for 15 minute followed by cooling upto room temperature in furnace. The cooling take place in approximately 5-6 hr.

**3.4 Microstructure and Microhardness analysis:** For observation of microstructure, samples (base and annealed) were cleaned by different emery paper with successively fine mesh girt of 120, 320, 600, 800, 1200 and 1500 followed by cloth polishing with alumina paste until a mirror-like surface was achieved. The sample was first cleaned using running water then etched for 10 second using 3% nital solution. The sample was immediately rinsed using running water and dried using hot air. To obtain the microstructure of the sample 'Dewinter' microscope is used and the microstructure is captured by 'Dewinter Biowizard' software. The microhardness (HV) tester (Micro Mech Technologies, India) was used to examine the microhardness of base sample and annealed sample. The microhardness test at the subsurface was carried out with 100 gm (981 mN) load 10 second dwell time on the cross section base sample. The indentations were done with a Vicker indenter starting from depth 15 μm from the edge and reading are taken in HV. The hardness measurement was performed up to depth 120 μm from the edge at a regular gap of 15 μm. To avoid interference between each indentation the indentation is performed in 2 lines. To compensate for the experimental tolerances, five hardness measurements is taken at each depth and the average value was considered for analysis. The hardness measurement of annealed samples was also taken with 100 mg load and 10 second dwell time five time each and their average is taken for analysis. Fig. 3.4 shows the Indentation of the micro-hardness-identator which was observed on the surface of sample during the hardness testing and the table 3.2 shows the Computation of indent diameter and Vickers Hardness Number for every trial.

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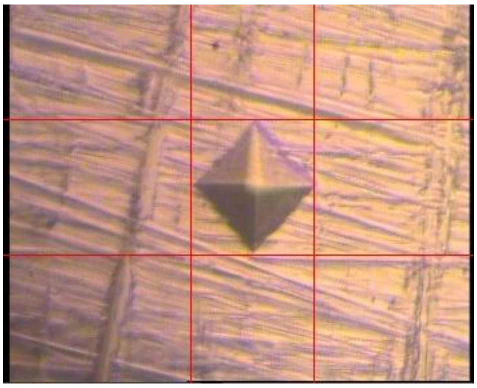

**Figure 3.4:Identation of the micro hardness identator.**

**Table 3. 2: Computation of indent diameter and Vickers Hardness Number**

| S.N. | Base sample | | | Annealed sample | | |
|---|---|---|---|---|---|---|
| | D1 (µm) | D2 (µm) | Vickers Hardness Number (HV) | D1 (µm) | D2 (µm) | Vickers Hardness Number (HV) |
| 1 | 36.33 | 36.13 | 141.25 | 58.37 | 58.03 | 109.47 |
| 2 | 37.55 | 37.59 | 131.35 | 37.96 | 37.59 | 129.93 |
| 3 | 38.78 | 38.69 | 123.57 | 57.14 | 56.57 | 114.71 |
| 4 | 37.14 | 37.23 | 134.08 | 38.37 | 39.05 | 123.73 |
| 5 | 37.96 | 37.96 | 128.66 | 56.73 | 56.93 | 114.81 |
| | Average Vickers hardness number | | **131.782** | Average Vickers hardness number | | **118.53** |

**3.5 BN data collection:** The experiment was conducted in two phases at different magnetization conditions. In first phase magnetic field intensity was kept constant while in second phase excitation frequency was kept constant. Parameter for MBN and hysteresis loop (HL) analysis are given in table 3.3 And 3.4 respectively.

**Table 3. 3: Parameter for BNA**

| | | |
|---|---|---|
| Common data for both phases | No of cycles | 3 |
| | Gain | 10 dB |
| | High pass filter (HPF) | 100 KHz |
| | Low pass filter (LPF) | 300 KHz |
| BN phase-I | Magnetic field intensity (MFI) | 800 Oe |
| | Magnetic frequency (MF) | 20, 30, 40, 50 Hz |
| BN phase-II | Magnetic field intensity (MFI) | 250, 500, 750, 1000 Oe |
| | Magnetic frequency (MF) | 25 Hz |

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**Table 3. 4: Parameter for HL**

| | | | |
|---|---|---|---|
| HL | phase-I | Waveform | Sine wave |
| | | Magnetic field intensity (MFI) | 500 Oe |
| | | Magnetic frequency (MF) | 0.1, 0.2, 0.3, 0.4 Hz |
| HL | phase-II | Magnetic field intensity (MFI) | 150, 300, 400, 600 Oe |
| | | Magnetic frequency (MF) | 0.1 Hz |

### 3.6 Post-processing analysis of Barkhausen Noise Data

**3.6.1 Raw BN Data:** It is very difficult to interpret information from a raw BN signal due to background noises, and vibrations, leading to stochastically nature. At one cycle of applied field, two bursts are obtained as illustrated in Figure 3.5(b) in a BN measurement of 3 cycle there are 6 brust with alternate magnetizing and dmagnetizing in nature. Burst 1 occurs when magnetization takes place in path e-f-a-b in B-H curve and burst 2 occurs in path b-c-d-e.

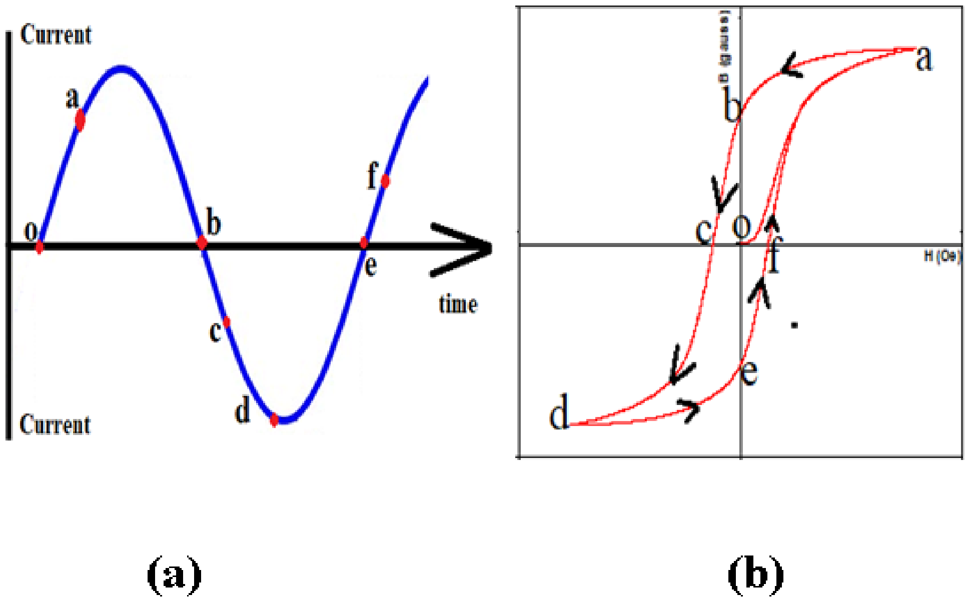


**Figure 3.5: (a)applied magnetic field (b)showing the path on the B-H curve**

**3.6.2 RMS Profile:** The RMS signal was obtained from the raw signal with zero phase filtering. The RMS distribution of k signal (k can take 1, 2...any integer), defined as:

$$\mathbf{rms} = \sqrt{\frac{\mathbf{1}}{\mathbf{n}} \sum_{i=\mathbf{k}-\mathbf{n}}^{\mathbf{k}} x_i^2}$$

Where, $x_i$is raw BN signal, n is sampling interval. This filtering was done using MATLAB program. Here, filtered BN signal shown in figure 3.6(a). Since, 3 cycles of applied magnetic field are used to perform BN test so 6 burst are obtained. Then, the burst 1, 3 and 5 are averaged to obtain required RMS distribution shown in figure 3.6(b), because these three bursts correspond to the same path e-f-a-b in B-H curve explained in figure 3.5. Single peak

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fit with Gaussian distribution is used to fit this modified signal with Levenberg Marquardt algorithm in ORIGINPRO also shown in figure 3.6(b). This was used because process annealing and facing would not cause any profound phase change from surface to the bulk. Thus, signal peak is expected for all samples.

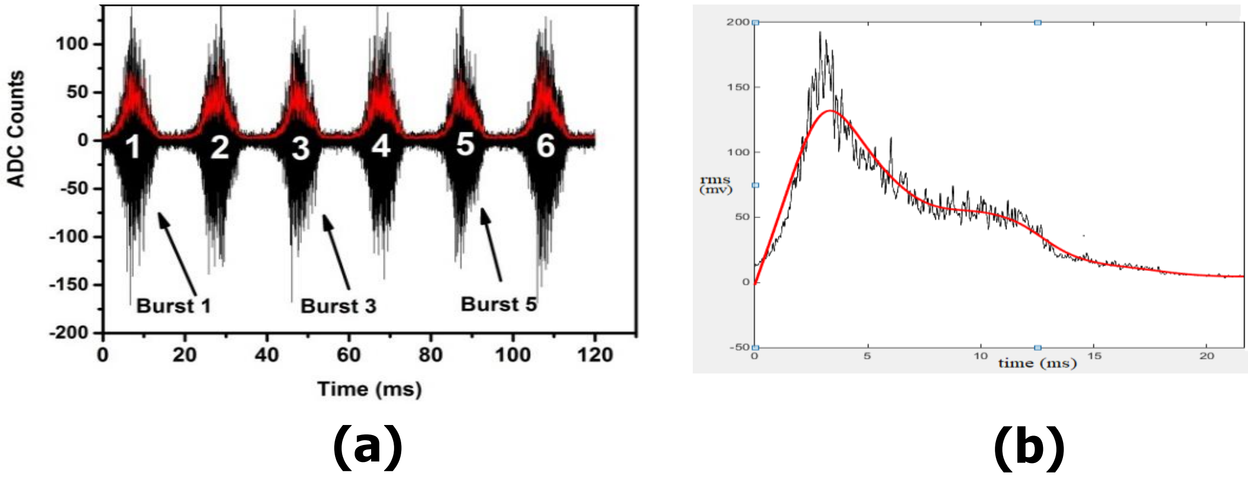


**Figure 3.6: (a)Measured BN signal along with filtered Signal in at 25 Hz,(b) Gaussian fit**

## RESULTS AND DISCUSSSIONS

### 4.1 Part I: effect of shape on BNA:

**4.1.1 Variation of RMS with Fq and MFI:** It can be seen f rom the variation of rms with excitation frequency and magnetic field intensity as shown in figure it is evident that the BN response for Rectangular shaped sample is strongest and that for the square shaped sample is weakest, while others are in between them. This can be due to shape anisotropy.

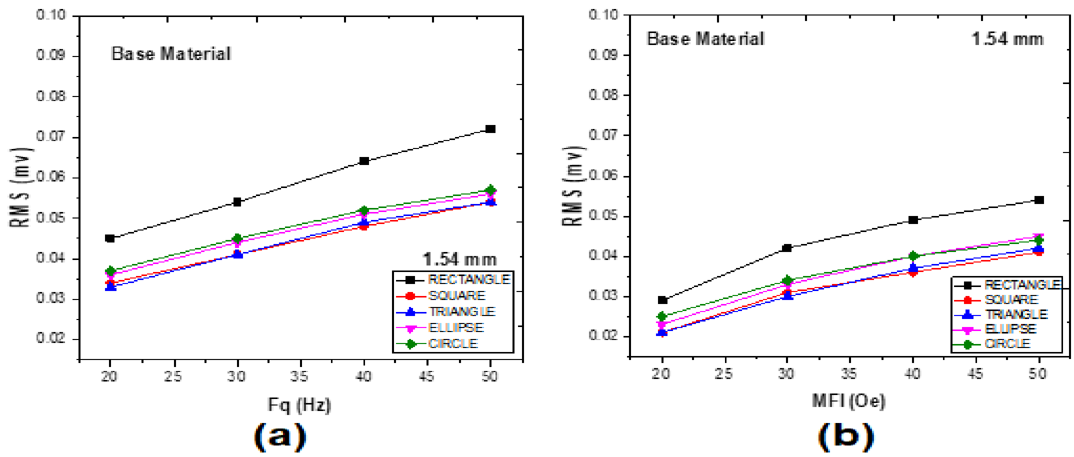


**Figure 4.1: (a) BN signal rms variation wrtMF, (b) BN signal rms variation wrtMFI**

**4.1.2 Variation of RMS with time:** Figure 4.2 and 4.3 shows the variation of rms with respect to time at different frequency and at different magnetic field intensity respectively. when sinusoidal applied field varies along this path, the field increases to maximum, and then decreases to zero to complete B-H curve on first quadrant Form the graph it is quite clear that change in frequency doesn't affects the peak value of rmswhile on the increase in magnetic field strength we get stronger BN response from all the sample. The peak value for rectangular sample is largest and smallest for square shaped sample that can be again due to shape anisotropy.

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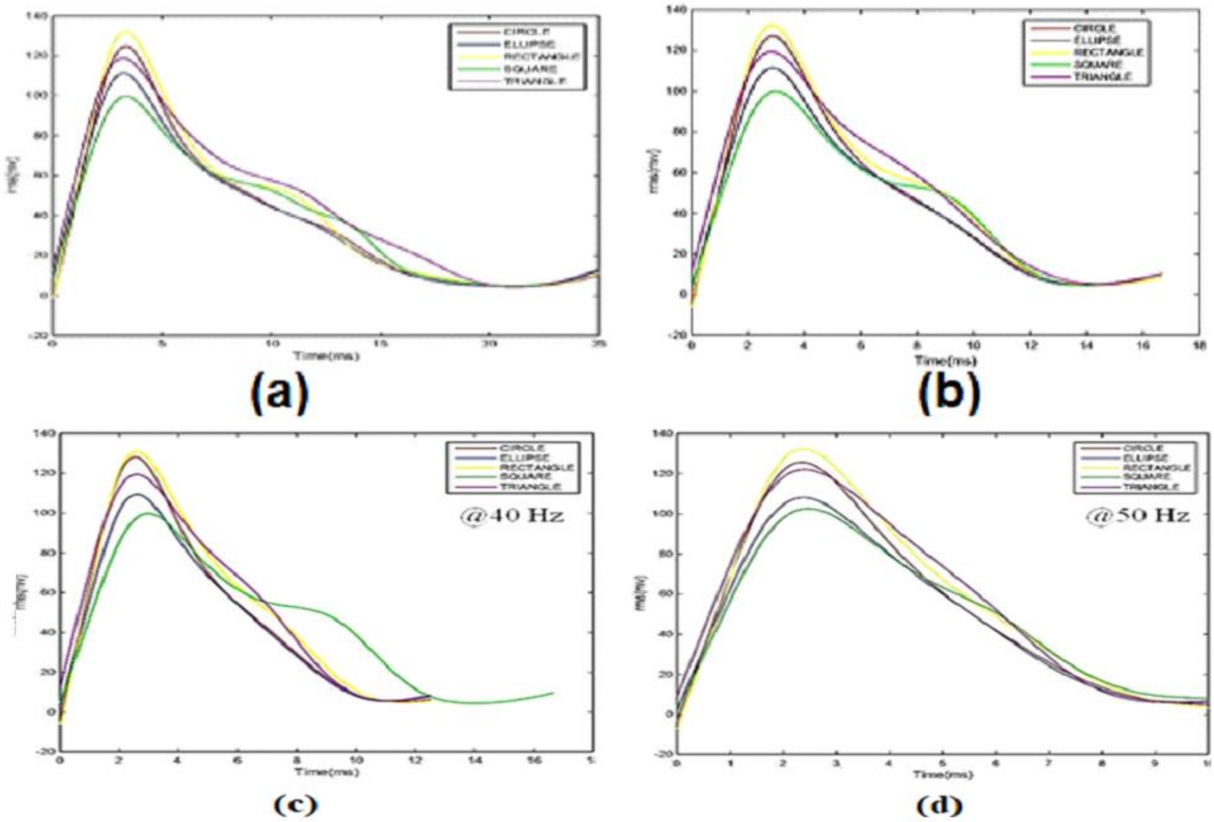


**Figure 4.2: BN signal rms variation wrt time at different excitation frequency**

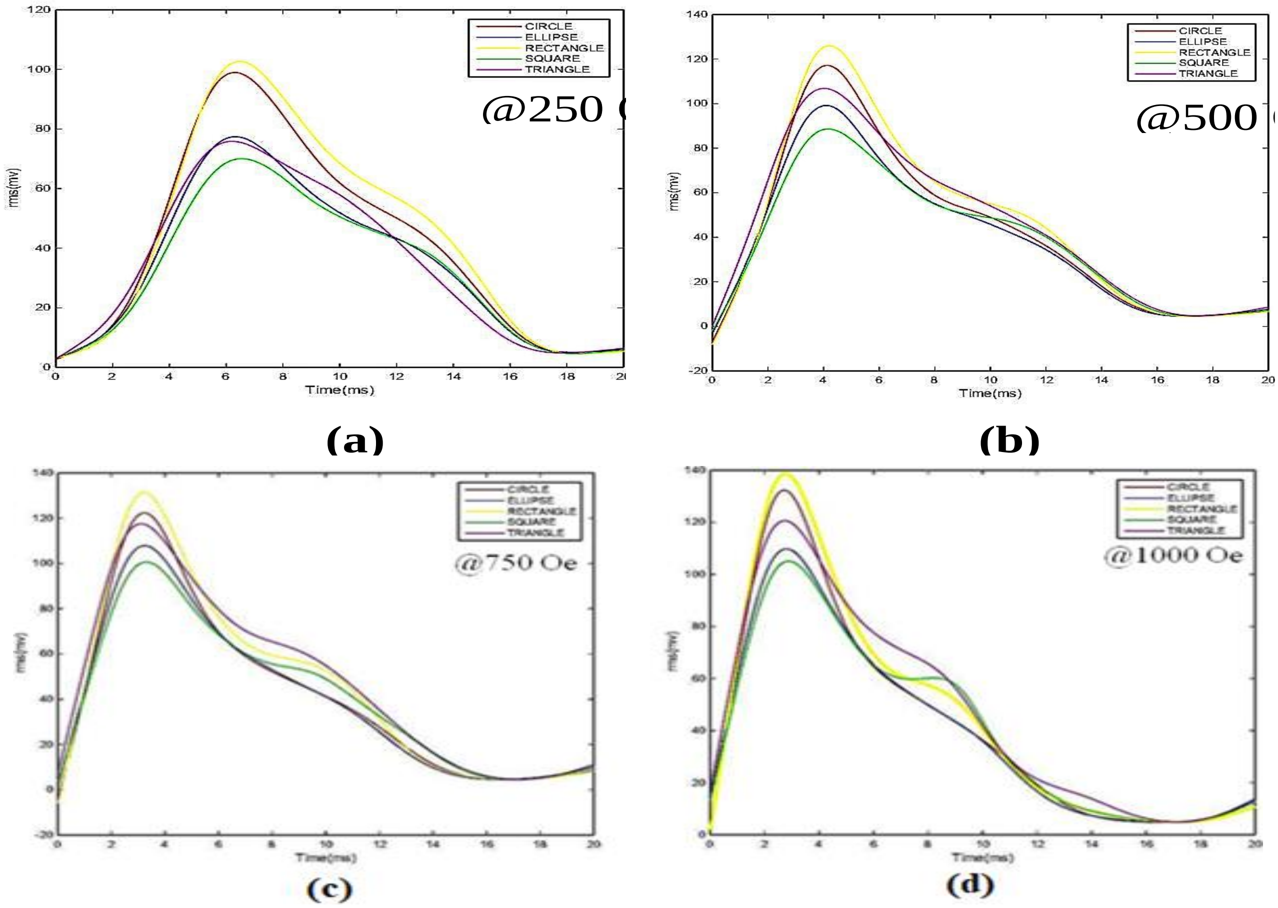


**Figure 4.3: BN signal rms variation wrt time at different applied magnetic field intensity**

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## CONCLUSION

- The BN signal obtain from the Rectangular shaped sample were strongest and weakest for square shaped sample hence the best suited sample for BNA is rectangular shaped sample.
- For the measurement of remanene based properties the shape of the sample is not a factor since remanence was unaffected by the change in shape.
- RMS value of BN signals increases after annealing .
- RMS value were found to be higher at lower hardness.
- No fixed change in skewness and Kurtosis were observed on changing the shape of sample.
- No fixed change in skewness and Kurtosis were observed after annealing
- In case of both the base and the annealed material linear variation is observed between Barkhausen noise (rms) and MF & MFI.
- Average permeability increases with the decrease in micro-hardness of material.
- Coercivity for base sample is lesser as compared to that of annealed sample.

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# Chapter: 67

# Study in Automation of Lathe Machine

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**ABSTRACT**

It is needed to use CNC lathe machine to get more accurate dimensions in irregular shape. Hence, CNC machines are becoming more and more important in modern industrialization. In developed country, it is required to convert these conventional lathe machines into semi-automatic control lathe machine. Developing and changing into semi-automatic control lathe machine, there are three requirements, namely, mechanical electronics and hydraulic. In this project we convert the convention lathes which have 5ft bed length into the semi-automatic lathe. We replace the ball screw by lead screw for better accuracy and remove unnecessary component like gears for providing space for motors. Adding extra plates or structure for installation of motors. Also provides a hydraulic circuit for coolant. In electronic side we used a servo/ stepper motor for both Z and X axis and provide controller for the efficient operation.

**KEYWORDS:** Automation, Retrofitting, CNC Turning Center

## INTRODUCTION

When we say that retrofitting related to some component that mean we try to upgrade that component and improve their efficacy through a present technology. But here we only talk about the retrofitting in lathe machine at time Retrofitting is the process of replacing the CNC, servo and spindle systems on an otherwise mechanically sound machine tool to extend its useful life. Rebuilding and remanufacturing typically include a CNC retrofit. It gives lower cost investment than purchasing a new machine and an improvement in uptime and availability. But there are often other unanticipated benefits to retrofitting including lower energy costs, higher performance and a new level of manufacturing data accessibility. CNC retrofitting is typically the lowest cost solution to improve the overall performance of an older machine tool. Though some electrical subassembly is often performed at the retrofitter's business location, minimizing the time that the machine is out of commission. Rebuilding typically includes the repair or replacement of some worn mechanical components such as ball screws, lubrication pumps, safety interlocks, guards, hoses, belts and electrical wiring.

Remanufacturing goes a step further to repair or replace mechanical components to the original, as new, factory specification. It is likely that the machine will be completely disassembled, cleaned, inspected, repaired and painted. All pneumatic, hydraulic and electrical systems will be updated. The machine may also be modified or have mechanical accessories added to re-purpose it for a new application. The main objective of the retrofitting of the lathe machine is to improve the existing conventional lathe machine to provide it features of CNC machine with very lower cost than the new CNC machine. Rather than above main objective there also several objectives of the retrofitting which is given below:

- To Increased productivity and improved control of machines.
- Far superior repeatability.
- To reduce machine downtime.
- Fast machine cycles.
- High accuracy, high feed-rate.
- To increased accuracy and part finished due to controller.
- User friendly programming and simulation software enables 3D graphic representation of job with automatic generation of G-Code.

- Eliminate additional tooling cost.
- The Up-gradation Package is less expensive and more readily justifiable.

## LITERATURE REVIEW

In 1984, Department of Mechanical Engineering, IIT, New Delhi [1], took a research topic named as “Machine tool failure data analysis for condition monitoring application”. With the development of modern manufacturing technology, Flexible Manufacturing Systems have become key equipment in factory automation. Machine tools are the heart of the Flexible Manufacturing Systems. Ex example Lathe machine is the general type of machine tool used by almost all the FMSs. During the operation of this machine tool, different kinds of failures are faced by the industry. A systematic study of such failures can help in identifying the critical sub-system of these machine tools. This will be useful for identifying the condition monitoring needs of the machine tools. This deals with the identification of critical sub-system based on the failure data analysis for different types of machine tools. Initially lathe has been classified into various sub- systems as shown in Figure. In the frequency of failures for each sub-system and failure modes have been considered for finding out the weakest sub-system. In analysis, failure frequencyand downtime have been taken into consideration for deciding critical sub-systems of machine tools. It can be observed that the maximum failures took place in headstock and carriage sub-systems. These sub- systems face failures in components like gear, gearbox bearing, spindle bearing, clutch and cross-slide jib. Here it could be observed that the bearing failures cause longer downtime.

In 2013, V. Roy & S. Kumar [2] from J institute Engineering, India published development of Lathe machine attachment for CNC machine. He has developed attachment for an existing CNC machine. The CNC machine operates on mechatronic controls and a computer interface called CAMSOFT and isused as a CNC Lathe after installing the respective attachment to it. He has designed the attachment using CAD software & fabricated different models. He has successfully designed & fabricated the model. The working of the CNC Lathe attachment is tested & checked by making proper machining operation like turning and thread cutting. The machine operations are successfully done. The CNC machine becomes multifunctional with the presently developed lathe attachment and can be used accordingly by installing the respective attachment to it. The CNC machineis useful for research work in both the fields, when installedwith the proper attachment.

Developed design is successfully implemented in theproposed work for the development of the lathe attachment including headstock, tailstock and tool post. The previously attached and developed lathe attachment make the CNC machine multifunctional. Thus, further research can be carried out in both the fields respectively. Various lathe operations like plain turning, step turning, taper turning, arcturning, threading operations and manufacturing of a bolt are successfully performed on the CNC machine, when installed with lathe attachment. The successful development of the lathe attachment for the CNC machine is done. In 2013, Karl-Heinz Schumacher [3] invented about Multi Spindle Lathe. Multi spindle lathe comprising a machine frame as spindle drum which is arranged in the machine frame is rotatable about a spindle drum axis and is made up at least partially of segments which are cut out from flat material ina stacking direction parallel to the spindle drum axis and extend in stacking planes transverse to the stacking direction these segments having receiving cutouts and cooling channel cutouts which overlap with one another such that the spindle drum has spindle motor receptacles for spindle motors and a cooling channel system separated there from by wall

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webs characterized in that the cooling channel system has several channel subsystems for a liquid. He has concluded that the addition of surface finish tool in turning process helps to improve the surface finish and this setup increases the tool life of the turning tool. From the experimental results, it is confirmed that there is no change of power consumption even after the additional usage of surface finish tool. Hence, the set up will be helpful in improving the quality of the product, with less load and power consumption.

## RETROFITTING PROCEDURE

Here we have divided the complete construction procedure into five steps. In 2013, M. Moses & Dr. Denis Ashok4 M. Tech, Retrofitted lathe machine from conventional lathe machine. Theses all steps are listed below, Mechatronic from School of Mechanical and Building Science, VIT University, Vellore, India published titled as Development of a new machining setup for energy efficient turning process. In the production unit, the lathe is one of the important protection machines. This paper focuses on producing a quality product in lathe machine with less power consumption. In order to achieve that, a special setup is developed in the lathe machine for turning and finishing of the components, to achieve quality product and also to improve the productivity. As a result of this new approach, a profuse amount of energy can be saved, quality products can be obtained, and tool life can be increased. The study aimed at evaluating the best process environment which could simultaneously satisfy requirements of both quality and as well as productivity. By conducting many experiments, it was found that this special setup process improves the quality and also reduces the power consumption as compared with the existing process.

**Step 1: Purchasing of electronic parts:** Some electronic parts like stepper motor, stepper drive, spindle drive, proximity switch and control panel were purchased.
**Step 2: Disassemble some parts from conventional lathe machine:** As per definition of retrofitting process, some non-used parts from conventional lathe machine were removed. So, Head stock gearing mechanism, Apron, Lead screw, Lead screw mounting bracket, Hand wheel, etc was removed. For decreasing friction on the slide and increasing such a part life turcide was used which is made from poly tetra fluro ethylene (PTFE) and bronze.
**Step 3: Dimensionally Design and fabrication of required mechanical parts:** We have dimensionally designed some parts which are required for retrofitting & fabricated and/or manufactured. Some of the parts designs are shown below.
**Step 4: Assemble all manufactured parts & electronics parts at desired place:** After manufacturing and/or fabricating all required parts, assembly procedure carried out. All the mechanical & electronics parts are attached to their desired place. Some of the parts are shown below.
**Step 5: Inspection & testing of newly developed Retrofitted Lathe Machine:** In this step we have checked all components are properly fitted with machine body and alignment of both ball screws. Also checked both slide working properly by stepper.

Then we have manufactured job on developed retrofitted lathe machine by using turning operation program which is from manual part program method. And checked surface finishing of the job.

## COMPARISON

For comparison we have compared job manufactured on conventional lathe machine & job manufactured on developed retrofitted lathe machine. And we have concluded that surface

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roughness, production rate, dimension stability, one time set up cost is high in retrofitted lathe machine while machining time, machine slide wear is too much below.

## CONCLUSION

By developing automation in conventional lathe machine by retrofitting stepper-based method, the machine works as CNC trainer for teaching, learning of the student subject. Also Cost of machine is minimizes approximate 4 times below the original CNC trainer. As automation new developed retrofitted lathe is done by replacing or removing the components from conventional lathe machine, therefore setup cost is high as compare with standard lathe machine, but production rate is too much high. So, it is very useful for mass production. The accuracy of the job manufactured in retrofitted lathe machine is also high, so repeatability and dimensional stability of manufactured part is achieved. At last, some complex jobs which is not manufactured in conventional lathe machine can be manufactured in new developed retrofitted lathe machine.

## REFERENCES

[1] Machine Tool Failure Data Analysis for Condition Monitoring Application, Department of Mechanical Engineering, Indian Institute of Technology, New Delhi. Kegs. R. L., On-line Machine and Process Diagnostics, Annals of the CIRP., 32(2), 469-473, 1984.

[2] V. Roy • S. Kumar from Inst. Eng. India Ser. C (April–June 2013) 94(2):187–195 DOI: 10.1007/s40032-013-0064-2

[3] Karl-Heinz Schumacher (2013), Multispindle Lathe. US patent # 2013008702/201.

[4] In 2013, M. Moses & Dr. Denis Ashok M. Tech, Mechatronic from School of Mechanical and Building Science, VIT University,

[5] Vellore, India 978-1-4673-6150-7/13/$31.00 ©2013 IEEE

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# Chapter: 68

# A Review on Thread Cutting Operation on Lathe Machine

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**ABSTRACT**

Here thread cutting on aluminium was studied using two types of tools. Coated and other uncoated and review of various factors affecting thread turning operation. Parametersie depth of cut, feed rate and spindle speed are studied. This study helps in understanding parameters effecting during operation.

**Key Words:** Thread cutting, Threading, Lathe, Aluminium, Annova, Cutting forces.

## INTRODUCTION

Lathes are used for various applications in the manufacturing industry. A Large number of operations is performed on lathe machines by using different tools. In this work a threading operation is carried out on lathe machine. Thread cutting is the process of making a thread. It is used to produce threads on the outer surface of the cylinder or on the inner surface of the bore. There are many methods of generating threads, including subtractive methods (thread cutting and grinding) or deformative or transformative methods (rolling and forming; molding and casting). The tool used in lathe operation is and the HSS tool and the workpiece is aluminium of cylindrical round shape. Parameters affecting tool life are speed, feed and depth of cut. Feed means the speed of the cutting tool's movement relative to the workpiece as the tool makes a cut. Spindle speed is the speed of the spindle and the workpiece per minute (rpm).

## THREADING OPERATION

**Thread Cutting:** Principle of threading depends on screw threads. Internal threads refer to nuts and tapped holes, External threads are on bolts, studs or screws. The thread form is the configuration of the thread in an axial plane; or more simply, it is the profile of the thread, composed of the crest, root, and flanks. The threading is done by turning on continuous linear Movement of the tool/insert relative to the rotational speed of the workpiece.

**Thread milling:** Thread milling is done on a thread milling machine with the help of a disc milling cutter. Disc milling cutters are mainly used for milling trapezoidal external threads on workpiece such as screw rods and worms. Thread milling is a metal removing process for cuttingthreads into various sizes by means of circular ramping movement of a rotating tool, the thread pitch being created by lateral movementin one revolution. Thread milling can cut threads on materials that are difficult to machine.

**Thread rolling:** Thread rolling is a type of threading process that involves deforming metal stock by rolling it through a die. This process creates external threads along the surface of the metal stock. Thread rolling is not a subtractive process. This means that it does not remove metal from the stock. Rolled thread fasteners offer advantages such as strong threads, accurate final dimensions, good surface finish and low coefficient of friction. The high pressure die physically changes the properties of the rolled metal parts to make the base part and threads harder and stronger.

**Thread tapping:** Tapping is the process of cutting a thread inside a hole so that a screw or bolt can be threaded into the hole. Along with this, it is alsoused to make thread on nuts and chamfered at the end, which is used to thread a screw or bolt into the hole. The tapping process

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is a highly efficient, productive, economical and easy threading method, especially for short threads, it can also produce threads on nuts.

**Advantages:** A cut thread (also called machine thread or ground thread) is a thread that is made by cutting material through blanks. This can be achieved using a threading die or a single point cutting tool such as a lathe.

- Cut threads can be to almost all specifications including large diameter sizes.
- Suitable for parts with cavities such as pipes etc.
- Cost effective for low volume production.
- High accuracy achievable.
- In addition to hard materials, thread cutting is Preferred Method for Thick Blanks That Won't Roll to Fill die thread.

**WORKING PRINCIPLE**

The basic principle of thread turning is dependent on screw threads. A screw thread is defined as a ridge of uniform section in the form of a helix on the outer or the inner surface of the cylinder. Internal threads refer to nuts and tapped holes, whereas External threads are on bolts, studs or screws. The thread form is the configuration of the thread in an axial plane; or more simply, it is the profile of the thread, composed of the crest, root, and flanks. At the top of the threads are the crests, at the bottom the roots, and joining them are the flanks. The above figure shows the way of principle of thread cutting by means of a leadscrew. Here the spindle, which is revolving with the chuck and component to be threaded, drives the leadscrew through gearing in this example by two gears each having 45 teeth and therefore ratio of 1:1. it means the leadscrew will revolve at same speed as the piece to be screwed, and at the same time will the nut to move from right to left by a certain distance for each revolution leadscrew. If the leadscrew has 4 threads to the inch, or pitch of 1/4 inch. Exact revolution of the leadscrew will cause the nut to advance1/4 inch. If the nut is made to carry a suitable holder and setup to fit tool, then a helix will be form on workpiece and the distance between any two adjacent helices will be 1/4 inch.

**Thread cutting procedure:** The thread cutting procedure are in the following steps:

- First, machine the workpiece to the larger diameter of the thread to be cut using the turning center.
- Now the workpiece is installed in the chuck for threading between the centers.
- So, set the quick-change gearbox according to the required pitch of the thread.
- Set the tool bit at right angles to the workpiece using the thread gauge.
- Now move the threading tool bit towards the workpiece using compound and cross feed.
- The micrometer of both feeds should be set to zero.
- The carriage is being moved to a predetermined distance per revolution of the job due to the rotation of the lead screw. This done by positioning the carriage’s half nut to get engaged with the lead screw.
- The half nut or split nut must be applied at a precise predetermined time for proper cutting

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of successive cuts. This is done by using a thread chasing dial or graduate dial. This dial is being attached to the carriage and driven by a worm gear attached to a lead screw.

- Take a scratch on the component without lubricant. Detach the half nut at the edge of the cut, stop the lathe and return the tool using cross feed. Return the carriage to the starting point.
- Now check the thread pitch using a screw pitch gauge. If it is correct then proceed to the next step.
- The process continues or continues to cut continuously until the thread approaches the desired depth or is within .025 mm ofthe final depth.
- Now check the size using the thread gauge.
- After finishing all this chamfer, the end of the thread to avoid damage to the thread.

## LITERATURE REVIEW

1. G.M.Sayeed Ahmeda (2015), Efficient turning of high performance Mild Steel material can be achieved through proper selection of turning process parameters to minimize surface roughness, feed and radial forces.. The experimentation plan is designed using Taguchi's L9 Orthogonal.

2.Array (OA) and Minitab-16 statistical software is used. Optimal values of process parameters for desired performance characteristics are obtained by Taguchi design of experiment. help of regression analysis method using Minitab-16 software and lastly the ideal and computed results are additionally checked with the help of confirmation examinations. Surface roughness is measured on each run according to Taguchi design of experiment and finally average roughness (Ra) is measures on confirmation experiment to compare with previous given machining parameters according to the Taguchi design of experiment.

3.Ravindra Nath Yadav (2016), the optimum condition obtained from Taguchi Methodology has been used as central value in Response Surface Methodology for the modeling and optimization. The result shows the significant improvement in surface finish with hybrid approach as compared to the Taguchi analysis. To improve the productivity with better surface finish, the performance of the turning process were studied by various researchers in different conditions. Sarma and Dixit studied the effect of process parameter during turning of the cast iron in dry and air-cooled conditions with ceramic cutting tool. They found improved surface quality and low tool wear with air cooled turning as compared to the dry turning. The effect of lubricants on surface roughness and tool wear during turning of AISI-4340 steel were studied by Dhar et al. The multi-pass turning is an unique method to achieve the better surface finish in which finish cut turning performed after several rough cut turning. Aslan experimental investigated the performance of the cutting tool during hard turning of the coldwork tool steel. Grzesik studied the effect of tool shapes on the wear and surface roughness in hard turning using different shaped ceramic tools. Asilturk and Akkus analyzed the effect of turning parameters on the surface quality during hard turning with application of Taguchi technique.

4.Dileep Kumar C., et al (2014) [4] focused on an experimental study to find the effects of cutting parameters on surface finish and optimize them for better surface finish and high Material Removal Rate (MRR) during turning of Ti-6Al-4V. The experiment plan is designed using Taguchi's L9 Orthogonal Array (OA). The results show that feed rate and nose radius

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are the most important parameters that affect the surface finish.

5.Basim A. K. et al (2015) [6] have experimented to develop a predictive model for surface roughness and temperature in turning operation of AISI 1020 mild steel using cemented carbide in a dry condition using the Response Surface Method (RSM). In this work,the input cutting parameters are cutting speed, feed rate and depth of cut.

6.Mohan S., Dharmpal D., et al (2010) [12] have investigated the robust design technique to minimize the variance of the response and orthogonal arrays. Experiments are designed and conducted based on Taguchi's L9 Orthogonal array design.

7.J.B.Shaikh, J.S.Sidhu, et al (2014) [14] have determined the influence of lubricant on surface roughness and material removal rate (MRR) by using CNC LATHE Machine with AISI D2 steel as a work material and TiAIN coated carbide tool as a tool material. M. Gupta, et al (2015) [15] they investigated the machinability of unidirectional glass fiber reinforced plastics (UD-GFRP) composite while carrying out turning operation. The parameters used to investigate their effect on output responses are tool nose radius, tool rake angle, feed rate, cutting speed, cutting environment (dry, wet and cooled) and depth of cut.

8.S. A. Rizvi, et al (2015) [16] have analyzed that an effort was made to optimize the cutting parameters to achieve better surface finish and to identify the most effective parameter for cost evolution during turning by using CNC LATHE MACHINE withIS 2062 steel rods (35 mm diameter) as a work material and Chemical Vapour Deposition (CVD) coated carbide inserts as a tool material. In this work, the input parameters are cutting speed, Feed Rate and Depth of cut.

9.S. Sahu, B.B.Choudhury(2015) [17] have analyzed the performance of multi-layer TiN coated tool in machining of hardened steel (AISI 4340 steel) as a work material under high speed turning uncoated tool use. In this work, the input parameters are cutting speed, Feed Rate and Depth of cut.

10.T. Rajasekaran, K. Palanikumar, et al (2013) [19] during this work, the input parameter area unit cutting speed, feed rate and depth of cut in turning by victimisation typical shaper (Make NAGMATI, INDIA). Experiments are designed and conducted based on Taguchi's L9 Orthogonal Array design. Ashvin J. M., et al (2013) [23] have investigated the effect of turning parameters such as cutting speed, feed rate, tool nose radius and depth of cut on surface roughness with AISI 410 steel as a work material and ceramic as a tool material using Response Surface Methodology (RSM). In this study Feed rate is the most significant factor on surface roughness.

11.Satyanarayana K., et al (2015) [22] have determined that effect of process parameters on performance characteristics in finish hard turning of MDN350 steel using cemented carbide tool. In this work, the input cutting parameters are cutting speed, feed rate and depth of cut. Li and Liang conducted an extensive study to analyze the performance of MQL machining with respect to the process parameters. It was found that application of MQL during machining reduced the tangential cutting forces upto a significant limit especially when machining is done at low cutting speeds.

12.Amrita et al. investigated and evaluated the performance of nano-graphite-based cutting fluid in turning and found that the use of MQL improved the cutting fluid's performance in comparison with conventional flood machining by reducing the surface roughness (30%),

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cutting forces (54%), cutting temperature (25%) and tool wear (71%). It also improved chip morphology.

13.Saini et al. used mineral oil for machining AISI 4340 steel, which resulted in cutting forces upto 17.07% & tool tip temperature upto 6.77%.

14.Saravanakumar et al. analyzed the dispersion of silver nanoparticle enriched cutting fluid and found that the cutting forceswere reduced up to 8.8% and surface roughness up to 7.5% by the use of nanofluid with the MQL technique.

15.Ravindra Kumar Verma, Purushottam Kumar Sahu, Jagdish Saini "Multi-Objective Optimization of Machining Parameters by using Response Surface Methodology EN-31 Alloy Steel Metal" (2020) This paper has presented an application of parameter design of the taguchi method in the optimization of turning operations in centre lathe machine.

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# Chapter: 69

# Hydrogen Producer Isolated from Agricultural Wastewater and Molasses

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**ABSTRACT**

Biohydrogen is one of the alternative energies that has a potential to be convenient future green energy. The supremacy of using H2 is that the only product of O2 and H2 reaction is water without carbon dioxide. H2 can be produced by biological dark-fermentative hydrogen-producing bacteria. Bacillus is one of efficient hydrogen producer belonged to the division of Firmicutes which is related to highly effective hydrogen producer Clostridium species. In this research, the new isolate of Bacilluscoagulans is isolated from molasses from bioethanol plant in Kanchanaburi Province. Reducing sugar, sucrose, and glucose were analyzed in molasses results sugar content 0.61, 3.0, and 0.08 g/100g, respectively. In this research, B.coagulans is focused on the ability to convert sugar into hydrogen. It is a gram positive, rod-shape bacterium that known to be an ideal biocatalyst for lignocellulosic biomass fermentation for biofuels production. Gas productions were observed after 168hr fermentation in modified sucrose-based synthetic medium. The isolate produces hydrogen gas 1.634 mol H2/mol hexose (48mL in 30mL synthetic medium supplemented with15g/ Lsucrose). Soluble metabolite such as volatile fatty acid (VFA) are observed.

**KEYWORDS**: biohydrogen; dark fermentation; Bacillus; wastewater; molasses.

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## INTRODUCTION

Hydrogen is one of the interested cleaner fuels for future. Combustion of hydrogen yields water as the final product (Hallenbeck and Benemann, 2002) The advantages of hydrogen engine using are various such as reduced CO, $CO_2$, $NO_x$, $SO_x$, and another hydrocarbon released to the city (Johnston et al., 2005; Das and Veziroglu, 2001; Adamson, 2004; Scott, 2004). The energy content of hydrogen gas is higher than that in the other fuels (122 kJ/g) (Madawar, Garg and Shah, 2000; Chandrasekhar, Jik Lee and Woo Lee, 2015; Chang and Lin, 2004) Hydrogen canbe applied in altered pattern such as convert to be electricity and applied in hydrogenation processes (Quakernaat,1995). Biohydrogen production has a key on biocatalysts application on process. Microorganisms that elated to the hydrogen production performance can be divided in to 5 groups (Nandi and Sengupta, 1998). First of all, anaerobic heterotrophs group such as Clostridia, rumen bacteria and Archeaeg. Caldicellulosiruptor (Yilmazel,Johnston and Duran, 2015). The second, facultative anaerobes group belongs to species of Escherichia coli and Enterobacter.

Third, Aerobes belong to species Alcaligenes and Bacillus. The other one, photosynthetic bacteriawhich is anoxygenic phototrophic organism. For examples, sulfur and non-sulfur bacteria both green and purplebacteria group. The lastone is cyanobacteria group. Dark fermentation to produce hydrogen gas is one of the efficient techniques for this application. Facultative anaerobe, which is Escherichia coli, Enterobacter, Citrobacter and strictly anaerobe in genus Clostridiaand methanogenic bacteria have been reported for the ability (Ghimire et al., 2015). The organisms contain the samecriteria on hydrogenase enzyme activities and the ability to convert varied carbon sources such as sugar andcellulosic materials to be organic substances (acetic acid, butyric acid and $CO_2$) in parallel of hydrogen production. However, the yield of production is still not reach to the breakeven point of the bioprocess because of material prices and product collection process. This work pay attention to screen the efficient microorganisms from natural resources which can be adapted to the lower cost material such as industrial agricultural waste.

## Material And Methods

**Sampling area:** Collect the samples from agricultural industrial area in Thailand included Sugar cane factory, coconut milk factory, pineapple can fruit factory. Sugar cane samples were derived from Thai Kanchanaburi sugar factory (Kanchanaburiprovince, Thailand). Coconut waste was collected from The Padungpon coconut milk factory (Nakhonpathomprovince, Thailand).

Pineapple waste was picked from Siam food canned-fruit factory in Chonburiprovince. Samples were kept and sealed at $4^0$C before analysis and screening for microorganisms. To collect the samples, 3 points of the area were selected to take the samples by chance. Wastewater was kept by plunge and mixed. Observed physical data of samples by color, temperature, pH from waste tank/pool area before wastewater treatment process.

**Wastewater analysis:** Collected wastewater were analyzed for chemical and physiological properties (pH, Total solid (TS), Total suspended solid (TSS), Total Dissolved Solid (TDS), Total Kjeldahl Nitrogen (TKN) by Macro-Kjeldahl Method4500-Norg B., Total Organic Carbon (TOC), Biological Oxygen Demand (BOD) by 5-Days BOD Test 5210 B., Chemical Oxygen Demand (COD) by Open Reflux Method 5220 B. Total carbohydrates were analyzed by AOAC method(AOAC 2012: 982.14).

**Bacteria screening:** CM medium was prepared (g/L):15 g sucrose, 1 g yeast extract, 5 g $Na_2HPO_4$, 1 g $KH_2PO_4$, 1 g NaCl, $MgSO_4$· 0.1 g $7H_2O$, 0.025 g $FeSO_4$, and supplemented with 2.0 mL trace element solution. Trace element solutionwas prepared (g/L): 2.86 g $H_3BO_3$, 2.03g $MnSO_4 \cdot 4H_2O$, 0.1 g $FeCl_3$.

The medium was prepared in 50mL serumbottle in anaerobic condition by nitrogen flushing. Weight 1 g of the samples into serum bottle to inoculate thebacteria and subculturing by transferred 100 mL of inoculum into CM medium for 3 times. Incubate bacteria under anaerobic condition at $37^0$Celsius for 48hr. Bacteria colonies were cross streaked on CM medium agar plate.

Bacterial genomics DNA from the samples were extracted by Bacterial DNA kit (OMEGA Bio-Tek, USA). 16SrRNA were amplified by using 27F (5'-AGAGTTTGATCATGGCTCAG-3') and 1492R (5'-GGTACCTTGTTACGACTT- 3') for 30 cycles of polymerase chain reaction, PCR) sequencing the conserved DNAby sent to analyzed at Pacific Science, Thailand. Identified species by prepared DNA sequence data submitted to GenBank and analyzed for Basic Local Alignment Search Tool (BLASTn).

**Hydrogen production:** Wastewater and agricultural waste are inoculated CM (15 g/L sucrose) in 30 mL medium under anaerobic condition (37 ˚C) for 96 hr. Culture were observed cell growth by optical density and gas production. Culture was transferred 3 times in gas pack and filled with nitrogen seal in DM medium supplemented with 15 g/L sucrose (Chen et al., 2004). Calculate hydrogen concentration (%v/v) by Dräger tube (Dräger, Germany) and analyze gas with gas chromatography.

**Results:** Specific energy content of hydrogen is highest among Methane, Propane, Tetradecane oil, Gasoline, Diesel, Biodiesel and coal, respectively. This research focused on hydrogen production by biological process. Figure 1 showhow hydrogen gas collected from the bacterial culture and detected by Drager gas detector (detection range between0.2-2.0%(v/v) and 0.5-3.0%(v/v).

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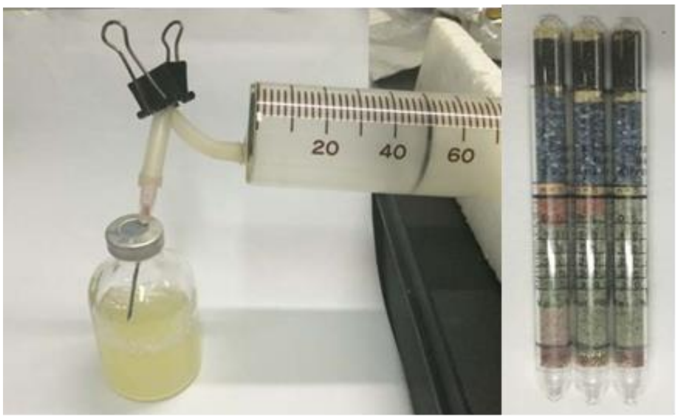


**Figure1.Gas collection tube (left) and Dräger gas detector by % volume (%v/v)**

The results in Table 1 indicated that molasses from bioethanol plant is quite acidic and contain highChemical oxygen demanded (COD) and biological demanded value (BOD). Total solid in molasses is also highaccording to COD and BOD value. Reducing sugar, sucrose and glucose were analyzed by HPLC in molasses results sugarcontent 0.61, 3.0, and 0.08 g/100g, respectively. This can be implied that molasses is one of possible alternative carbon sourcesfor chemical refinery substrate for bioprocess demand. Especially in biohydrogen production, there are many reported showsucrose is one of appropriate carbon source for biohydrogen production. In this study, 15 g/L sucrose is added as a supplemented carbon for initiate growth of Bacillus culture and the other bacteria from screened process.

| Parameter | Results | Method |
|---|---|---|
| | Molasse samples | |
| pH | 5.2 | Electrometric Method 4500-$H^{+}$B. |
| Total Solids (TS) | 85,990 | Total Solids Dried at 103-105$^{0}$C, 2540B. |
| Total Suspended solids (TSS) | 508 | TotalSuspendedSolidsDriedat103-105$^{0}$C,2540B. |
| Total Dissolved solid (TDS) | 58,810 | Total Dissolved Solids Dried at 180$^{0}$C-254$^{0}$C. |
| COD | 94,944 | Open Reflux Method 5220B. |
| BOD | 43,550 | 5-Days BOD Test 5210B. |
| TKN | 402 | Macro-Kjeldahl Method 4500-NorgB. |
| TOC | 62,860 | Combustion-Infrared Method 5310B. |

**Table 1. Physiological and biochemical properties of molasses samples collected from bioethanol plant in Kanchanaburi.**

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The new isolate is selected from molasses samples from ethanol plant. Colony morphology and the other properties ofthe isolate are studied as shown in figure 2. Partial 16S rDNA sequence is closely related to Bacillus species at 99% similarity (MO11: Bacillus coagulans and MO12: Bacillus circulans) (Table 1). The isolate Bacillus coagulansMO11 produces hydrogengas 1.634 mol H2/mol hexose (48 mL in 30 mL synthetic medium supplemented with 15 g/L sucrose). Total gas production in DMmedium is higher than that in Clostridium butyricum for 4times (80mLand20m, respectively) (Table2). However, total H2 production in C. butyricumis higher than in Bacillus according to %(v/v) of H2 detection by Dräger tube (8 mL and 0.4 mL, respectively) as shown in Table 3. Total gas yield is affected by other gas production in metabolism during cell growth such as carbon-dioxide.

| Sample | Total gas (mL) | %(v/v) $H_2$ | $H_2$(mL) |
|---|---|---|---|
| BacilluscoagulansMO11 | 80 | 0.5 | 0.4 |
| Clostridiumbutyricum | 20 | 40 | 8 |

**Table2. Biohydrogen as production by % volume (%v/v) at retention time 168hr fermentation in DM medium.**

**Figure2. Colony morphology of Bacilluscoagulans MO11.**

## CONCLUSION

This research focused on new bacteria isolated from ethanol plant and molasses. The selected bacteria are adapted in hydrogen production using sucrose based-medium as a carbon sources. Hydrogen yields which producedby the new isolated is compared to the efficient

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hydrogen-producing strain model as Clostridium species. The results revealed that screened bacteria can be generated and produce hydrogen gas moderately in modified sucrose medium which can be developed the appropriate medium for higher hydrogen yield and cheaper from molasses waste further.

## REFERENCES

[1] Hallenbeck PC, Benemann JR. Biological hydrogen production: fundamentals and limiting processes. Int J Hydrogen Energy 2002; 27:1185-1193.

[2] JohnstonB, MayoMC, and KhareA. (2005). Hydrogen: the energy source for the 21$^{st}$century. Technovation 2005; 25(6) :569-585.

[3] Das D, and Veziroglu TN. (2001). Hydrogen production by biological processes: a survey of literature. Int J Hydrogen Energy. 2001; 26:13–28

[4] Adamso, K. Hydrogen from renewable resources-the hundred-year commitment Fuel and Energy. Energy Policy 2004;32(10):1231-1242.

[5] ScottDS. Contrails Against an Azure Sky. Int. J. Hydrogen Energy 2004; 29: 1317-1325.

[6] MadawarD, GargN, ShahV. 2000. Cyanobacterial hydrogen production. World J. Microb Biot 2000; 16:757-767.

[7] ChandrasekharK, JikLeeY, and WooLeeD. Biohydrogen Production: Strategies to Improve Process Efficiency through Microbial Routes. Int. J. Mol. Sci. 2015; 16(4): 8266-8293.

[8] ChangFY, and LinCY. Biohydrogen production using an up-flow anaerobics ludge blank etreactor. Int. J. Hydrogen Energy 2004,29:33-39.

[9] QuakernaatJ. From hydrogen economy to hydrogen civilization. Int.J. Hydrogen Energy 1995;20:485-492

[10] NandiR. and SenguptaS. Microbial production of hydrogen: an overview. Crit RevMicrobiol1998;24,61-84.

[11] Yilmazel YD,JohnstonD,and DuranM. Hyperthermophilic hydrogen production from wastewater biosolids by Caldicellulosiruptorbescii. Int.J. Hydrogen Energy 2015;40:12177-12186.

[12] GhimireA, FrunzoL, PirozziF, TrablyE, EscudieR,Lens PN,and EspositoG. Are views on dark fermentative biohydrogen production from organic biomass: process parameters and use of byproducts. Applied Energy 2015; 144:73-95.

[13] Chen,WM, Tseng, ZJ, Lee, Ks, Chang, JS. Fermentative hydrogen production with Clostridium butyricum CGS5 isolated from anaerobic sewages ludge. Int. J. Hydrogen Energy 2005; 30: 1063-1070.

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# Chapter: 70

# Bacteria's Role in The Protection of RCC From Corrosion

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**ABSTRACT**

In the presence of oxygen and water, steel begins to oxidise, also known as corrode. Even the presence of oxygen in the pores of the concrete will not promote corrosion in an environment with a high alkaline concentration. The presence of small holes in concrete, each of which includes significant amounts of soluble calcium, sodium, and potassium oxides, results in an alkaline situation with a pH ranging from 12 to 13. The presence of alkali causes the surface of the steel to develop a layer known as a "passive" layer. The alkalinity is prevented by the dense passive layer that is placed over the reinforcement. The prevention of corrosion in concrete by the utilization of bacteria for the purpose of preserving alkalinity in the concrete is the focus of this research.

**KEYWORDS:** corrosion, passive layer, alkaline, bacteria, reinforcement.

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## INTRODUCTION

When concrete carbonates to the level of the steel rebar, the normally alkaline environment, which protects steel from corrosion, is replaced by a neutral environment. Under these conditions the steel is the ion dissolve in the pore water would not see cracking and spelling of the concrete. Several more stages must occur for ‘rust’ to form. Ferrous hydroxide becomes ferric hydroxide and then hydrated ferric oxide or rust. This rust cause spelling and crack over the concrete as shown in fig.3. Not passive and rapid corrosion begins. The rate of corrosion due to carbonated concrete cover is slower than chloride-induced corrosion. Occasionally, a lack of oxygen surrounding the steel rebar will cause the metal to dissolve, leaving a low pH liquid. Carbon-dioxide combines with water to form acid in which reduce the pH of concrete by consuming the calcium hydroxide which is formed in hydration process of cement, at low pH corrosion begins. Prevention of carbonization, prevent the alkalinity in which corrosion do not take place. Chloride in the pore of concrete involves during the corrosion only, it just acts as the catalyst in the corrosion process. Presence of chloride in concrete pore is inert at alkaline condition.

**Corrosion Process:** When the passive layer breaks down then rust will start appearing on the steel surface. The chemical reactions are the same whether corrosion occurs by chloride attack or carbonation. When steel in concrete corrodes it dissolves in the pore water and gives up electrons:

The anodic reaction is $Fe \rightarrow Fe^{2+} + 2e^{-}$

The two electrons (2e) created in the anodic reaction must be consumed elsewhere on the steel surface to preserve electrical neutrality.

The catholic reaction is $2e^{-} + H_2O + ^{1/22} {}^{\rightarrow 2OH-}$

Unhydrated ferric oxide $Fe_2O_3$ formed in the bow reaction has a volume of about twice that of the steel it replaces when fully dense. When it becomes hydrated it swells even more and becomes porous. This means that the volume increase at the steel/concrete interface is six to ten times. This leads to the cracking and spelling as shown in fig.3, that we observe as the

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usual consequence of corrosion of steel in concrete and the red/brown brittle, flaky crust we see on the bar and the rust stains we see at cracks in the concrete. Fig.2 shows the relative volume of the iron and its oxide formed in corrosion process.

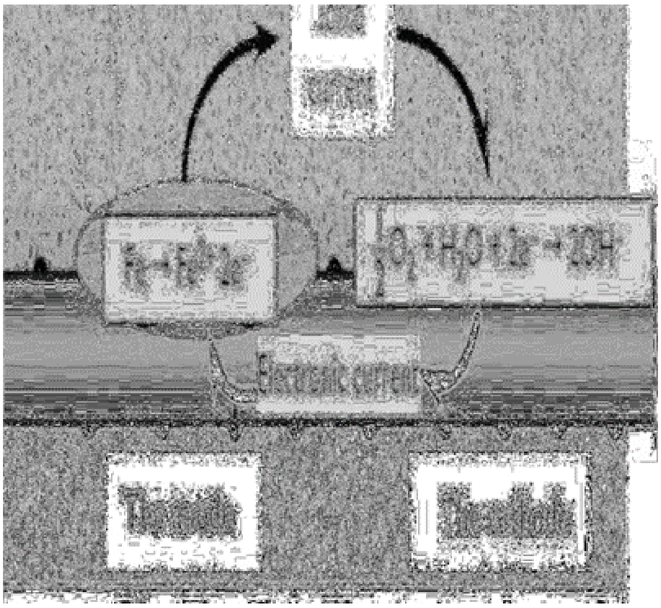

**Fig 1. Anode and cathode reaction of corroding bar $Fe^{2+}$ and $OH^{-}$ formed in anode and cathode combined to form ferrous hydroxide and further undergoes chemical reaction as below:**

## CARBONATION

Carbonation is the result of the interaction of carbon dioxide gas in the atmosphere with alkaline hydroxides in the concrete. Like many other gases carbon dioxide dissolves in water to form an acid. Unlike most other acids the carbonic acid does not attack the cement paste, but just neutralizes the alkalinity in the pore water, mainly forming calcium carbonate that lines the pores: There is a lot more calcium hydroxide in the concrete pores that can dissolve in the pore water. This helps maintain the pH at its usual level of 12–13 as the carbonation reaction occurs. However, as carbon dioxide proceeds to react with the calcium (and other) hydroxides in solution, eventually all the calcium hydroxide reacts, precipitating the calcium carbonate and allowing the pH to fall to a level where steel will corrode. This is illustrated in [1] Figure 4(a) and (b) which show the pH drop across the carbonation front and the corrosion rate of steel as the pH changes. At the carbonation front there is a sharp drop in alkalinity from pH 11–13 down to less than pH 8. At that level the passive layer was created by the alkalinity, is no longer sustained so corrosion proceeds by the general corrosion mechanism will takes place.

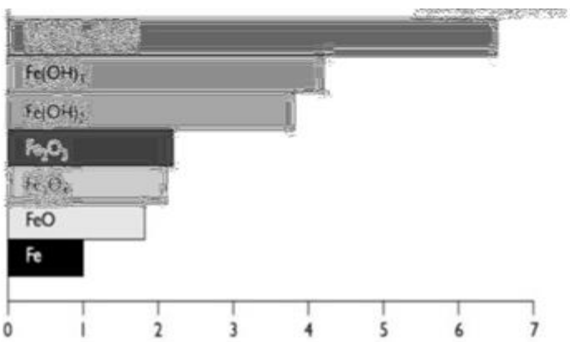


fig.2 Relative volume of iron and its oxides from Mansfield *Corrosion*, 1981, 37(5) 301–307

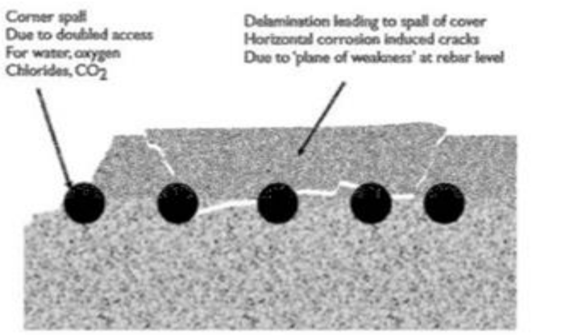


fig.3 Schematic of corrosion induced spalling at corners and delamination at the plane of the reinforcement.

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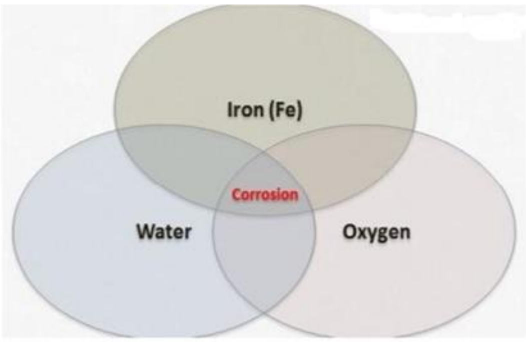


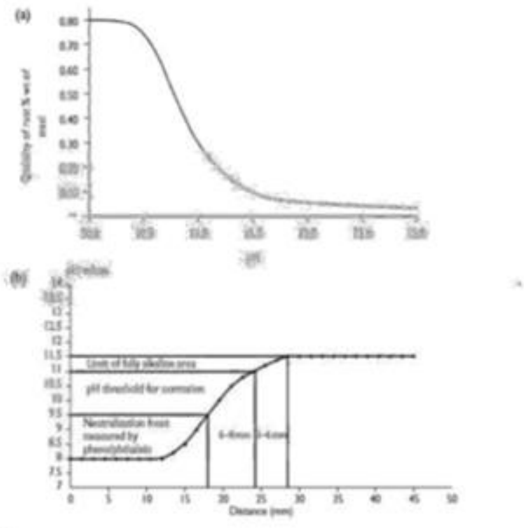

fig.4 (a) Corrosion of steel in aqueous solutions as a function of pH, showing the effect of the passive layer above pH 12.5. Adapted from Shalon and Raphael JACI, 1959, 30(12): 1251–1268. (b) The pH levels for carbonation, corrosion and phenolphthalein indicator.

Reduce the pH of the concrete. In the absence of water carbon dioxide is active. Chloride in concrete is alsoin active conditions. In corrosion process carbon-dioxide acts as initiator and chloride acts as a catalyst. We can prevent corrosion by preventing the contact of water, carbon- dioxide and oxygen. Even in the presence of water steel will not undergo corrosion at alkaline environment.

**CHLORIDE ATTACK**

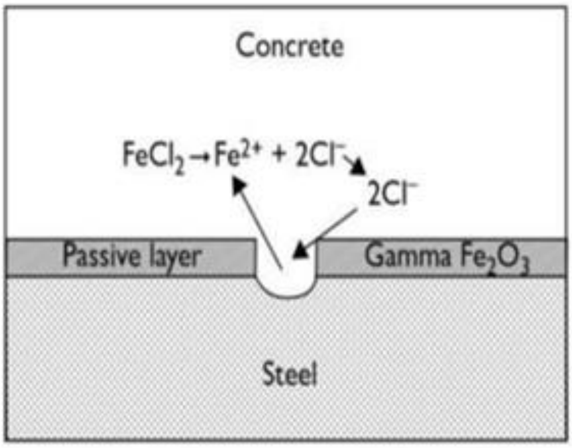


fig. 5

The breakdown of the passive layer and 'recycling' chlorides.

The chloride ion attacks the passive layer although in this case (unlike carbonation) there is no overall drop in phi Chlorides act as catalysts to corrosion. They are not consumed in the process but help to break down the passive layer of oxide on the steel and allow the corrosion process to proceed quickly as shown in fig.5. The effective recycling of chloride ions makes chloride attack more difficult to remedy as chlorides are therefore harder to eliminate. Fig.4 shows the recycling of chloride ions.

Obviously, a few chloride ions in the pore water will not break down the passive layer. Prevention of corrosion Carbon dioxide and chloride present in the concrete are inert in the absence of the water and oxygen. Carbon dioxide in the pore of the concrete reacts with water to form carbonic acids which. The bacteria and Ca $(OH)_2$ of pH 13 is added to the concrete in capsules. The bacteria are Bacillus alkali- nitrulicus, an alkali-resistant soil bacterium,

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psychrophilic bacterium, [8] Bacillus pasteurii is added, which can survey at high pH of 9 to 13 and at the temperature range of 10 to 40 degree centigrade. [5] Capsule of 15 kg is added to a 1m3 of concrete. The spores became active when getting contact with water; still, it will be inactive in concrete. When bacteria contact with carbon-dioxide and convert calcium hydroxide to limestone. On reaction $CO_2$ is arrested from diffusion. [9] Limestone will fill the crack and there is no possibility to leakage of water and diffusion of carbon-dioxide. Hear our primary aim is to prevent the carbon-dioxide penetration and then to prevent the water infiltration to concrete.

$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

In self-healing concrete capsule containing bacteria and calcium lactate is added. In atmosphere quantity of $CO_2$ is less to speed up the self-healing process calcium lactate is added in which it precipitate CaCO3 and liberate $CO_2$. $Ca(C_3H_5O_2)_2+7O_2 \rightarrow CaCO_3+5CO$ $2+5H_2O$

**DIFFUSION OF $CO_2$:** Concrete will carbonate whenever carbon dioxide and some waters are available. The speed of carbonation depends on how fast the carbon dioxide and/or the carbonate ions can move into the concrete and react:

$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

$$\underset{\text{Gas}}{CO_2} + \underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Carbonic acid}}{H_2CO_3}$$

$$\underset{\text{Carbonic acid}}{H_2CO_3} + \underset{\text{Pore solution}}{Ca(OH)_2} \rightarrow CaCO_3 + 2H_2O$$

In self-healing concrete capsule containing bacteria and calcium lactate is added. In atmosphere quantity of $CO_2$ is less to speed up the self-healing process calcium lactate is added in which it precipitate CaCO3 and liberate $CO_2$.

$Ca(C_3H_5O_2)_2+7O_2 \rightarrow CaCO_3+5CO$ $2+5H_2O$

Concrete will carbonate whenever carbon dioxide and some waters are available. The speed of carbonation depends on how fast the carbon dioxide and/or the with the cement paste. Diffusion is mass transport down a concentration gradient. Steady state diffusion follows Fick´s first law. Cement ratio of 0.38.

However, addition of water to the concrete for workability is not a good construction practice. Super plasticizer and new generation plasticizer are recommended for workability. Addition of plasticizer increases the strength up to optimum level above that it decreases the strength. [2] Fig.8 shows the variation of the compressive strength of the concrete at various volumes of lingo-sulphonate. Hence optimum ratio of plasticizer is recommended. [2] Plasticizer reduces water content up to 10%, super plasticizer reduces about 20%, pc-based admixture reduces up to 30.

**WATER CEMENT RATIO TOREDUCE 'D'**

Water cement ratio in the concrete plays an important role in the strength and durability of the concrete. It has also been estimated that on an average 23% of water by weight of cement is required for chemical reaction with Portland cement compounds.

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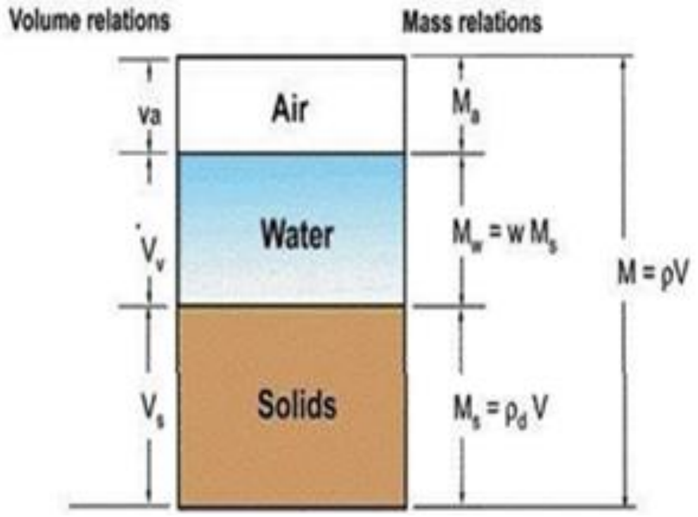


**Fig.7 Phase diagram of concrete**

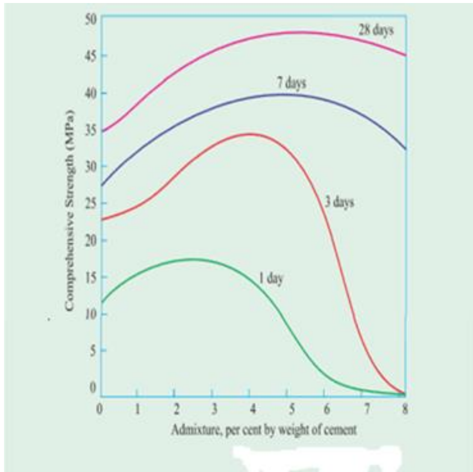


**Fig.8 variation of strength in concrete respect to admixture**

This 23% of water chemically combines with cement and, therefore, it is called bound water. A certain quantity of water is imbibed within the gel- pores. This water is known as gel-water. It can be said that bound water and gel-water are complimentary to each other. If the quantity of water is inadequate to fill up the gel- pores, the formation of gel itself will stop and if the formation of gel stops there is no question of gel-pores being present. It has been further estimated that about 15 per cent of the weight of cement is eon to fill up the gel- pores. [2]

Therefore, a total of 38 per cent of water by weight of cement is required for the complete chemical reactions and to occupy the space within gel-pores. If water equal to 38 per cent by weight of cement is only used it can be noticed that the resultant paste will undergo full hydration and no extra water will be available for the formation of undesirable capillary cavities. On the other hand, if more than 38 per cent of water is used, then the excess water will cause undesirable capillary cavities.

Therefore, the greater the water above the minimum required is used (38 per cent), the more will be the undesirable capillary cavities. In all this it is assumed that hydration is taking place in a sealed container where moisture to and from the paste does not take place. Increases in cavity in a concrete increase the coefficient of diffusion in concrete. At the same time, it is difficult to work in concrete in water.

## CONCLUSIONS

Masan will shovel mortar with water. Fine partial cement settles, leaving only sand for plating above. So, construction workmanship is paramount. Corrosion can be prevented by covering the reinforcement. The nominal cover must be 40 mm.

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