MULTIDISCIPLINARY RESEARCH & INNOVATION

EDITORS

Dr. E.Shyamaladevi

Dr. Neeta Baglari

Dr. S.L.Sindhu

Dr. E.Joseph Rubert

MULTIDISCIPLINARY RESEARCH & INNOVATION

Dr.Shamaladevi E
Assistant Professor
Department of International Business
PSG College of Arts & Science, Coimbatore

Dr. Neeta Baglari
Assistant Professor, Department of Education
Cotton University, Guwahati

Dr.AL.Sindhu
Assistant Professor
Department of Management Studies
Rajalakshmi Engineering College,Chennai

Dr.E.Joseph Rubert
Professor & Head
Department of Management Studies
Arunachala College of Engineering for Women
Kanyakumari,Tamilnadu

Edition: First

Year: April, 2025

ISBN: 978-81-987436-5-7

Publisher

MERIMAX
INTERNATIONAL PUBLICATIONS
www.merimaxpub.org

Australia, Chennai & Kanyakumari
Phone: +91 6384730258
E-Mail: editor@merimaxpub.org
www.merimaxpub.org

PERFACE

In the ever-evolving landscape of knowledge and discovery, the boundaries between academic disciplines are increasingly becoming fluid. The global challenges we face today ranging from climate change and public health crises to technological disruption and social inequality demand solutions that transcend traditional disciplinary frameworks. It is against this backdrop that we proudly present *Multidisciplinary Research & Innovation*, a compilation of diverse scholarly contributions that exemplify the power of cross-disciplinary collaboration. This volume brings together a wide array of research endeavors from fields as varied as science, engineering, technology, social sciences, humanities, management, and education. It represents a collective commitment to knowledge integration, creativity, and innovation. Each contribution featured in this publication reflects rigorous academic inquiry and a dedication to addressing both theoretical questions and practical problems through collaborative and often unconventional approaches. The purpose of this publication is not only to share the latest findings from multiple disciplines but also to create a vibrant intellectual space where ideas can intersect, challenge one another, and give rise to new perspectives. By embracing a multidisciplinary approach, researchers and practitioners can draw upon a broader base of knowledge, employ more holistic methodologies, and produce outcomes that are both impactful and sustainable. One of the most significant strengths of multidisciplinary research lies in its ability to foster innovation. When insights from one field inform the practices of another, new solutions emerge that may not have been conceivable within the limits of a single discipline. The articles and studies included here exemplify this principle, offering fresh viewpoints and novel strategies that may inspire further inquiry and practical implementation. This compilation would not have been possible without the enthusiastic participation of our contributors, who have submitted work that is both original and insightful. We extend our sincere gratitude to all the authors for their commitment to scholarly excellence and to the peer reviewers for their invaluable feedback and critical evaluation. Their dedication has ensured the high standard and integrity of this publication. We also wish to thank the editorial board, organizing committee, and institutional partners whose support and collaboration have been crucial throughout the process. Their efforts have not only facilitated the compilation and review of these works but have also reinforced the importance of academic cooperation in advancing interdisciplinary research. We hope that *Multidisciplinary Research & Innovation* will serve as a valuable resource for researchers, students, educators, policy-makers, and industry professionals alike. May it encourage new conversations, spark collaborative ventures, and contribute to a deeper understanding of the complex and interconnected world we inhabit.

Editors

CONTENTS

Multidisciplinary Research Promote Sustainable Innovation: Rethink Approach

Dr. Dinesh Kumar
Assistant Professor, Faculty of Education
Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India.

Introduction

Since the 1970s, researchers from several fields have worked together to tackle global concerns using a transdisciplinary approach. Researchers that operate across disciplines employ a variety of specific academic techniques to uncover the truth. Hypothesis testing utilizing many methods, domains, and scholarly processes is an example of multidisciplinarity. Thanks to interdisciplinary study, evolutionists, educators, and legislators may bring together the fields of humanities, biology, and the earth to form a more complete image of sustainability based on original ideas. Alternatively, it may be described as a methodical and impartial pursuit of new information by integrating several fields of study (Dalton et al., 2021). The cultural and linguistic diversity of the world in the 21st century necessitates an integrated approach to understanding, making multidisciplinary collaboration important. It aids academics in comprehending contrasting viewpoints, synthesising information, thinking critically, and reevaluating the world and its possibilities (Ajakaye and Ogunniyi, 2021). Academic placements and advancement can be impeded by individuals with multidisciplinary backgrounds (Lyu et al., 2024). Since global concerns cannot be adequately addressed by a single field, research has evolved into a collaborative effort due to the advancements in science and technology. Drug control, catastrophe preparedness, and welcoming refugees into wealthy nations are all challenging concerns. According to Arnold et al. (2021), a wide range of expertise, experiences, and viewpoints are pooled in multidisciplinary research.

This approach acknowledges that numerous complex problems in the real world defy solution by a single discipline. In order to tackle pressing global health issues, technological advancements, and climate change, interdisciplinary research is more important than ever. In order to fully comprehend the phenomenon under study, interdisciplinary teams draw from a variety of relevant and seemingly unrelated fields of study (Zhuravlova, 2019). The capacity to increase innovation is a benefit of interdisciplinary research. Researchers may be able to come up with more original and original solutions to challenges if they pool their knowledge from different fields. To address public health concerns, knowledge from the medical, social, economic, and technical spheres is required. By working together, experts in fields as diverse as statistics, engineering, sociology, and biology can uncover solutions that go beyond their individual expertise. Discovery is accelerated through cross-disciplinary research. Traditional research approaches could involve multiple steps when transferring results from one field to another (Antonenko et al., 2014).

However, collaboration across disciplines opens up new avenues of study and synergy, which could lead to more rapid advancements. Immediate and effective resolution of pressing global issues need this accelerated pace. Beyond the classroom, transdisciplinary

ISBN: 978-81-987436-5-7

research has practical benefits. In this review, we urge and support interdisciplinary teams to work together for a paradigm change. Universities and other educational institutions should push for interdisciplinary research and faculty members to work together on big projects. Research that draws from a variety of disciplines seeks to answer pressing questions in many fields today. Conflicts between social, environmental, and economic needs might arise in such complicated systems (Vanasupa et al., 2014). From transdisciplinary research have arisen a number of academic subjects. The fields of biomedical engineering, biochemistry, and biotechnology bring together the biological and technological aspects of engineering, mathematical psychology and mathematics, the field of organizational behavior and management studies various types of behavior in groups and management techniques, and mathematical philosophy encompasses both mathematics and philosophy. Both Hall et al. (2018) and Ramani and Sikdar (2018) note that these fields gave rise to new interdisciplinary fields. The world's pioneers face harsh problems and complex, dynamic challenges. A transdisciplinary approach integrating economics, sociology, agriculture, biology, and organization would be ideal for research aiming to assist policymaking in such dangerous environments. Despite the great potential of interdisciplinary research, Dozier et al. (2014) pointed out that it is inherently more complex to manage, facilitate, and evaluate research that integrates disciplinary knowledge. Most of the literature is devoted to integration-related themes, such as philosophical disputes, ill-defined project objectives, and ways to get people to be proud of their work when they work together on a project (Bark et al., 2016). Furthermore, in this era of cutting-edge technology and artificial intelligence, global success requires researchers and scientists to collaborate holistically and possess a multidisciplinary perspective (Dwivedi et al., 2023; Odugbesan et al., 2023). It is worth noting that multiple studies highlight the positive perception of interdisciplinary researchers in prestigious organizations and institutes. Based on the research conducted by Fontana et al. (2022), Petersen et al. (2021), Xiao et al. (2022), Leahey et al. (2019), and Li and Yin (2023), it appears that combining knowledge from several disciplines is a powerful and productive way to boost good development in the next decades.

Defining Multidisciplinary, Interdisciplinary, and Transdisciplinary Research

It is important to distinguish between multidisciplinary, interdisciplinary, and transdisciplinary research, as these terms are often used interchangeably but represent distinct approaches to collaborative research. Multidisciplinary research involves researchers from different disciplines working together on a common problem, but each researcher typically maintains their disciplinary perspective and methods. The different disciplines contribute to the overall project, but there is limited integration of concepts or methods.Interdisciplinary research involves a greater degree of integration than multidisciplinary research. Researchers from different disciplines work together to develop a shared understanding of the problem and to integrate concepts and methods from their respective fields. This integration can lead to new insights and approaches that would not be possible within a single discipline. Interdisciplinary collaboration between mainstream school teachers and special teachers, for instance, can contribute to the development of an inclusive learning environment (Hedegaard-Soerensen, L., Jensen, C. R., & Tofteng, D. M. B. ;2017)

Transdisciplinary Research: Transdisciplinary research is the most integrated approach to collaborative research. It involves researchers from different disciplines working together with stakeholders from outside academia to address a complex problem. Transdisciplinary research aims to produce knowledge that is both scientifically sound and socially relevant. Christian Pohl and Gertrude Hirsch Hadorn define it as interdisciplinary research with a purpose (Pohl, C. & Hadorn, G. H.;2007).

Evolution of Disciplinary Boundaries and Emergence of Multidisciplinary Research: The landscape of research has undergone a significant transformation, marked by the blurring of traditional disciplinary boundaries and the rise of multidiscplinary, interdisciplinary, and transdisciplinary approaches. This evolution is driven by the need to address complex, real-world problems that transcend the scope of any single discipline. This response will explore the factors driving this shift, the challenges and opportunities associated with collaborative research, and the implications for knowledge production and problem-solving.Factors Driving the Shift Towards Multidisciplinary Research. Several factors have contributed to the increasing prevalence of multidisciplinary research.

The Complexity of Modern Problems: Many of the challenges facing society today, such as climate change, public health crises, and sustainable development, are inherently complex and require expertise from a variety of fields. Addressing the COVID-19 pandemic, for example, necessitated multidisciplinary work involving social, environmental, and technological disciplines and understanding and managing zoonotic diseases requires integrating insights from anthropology and other social sciences with those from biomedical fields (Alamoodi, A., Zaidan, .. B. B., Albahri, .. O. S., Garfan, S., Ahmaro, I. Y. Y., Mohammed, .. R. T., Zaidan, A. A., Ritahani, A., Albahri, A., Momani, F., Al-Samarraay, M. S., Ali, .., Jasim, N., R.Q.Malik, .., & Keywords, A. 2023;MacGregor, H. & Waldman, L. 2017)

- **Technological Advancements:** Advances in information and communication technologies have facilitated collaboration among researchers from different disciplines and geographical locations. These technologies enable researchers to share data, communicate more effectively, and access a wider range of resources, making it easier to conduct multidisciplinary research projects.
- Funding Priorities:Funding agencies increasingly prioritize multidisciplinary research projects that address pressing societal challenges. This shift in funding priorities reflects a growing recognition that complex problems require integrated solutions that draw on expertise from multiple fields. The US National Science Foundation, for example, has supported collaborative research across disciplinary and university boundaries (Cummings, J. N. & Kiesler, S. 2005)
- The Rise of "Big Data": The availability of large datasets has created new opportunities for multidisciplinary research. Analyzing these datasets often requires expertise from a variety of fields, including computer science, statistics, and domain-specific disciplines. The application of machine learning techniques to precision agriculture, for example, represents a multidisciplinary approach to addressing challenges in this field (Condran, S., Bewong, M., Islam, M. Z., Maphosa, L., & Zheng, L. 2022).

Challenges and Opportunities in Collaborative Research While collaborative research offers numerous benefits, it also presents several challenges.

- **Coordination Costs:**Collaborative research projects, especially those involving researchers from multiple organizations, can incur high coordination costs (Cummings, J. N. & Kiesler, S. 2005).These costs can include the time and effort required to communicate, coordinate activities, and resolve conflicts.
- **Communication Barriers:**Researchers from different disciplines may have different communication styles, terminologies, and perspectives, which can create barriers to effective communication. Overcoming these barriers requires a willingness to learn about other disciplines and to develop a shared language.
- **Differences in Research Cultures:**Different disciplines may have different research cultures, including different norms for authorship, data sharing, and intellectual property. These differences can create tensions within collaborative research teams.
- **Evaluation and Reward Systems:**Academic evaluation and reward systems often favor individual achievements over collaborative ones, which can discourage researchers from participating in interdisciplinary research. This is especially true for early career researchers (Goring, S., Weathers, K. C., Dodds, W. K., Soranno, P. A., Sweet, L. C., Cheruvelil, K. S., Kominoski, J. S., Regg, J., Thorn, A. M., & Utz, R. M. 2014; Sobey, A., Townsend, N., Metcalf, C., Bruce, K. D., & Fazi, F. M. 2013).
- **Publication Bias:**Interdisciplinary research may be more difficult to publish in traditional disciplinary journals, which may be reluctant to publish research that does not fit neatly within their scope. interdisciplinary publications sometimes have lower impact factors (Barthel, R. & Seidl, R. 2017)..

Despite these challenges, collaborative research offers numerous opportunities.

Enhanced Creativity and Innovation: Bringing together researchers from different disciplines can spark creativity and lead to innovative solutions to complex problems. Different perspectives and approaches can challenge existing assumptions and lead to new insights.

Increased Impact: Collaborative research projects are more likely to have a significant impact on society than research projects conducted within a single discipline. By addressing complex problems from multiple perspectives, collaborative research can produce knowledge that is more relevant and useful to policymakers, practitioners, and the public.

Expanded Skill Sets: Participating in collaborative research projects can help researchers to develop new skills and expertise, such as communication, project management, and data analysis. These skills can enhance their career prospects and make them more effective researchers.

Strategies for Promoting Successful Collaborative Research: To overcome the challenges and capitalize on the opportunities of collaborative research, it is important to implement strategies that promote effective collaboration.

Establish Clear Goals and Expectations: Before embarking on a collaborative research project, it is important to establish clear goals and expectations for all team members. This includes defining the scope of the project, identifying the roles and responsibilities of each team member, and establishing a timeline for completing the project.

Foster Open Communication: Open communication is essential for successful collaboration. Team members should be encouraged to share their ideas, ask questions, and provide feedback in a respectful and constructive manner. Regular team meetings and communication channels can help to facilitate open communication.

Develop a Shared Language: To overcome communication barriers, it is important to develop a shared language that all team members can understand. This may involve learning about the terminology and concepts used in other disciplines.

Establish Clear Decision-Making Processes: Clear decision-making processes can help to prevent conflicts and ensure that the project stays on track. The team should agree on how decisions will be made, who will have the authority to make decisions, and how conflicts will be resolved.

Recognize and Reward Collaboration: Academic institutions and funding agencies should recognize and reward collaborative research efforts. This may involve developing new metrics for evaluating research performance that take into account the contributions of all team members. Simon Goring, Kathleen C. Weathers, Walter K. Dodds, Patricia A. Soranno, Lynn C. Sweet, Kendra Spence Cheruvelil, John S. Kominoski, Janine Regg, Alexandra M. Thorn, and Ryan M. Utz suggest expanding measures of success to include educational outcomes, dataset creation, and outreach products (Goring, S., Weathers, K. C., Dodds, W. K., Soranno, P. A., Sweet, L. C., Cheruvelil, K. S., Kominoski, J. S., Regg, J., Thorn, A. M., & Utz, R. M.; 2014)

Provide Training in Collaboration Skills: Training in collaboration skills can help researchers to work more effectively in interdisciplinary teams. This training may include topics such as communication, conflict resolution, and project management.

The Role of Interdisciplinary Research in Addressing Societal Challenges:Interdisciplinary research is playing an increasingly important role in addressing a wide range of societal challenges.

Climate Change: Climate change is a complex problem that requires expertise from a variety of fields, including atmospheric science, ecology, economics, and political science. Interdisciplinary research is needed to understand the causes and consequences of climate change, to develop effective mitigation and adaptation strategies, and to communicate these strategies to the public. Wndi Bruine de Bruin and M. Granger Morgan describe interdisciplinary projects focused on climate change communication (Bruin, W. B. D. & Morgan, M. G. 2019).

Public Health: Public health challenges, such as infectious diseases, chronic diseases, and health disparities, require interdisciplinary approaches that integrate biomedical, behavioral, and social sciences. Interdisciplinary research is needed to understand the complex factors that influence health, to develop effective interventions, and to improve health outcomes.

Sustainable Development: Sustainable development requires balancing economic growth, social equity, and environmental protection. Achieving sustainable development goals requires interdisciplinary research that integrates perspectives from economics, sociology, environmental science, and engineering.

Urban Ecology: Advancing urban ecology requires synthesis, knowledge and data sharing, cross-city comparative research, new intellectual networks, and engagement with additional

disciplines (McPhearson, T., Pickett, S. T. A., Grimm, N. B., Niemel, J., Alberti, M., Elmqvist, T., Weber, C., Haase, D., Breuste, J., & Qureshi, S. ; 2016)

Precision Agriculture: The application of machine learning techniques to precision agriculture represents a multidisciplinary approach to addressing challenges in this field .

The Future of Disciplinary Boundaries: The trend towards multidisciplinary, interdisciplinary, and transdisciplinary research is likely to continue in the future. As societal challenges become increasingly complex, the need for integrated solutions that draw on expertise from multiple fields will only grow. This trend will likely lead to a further blurring of traditional disciplinary boundaries and the emergence of new hybrid fields that combine elements from different disciplines.

The Importance of Maintaining Disciplinary Expertise: While interdisciplinary research is essential for addressing complex problems, it is also important to maintain disciplinary expertise. Interdisciplinary research relies on the contributions of experts from different disciplines, and these experts need to have a deep understanding of their own fields in order to make meaningful contributions.

The Need for New Models of Education and Training: To prepare researchers for the future of collaborative research, it is necessary to develop new models of education and training that emphasize interdisciplinary thinking and collaboration skills. This may involve creating new interdisciplinary degree programs, providing training in communication and project management, and fostering a culture of collaboration within academic institutions.

The Role of Technology in Facilitating Collaboration: Technology will continue to play a key role in facilitating collaborative research. Advances in communication, data sharing, and data analysis tools will make it easier for researchers from different disciplines and locations to work together effectively.

Conclusion: The evolution of disciplinary boundaries and the emergence of multidisciplinary research reflect a fundamental shift in the way knowledge is produced and problems are solved. This shift is driven by the increasing complexity of societal challenges, technological advancements, and changing funding priorities. While collaborative research presents several challenges, it also offers numerous opportunities for enhanced creativity, increased impact, and expanded skill sets. By implementing strategies that promote effective collaboration, academic institutions, funding agencies, and individual researchers can help to ensure that collaborative research efforts are successful and that they contribute to addressing the pressing challenges facing society today. The integration of rehabilitation and regeneration, for example, can be fused at the onset of therapeutic development, allowing achievement of functional goals faster and more effectively . The need for interdisciplinary research and international cooperation is highlighted in the context of deepsea mining, which requires understanding economic, environmental, social, and legal implications. AI is undergoing a paradigm shift, and much critical research will require interdisciplinary collaboration commensurate with its fundamentally sociotechnical nature. In conclusion, the move towards multidisciplinary research is essential for tackling complex issues, promoting innovation, and fostering a more holistic understanding of the world around us.

References

1.Ajakaye, J. E and Ogunniyi, S. O. (2021). 21st-Centur Multidisciplinary Collaboration in Research in Library. Library Philosophy and Practice (e-journal). 6228.

2.Alamoodi, A., Zaidan, .. B. B., Albahri, .. O. S., Garfan, S., Ahmaro, I. Y. Y., Mohammed, .. R. T., Zaidan, A. A., Ritahani, A., Albahri, A., Momani, F., Al-Samarraay, M. S., Ali, .., Jasim, N., R.Q.Malik, .., & Keywords, A. (2023). Systematic review of mcdm approach applied to the medical case studies of covid-19: trends, bibliographic analysis, challenges, motivations, recommendations, and future directions. Complex & Intelligent Systems. https://doi.org/10.1007/s40747-023-00972-1

3.Antonenko, P. D., Jahanzad, F., and Greenwood, C. (2014). Fostering collaborative problem- solving and 21st century skills using the DEEPER scaffolding framework. Journal of College Science Teaching, 43(6), 79-88. https://www.jstor.org/stable/43631763

4.Arnold, A., Cafer, A., Green, J., Haines, S., Mann, G., and Rosenthal, M. (2021). Perspective: Promoting and fostering multidisciplinary research in universities. Research Policy. Volume 50, Issue 9. https://doi.org/10.1016/j.respol.2021.104334

5.Bark, R., Kragt, M., and Robson, B. (2016). Evaluating an interdisciplinary research project: Lessons learned for organisations, researchers and funders. International Journal of Project Management. Volume 34, Issue 8. https://doi.org/10.1016/j.ijproman.2016.08.004

6.Barthel, R. & Seidl, R. (2017). Interdisciplinary collaboration between natural and social sciences status and trends exemplified in groundwater research. Public Library of Science. https://doi.org/10.1371/journal.pone.0170754

7.Bruin, W. B. D. & Morgan, M. G. (2019). Reflections on an interdisciplinary collaboration to inform public understanding of climate change, mitigation, and impacts. National Academy of Sciences. https://doi.org/10.1073/pnas.1803726115

8. Condran, S., Bewong, M., Islam, M. Z., Maphosa, L., & Zheng, L. (2022). Machine learning in precision agriculture: a survey on trends, applications and evaluations over two decades. Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/access.2022.3188649

9. Cummings, J. N. & Kiesler, S. (2005). Collaborative research across disciplinary and organizational boundaries. SAGE Publishing. https://doi.org/10.1177/0306312705055535

10. Dalton, A., Wolff, K., and Bekker, B. (2021). Multidisciplinary Research as a Complex System. International Journal of Qualitative Methods. Volume 20: I-II. DOI:10.1177/16094069211038400

11. Dhadphale, T and Baughman, J. (2018). Understanding Characteristics of Multidisciplinary Collaboration using Concept maps. International Conference on Engineering and Production Design Education. 20th International Conference on Engineering and Production Design Education.

12. Dozier, A. M., Martina, C. A., and O'Dell, N. L. (2014). Identifying emerging research collaborations and networks: method development. Eval. Health Prof. 37(1):19–32. doi: 10.1177/0163278713501693.

13. Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L, Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., and Wright, R. (2023) Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational

AI for research, practice and policy. Int J Inf Manag 71:102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

14. Edward, G. I. (2019). Multidisciplinary Approach to Environmental Problems and Sustainability. Springer Nature Switzerland. Encyclopedia of Sustainability in Higher Education. https://doi.org/10.1007/978-3-319-63951-2_241-1
15. Fazey, I., Bunse, L., Msika, J., Pinke, M., Preedy, K., Evely, A. C., Lambert, E., Hastings, E., Morris, S., and Reed, M. S. (2014). Evaluating knowledge exchange in interdisciplinary and multi-stakeholder research. Glob Environ Chang 25:204–220
16. Fontana, M., Iori, M., Leone, S. V., and Souza, D. (2022). The interdisciplinarity dilemma: public versus private interests. Res Policy 51(7):104553. https://doi.org/10.1016/j.respol.2022.104553
17. Goring, S., Weathers, K. C., Dodds, W. K., Soranno, P. A., Sweet, L. C., Cheruvelil, K. S., Kominoski, J. S., Regg, J., Thorn, A. M., & Utz, R. M. (2014). Improving the culture of interdisciplinary collaboration in ecology by expanding measures of success. Wiley. https://doi.org/10.1890/120370
18. Hall, K. L., Vogel, A. L., and Huang, G. C. (2018). The science of team science: a review of the empirical evidence and research gaps on collaboration in science. American Psychologist 2018; 73 (4): 532–548. DOI: 10.1037/amp0000319.
19. Hedegaard-Soerensen, L., Jensen, C. R., & Tofteng, D. M. B. (2017). Interdisciplinary collaboration as a prerequisite for inclusive education. Taylor & Francis. https://doi.org/10.1080/08856257.2017.1314113
20. Li, H and Yin, Z. (2023). Influence of publication on university ranking: citation, collaboration, and level of interdisciplinary research. J Librariansh Inf Sci 55(3):828– 835. https://doi.org/10.1177/09610006221106178
21. Lyu, W., Huang, Y and Liu, J. (2024). The multifaceted influence of multidisciplinary background on placement and academic progression of faculty Humanit Soc Sci Commun 11, 350 (2024). https://doi.org/10.1057/s41599-024-02818-8
22. Leahey, E., Barringer, S. N., and Ring-Ramirez, M. (2019). Universities' structural commitment to interdisciplinary research. Scientometrics 118(3):891– 919. https://doi.org/10.1007/s11192-018-2992-3
23. MacGregor, H. & Waldman, L. (2017). Views from many worlds: unsettling categories in interdisciplinary research on endemic zoonotic diseases. None. https://doi.org/10.1098/rstb.2016.0170
24. McPhearson, T., Pickett, S. T. A., Grimm, N. B., Niemel, J., Alberti, M., Elmqvist, T., Weber, C., Haase, D., Breuste, J., & Qureshi, S. (2016). Advancing urban ecology toward a science of cities. Oxford University Press. https://doi.org/10.1093/biosci/biw002

Comparative study of Promotional Strategy of Mopeds: case study on Sangli city of Maharashtra state

Dr. Prakash Rajaram Chavan
Head and Associate Professor
Department of Statistics,
Smt. Kasturbai Walchand College of Arts & Science, Sangli, Maharashtra (INDIA)
Shivaji University, Kolhapur

ABSTRACT

in this paper we have to study the Promotional Strategy of Mopeds on Sangli city. To represent the collected data graphically. By using statistical analysis we have to check whether the mopeds & occupations are independent or not. Also we have checked whether the mopeds & gender are independent or Not. Finally we estimate mileage of mopeds and to test the manufacturer's Claim.

Key Words: Online shopping, Statistical analysis, Random sampling, secondary data

INTRODUCTION

The popularity of mopeds in India as one of the most convenient personal transport vehicle has taken shape since its introduction.First manufactured mopeds in India were by the TVS company, at Hasur in Tamilnadu. Mopeds are usually used for the purpose of transformation, used by those in the lower middle-class segment. The mopeds are even very popular with the rural sector as a utility vehicle for its capacity to bear heavy loads on rough village roads. Firstly, the price of mopeds in India was very reasonable & secondly, its consumed very less fuel. Though, it was under-powered(less than 100cc).The mopeds in India were popular. With the slow but gradual growth in the economy & the rise in the income of customers, the popularity of the mopeds in India started declining. The main factor behind the fall in the sales of mopeds in India is due to the availability of a lot of options in the two-wheeler segment.

DATA COLLECTION:

- **Primary Data collection :**We have collected data from customers and their mopeds by taking their interview using a questionnaire.
- **Secondary data collection :**We have collected secondary data relevant to mopeds like average, ideal conditions for good mileage etc. from the dealers. Dealers have given us the corresponding pamphlets.

- **Sampling :** A method of selecting a sample from population is called as sampling. There are various methods of sampling like random sampling , systematic sampling ,stratified sampling ,cluster sampling , quota sampling , accidental sampling .But in this project we use simple random sampling.
- **Sample size :**Sample size means number of observations .In this project a sample of 150 customers from different locations from Sangli city is taken.
- **Simple Random Sampling :**In this paper we use the simple random sampling method. We choose 150 mopeds from Sangli city. Each moped chosen randomly.

STATISTICAL TOOLS USED

- **Descriptive Statistics :**
  1) Mean
  2) Percentile
  3) Coefficient of variance(C.V)

- **Contingency Table For Independence Of Events :**If A & B are two variables then these two variables are independent when they follows the following condition
  $P(A/B) = P(A \cap B)/P(B)$ But, $P(A/B) = P(A)$ $\therefore P(A \cap B) = P(A).P(B)$
- **m×n Contingency table for independence of attributes:**

In this test we have to test whether the attribute A & B are independent.
The following table shows m×n contingency table ,

	B_1	B_2	. . .	B_j	. . .	B_n	T
A_1	(A_1,B_1)	(A_1,B_2)		(A_1,B_j)		(A_1,B_n)	A_1
A_2	(A_2,B_1)	(A_2,B_2)		(A_2,B_j)		(A_2,B_n)	A_2
:							:
A_i	(A_i,B_1)	(A_i,B_2)		(A_i,B_i)		(A_i,B_n)	A_i
:							:
A_m	(A_m,B_1)	(A_m,B_2)		(A_m,B_j)		(A_m,B_n)	A_m
T							N

Where, A_i = Number of persons passing attribute A_i
B_i = Number of persons passing attribute B_j i= 1,2,…….,n & j= 1,2,…….,m
In this test we have to test the null hypothesis,
H_0 : Two attributes A & B are independent.
H_1 : Two attributes A & B are not independent.

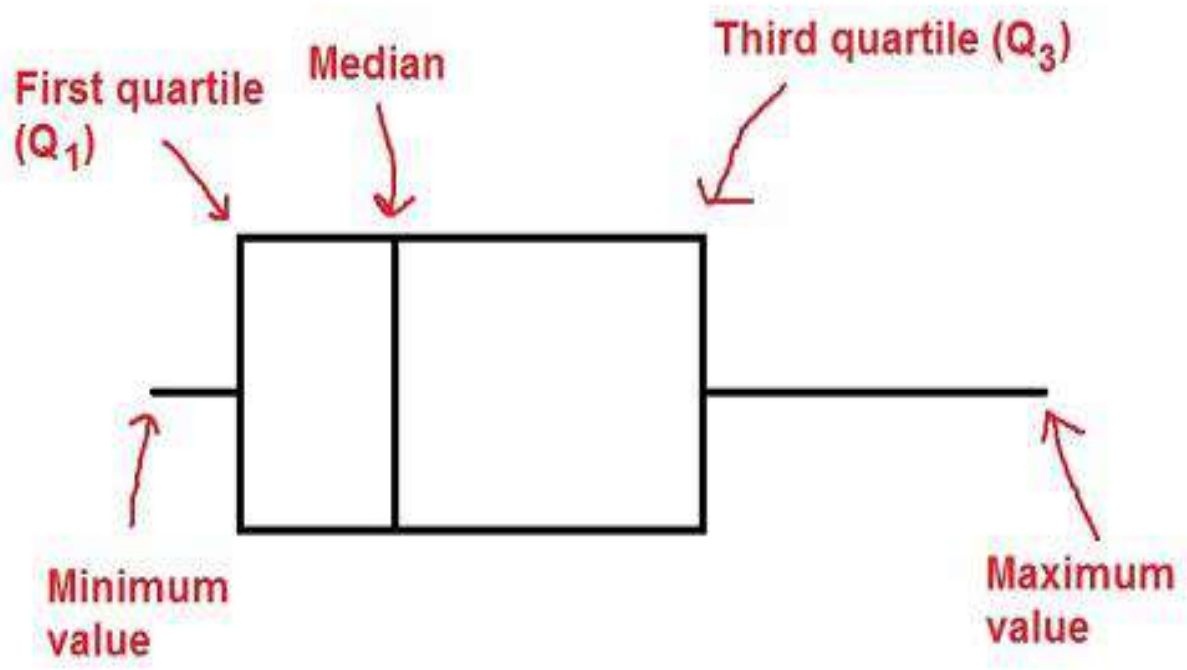
To find the expected frequency, we use the formula, $(AiBj)o = \frac{(Ai)(Bj)}{N}$

Under the null hypothesis, $\chi^2 = \sum\sum \frac{((AiBj)-(AiBj)o)2}{(AiBj)o}$

Degree of freedom = (m – 1)(n – 1)
If $\chi^2_{cal} > \chi^2_{tab}$ then reject null hypothesis H_0 at 5% , level of significance otherwise accept it.

- **Box plot:** It is the standardized way of displaying the distribution of data based on the five number summary :

1) Minimum value 2) First Quartile 3) Median (Second Quartile)
4) Third Quartile 5) Maximum value

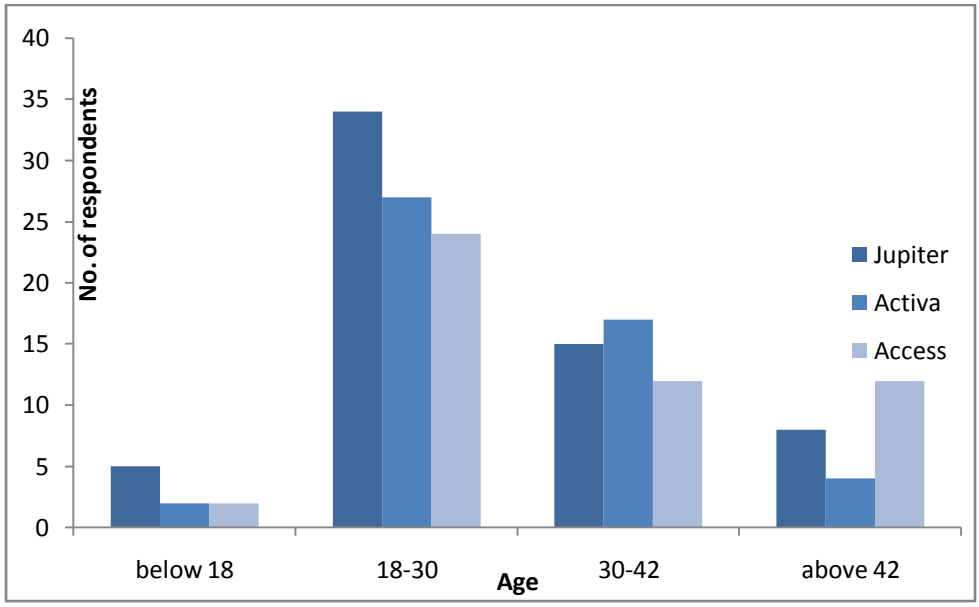


- Minimum Value : The smallest value in the data set.
- First Quartile : The cutoff point for the lowest 25% of the data set(median of the lower half).
- Median : It separates lower & upper halves of the data. It is also called as second quartile.
- Third Quartile :The cutoff point for the upper 25% of the data set(median of the upper half).
- Maximum value :The largest value in the data set.

DATA ANALYSIS:

Age wise classification

	Age	Jupiter	Activa	Access
1	Below 18	5	2	2
2	18 to 30	34	27	24
3	30 to 42	15	17	12
4	Above 42	8	4	12



Figure(1)

Interpretation:

1) From the above graph we seen that most of the customers in 18-30 age group use these three mopeds.

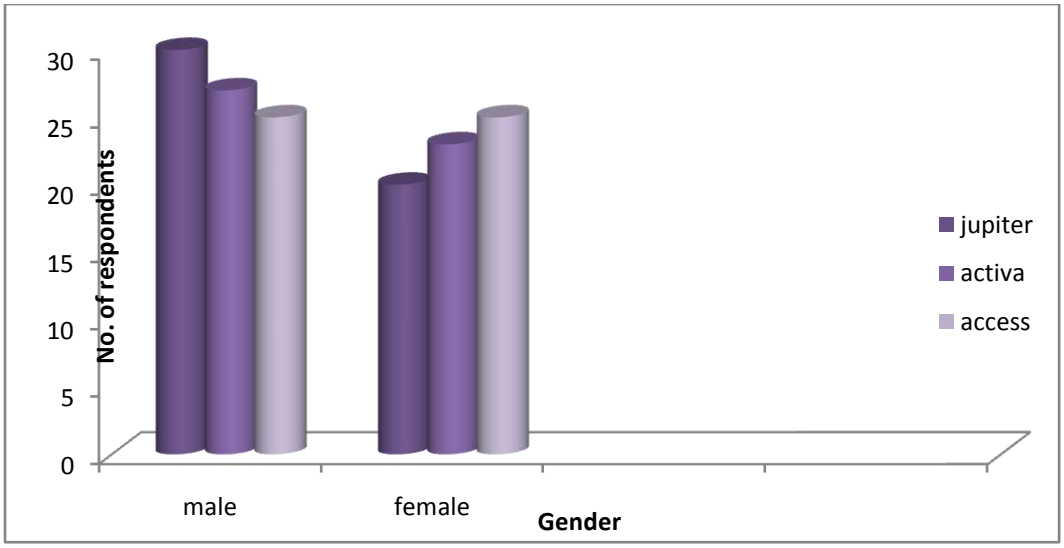
2) Also we seen that in this age group most of the customers use Jupiter moped.

Gender wise classification

Data :

	Gender	Jupiter	Activa	Access
1	Male	30	27	25
2	Female	20	23	25

Analysis :



Figure(2)

Interpretation :

1) From the above graph we seen that as compaired to female,

male preferred to use Jupiter & Activa moped.

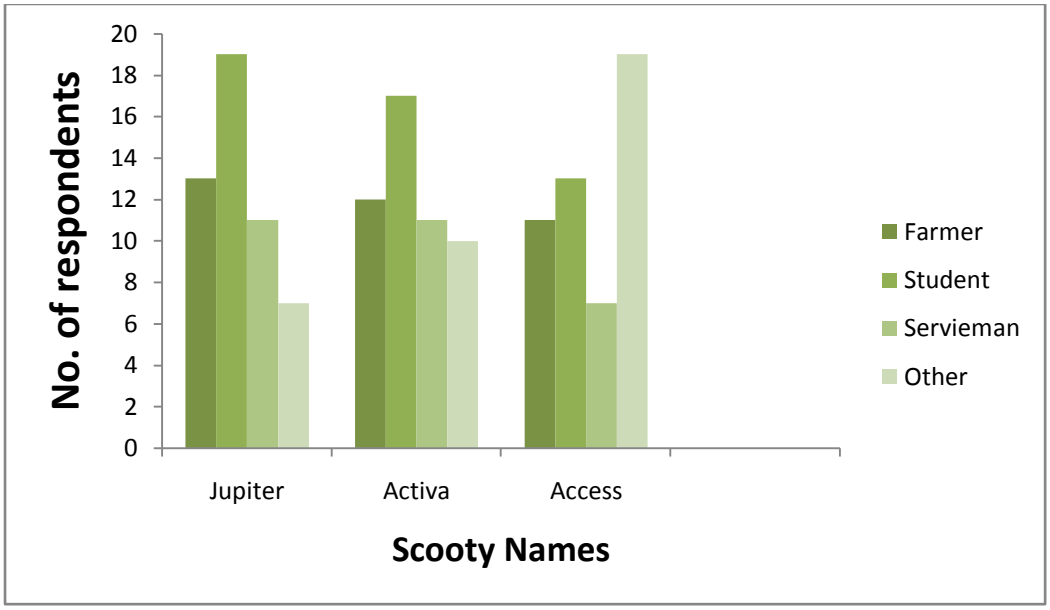
2) Also we seen that females prefers to use the Access moped.

Occupation wise classification

Data:

Mopeds	Farmer	Student	Serviceman	Other
Jupiter	13	19	11	7
Activa	12	17	11	10
Access	11	13	7	19

Analysis:



Figure(3)

Interpretation :

1)From the above graph we can see that student choose Jupiter moped as compaired to other mopeds

2) On other hand more customers like housewife,businessman, teacher etc. are used Access moped.

- **Descriptive Statistics :**

jupiter

	Values
Mean	57.06
Variance	14.9555
Standard Deviation	3.8672
Median	58.5
Mode	60
Range	19
Skewness	-1.3661

Activa

Mean	54.9

Variance	39.07
Standard Deviation	6.2507
Median	57.5
Mode	60
Range	20
Skewness	-0.9756

Access

Mean	56.76
Variance	33.3289
Standard Deviation	5.7731
Median	58.5
Mode	50
Range	19
Skewness	-0.4911

- **Contingency Table For Independence of Events**

Following contingency table shows the number of males and females having mopeds. We have 82 males and 68 females in the data set. We have total 150 peoples in the data. Also we have total number of each moped as 50.

Moped Name	Jupiter	Activa	Access	Total
Male	30	27	25	82
Female	20	23	25	68
Total	50	50	50	N = 150

We have to determine that if being male and having Jupiter moped are independent or dependent.

To prove that two variables (Say A and B)are independent , we must show that , $P(A \cap B)=P(A|B).P(B)=P(A).P(B)$ Let, $P(A)=P(\text{Male})$ $P(B)=P(\text{Jupiter})$ $P(A \cap B)=P(\text{Male AND Jupiter})$ $P(A|B)=P(\text{Male GIVEN Jupiter})$ From the contingency table ,

$P(A)=P(\text{Male})= 82/150 =0.5466$

Moped	Jupiter	Activa	Access	Total
Male	30	27	25	82
Female	20	23	25	68
Total	50	50	50	N = 150

$P(B) = P(\text{ Jupiter }) = 50/150 = 0.3333$

Moped	Jupiter	Activa	Access	Total
Male	30	27	25	82
Female	20	23	25	68
Total	50	50	50	N = 150

P(A∩B) = P(Male AND Jupiter) = 30/150 = 0.2

Moped	Jupiter	Activa	Access	Total
Male	30	27	25	82
Female	20	23	25	68
Total	50	50	50	N = 150

P(A|B) = P(Male GIVEN Jupiter)= 30/50 = 0.6

Moped	Jupiter	Activa	Access	Total
Male	30	27	25	82
Female	20	23	25	68
Total	50	50	50	N = 150

P(A∩B) = P(A|B).P(B) =P(A).P(B)
0.2 = 0.6 × 0.3333 = 0.5466 × 0.3333
0.2 ≠ 0.1998 ≠ 0.1821

Result :
Given data is dependent.
Conclusion :
Male having Jupiter moped is dependent on each other.

- **m × n Contingency table for independence of attributes**

We have to test that , occupations & mopeds are independent on each other.

Moped Name	Farmer	Student	Serviceman	Other	Total
Jupiter	13	19	11	7	50
Activa	12	17	11	10	50
Access	11	13	7	19	50
Total	36	49	29	36	N = 150

H_0 : Mopeds & occupations are independent.
H_1 : Mopeds & occupations are not independent.
Now,to find the expected frequency the formula is ,
$E_{ij} = \frac{(Ai)(Bj)}{N}$ Here , i = 1,2,3 & j = 1,2,3, 4
To calculate χ^2 for each observation , the formula is ,
$\chi^2 = \sum\sum \frac{(Oij - Eij)2}{Eij}$ χ^2 = 8.9134 d.f = (n – 1) (m – 1) =(3 – 1) (4 - 1)= 6
χ^2_{tab} = 12.592

Here , calculated $\chi^2 < \chi^2$ tabulated

Result : We do not reject H_0 at 5 % level of significance.
Conclusion: Mopeds & occupations are independent.

CONCLUSION

From the fig(1) we seen that most of the customers. in 18-30 age group use Jupiter, Activa & Access mopeds. Also we had seen that in 18-30 age group most of the customers use Jupiter moped. From the fig (2) we have seen that as compared to female, male preferred to use Jupiter & Activa moped. Also we have seen that females prefer to use the Access moped. From the fig (3) we seen that student choose Jupiter moped as compared to other mopeds. On other hand more customers like housewife, businessman Professional, teachers etc. are used Access moped. Male having Jupiter moped is dependent on each other Mopeds & occupations are independent on each other. At least 75% mopeds have mileage less than the Manufacturer's claim. Hence we can say that manufacturer's Claim is not correct.

REFERENCES

1. Duggani Y. & Rao, S. D. (2014). Customer satisfaction towards honda two wheelers: a case study in Tirupati. IOSR Journal of Business and Management, 16 (5), 65-74.
2. Fitzsimmons, M. J. (2017). Service Management: Operations, Strategy, Information Technology. McGraw Hills Education (Eds. 9th pp 05).
3. Kathirvel, N. and Chandrasekaran, N. (2009). Consumer behaviour and brand preference towards Onida Television: An empirical study with reference to Karur, Tamilnadu. Indian Journal of Marketing, 39,(7), 58.
4. Kotler P. (2012). Marketing management. Pearson Education Ltd., 147-148.
5. Kotler, P. & Armstrong, G. (1993). Principle of Marketing. New Delhi: Prentice Hall of India.
6. Mahanty, B. and Bagodi, V. (2008). Two-wheeler service sector in India: Factors of importance for sustainable growth. Journal of Advances in Management Research, 5, 21 – 27.
7. Mamoun, A. (2012). An empirical model of marketing strategy and shareholder value: A value-based marketing perspective. Competitiveness Review: An International Business Journal incorporating Journal of Global Competitiveness, 22(1), 48 – 89.
8. Milind, B. (2011). 4P's, Brand Journey Bajaj Auto. Business and Marketing, 6, 34.
9. Oyama, (2012). The Mint Report for 1 March, 2012, 6, pp 08. Sharma, J.P. & Bhatnagar, A. (2006). Automobile industry and productivity, 47, (1-2).
10. Singh, A. and Kumar, B. (2011). Customer relationship management tools: An overview. Marketing Mastermind, 11, 23-26.

COMMENCEMENT OF BUSINESS

Dr.S.Lakshmi,
Assistant Professor
Faculty of Management,
SRM Insitute of Science and Technology, Ramapuram, Chennai, Tamil Nadu.

Dr.M.Sampath,
Associate Professor,
Department of Economics,
PSG College of Arts and Science, Coimbatore, Tamil Nadu

Dr.N.Yuvaraja
Assistant Professor,
Faculty of Management,
SRM Insitute of Science and Technology, Ramapuram, Chennai, Tamil Nadu

A private company can commence business soon after its incorporation. But a public company can do so sonly after obtaining one more certificate from the Registrar namely the 'Certificate of commencement of Business". The promoters of a public Limited Company shall have to take the following preliminary steps for obtaining the certificate.

1. They have to prepare a document know as 'prospectus' to be issued to the public, if the company would like to raise capital from the public by issuing share certificates
2. They have to call the first meeting of the Board of Directors in order to appoint bankers, auditors, secretary, solicitors and brokers.
3. When there is no "pro term' secretary they have to appoint the first secretary and decide the terms and conditions of his appointment.
4. The Board of Directors have to pass a resol8tion to open an account in a scheduled bank in order to deposit money received by the company.
5. They have to enter into contract with an underwriting agency.

Restriction on commencement of Business by a Company
It is laid down under section 149 of the companies Act, 1956. According to the section two sets of restrictions have been provided namely

a. In respect of the companies that have issued a prospectus and
b. In respect of the companies that have not issued a prospectus.
   Companies which have issued a prospectus cannot commence business unless the following conditions are to be fulfilled:

a. That the minimum subscriptions in cash has been received.
b. That every director of the company has paid in cash his qualification shares.
c. That a statutory declaration duly verified by one of the director or the secretary in prescribed form stating that the above conditions have been compiled with, is filed with the Registrar.

Company which have not issued a prospectus cannot commence business unless the following conditions are to be fulfilled:

a. That the statement in lieu of prospectus has been filed with the Registrar
b. That every director of the company has paid in cash his qualification shares.
c. That statutory declaration duly verified by one fothe directors or the secretary in prescribed form staring that the above conditions have been complied with is filed with the Registrar.

On receipt of the above-mentioned documents in accordance with the provisions as laid down under section 149, the Registrar issues a certificate known as 'the certificate of commencement of Business'. This certificate is the conclusive evidence that the company is entitled to commence business.

PROSPECTUS:

Definition (sec 2(36)

'Prospectus' means "any document described or issued as a prospectus and includes any prospectus, notice, circular, advertisement or other document inviting deposits from the public or inviting offers from the public for the subscription or purchase of any shares in or debentures of a body corporate. A private compnahy is prohibited to issue a prospectus but a public company, if it approaches the public for raising the capital must issue prospectus, or a statement in lieu of prospectus. Before issuing the prospectus, a copy of it must be filed with the Registrar. It is an invitation to the public to subscribe for shares in or debentures of the company. It must be dated and signed by the proposed directors or by their agents int he case of a newly established company and by all the directors int eh case of an existing company. It must be issued within 90 days from the date n which a copy is filed with the Registrar for registration. If it is issued to the public without sending a copy to the Registrar for registration, the company and every person who is a party to the issue of the prospectus shall be punishable with fine which may extend up to Rs.5000.

Contents of prospectus:

According to parts I and II of schedule 11 of the companies Act, a Prospectus should contain the following:

1.Main objects of the company and signatories:

The objects of the company must be clearly spelled out. It must contain the particulars of signatories to the memorandum of Association and the number of shares taken by them.

2.Classes of shares:

Number of shares available for subscription, different classes of shares and their privileges.

3.Redeemable preference shares:

Number of redeemable preferences shares available for subscription, date and method of redemption.

4.Qualification shares:

Number of shares being held by a director as 'Qualification of shares". Qualification shares mean the minimum number of shares to be subscribed by a number in order to act as a qualified director.

5 Managerial personnel:
The names, addresses, description and occupations of directors, managing director, manager and the provisions regarding the appointment of a Managing director or manager and their remuneration.

6.Minimum Subscription:
The amount which in the opinion of the board of directors is to be raised by issuing shares, in order to:

- ✓ Meet the purchase price of any property
- ✓ Meet the preliminary expenses
- ✓ Repay the money borrowed
- ✓ Meet the working capital and
- ✓ Any other expenditure of the company.

7.Subscription List:
The time of the opening of subscription list and the amount payable on application and allotment for each share

8.Particualrs of any option to subscribe for shares:
When person enter into contract or propose to enter into contract, it is left to their option to subscribe for share or debentures.

9.Shares or Debentures Issued for consideration other that cash:
The number and amount of shares and debentures issued within the two proceedings years for consideration other than cash.

10.Premium on shares:
The amount paid or payable as premium on each share within 2 years preceding the date of the prospectus.

11.Underwriting commission:
The name of the underwriters and the opinion of the directors that the underwriters have sufficient resources to discharge their liabilities.

12. Particulars of property;
The name, addresses and occupation of venders from whom the property has been or is proposed to be purchased by the company. It also includes the amount paid or payable as purchase consideration in cahs, shares or debentures.

13. Underwriting commission:
The amount paid or payable as underwriting commission within two years preceding the date of the issue of prospectus.

14. Preliminary expenses:
The amount of preliminary expenses paid or to be paid and the person by whom these expenses have been or are to be paid

15.Benefits to promoters:
The amount of benefit given or to be given within the 2 preceding years to any promoter or officer. The purpose for which the benefit is given or to be given must also be included.

16.Particulars of contracts:

Particulars regarding dates, names of parties and the general nature of every contract entered into by the company within the proceeding 2 years before the date of the prospectus.

17.Auditors:

The names and addresses of the auditors if any of the company.

18.Nature of interest of every Director of promoter

Particulars of the nature and extent of the interest of every director or promoter int eh promotion of the company within the preceding 2 years.

19.Voting and Dividend rights:

The rights attached to different classes of share sin respect of voting at meetings and dividends and also the restriction of rights imposed by the articles in respect of the right to speak, attend or vote at meetings.

20. Length of business:

In the case of an existing company, the length of time during which the business ahs been carried on. If the company proposes to acquire a running business which has been carried on for les than 3 years, the length of the time during which the business has been carried on.

21.Capitalisation of profit and surplus form Revaluation of assets:

Particulars of any capitalization fo profits or reserves of the company and particualrs of any surplus arising from revaluation of assets during the preceding 2 years.

22. Inspection of Balance sheets and Profit and Loss Accounts:

A reasonable time and place at which copies of Balance sheet and profit and loss account of the company my be inspected.

Each copy of prospectus must accompany with blank application form. Perons who are willing to buy shares in or debentures of a company must fill up this application form and forward the same to the company along with the application money.

Apart from the above said information's, a prospectus must also contain the reports as specified in part II of schedule II of the companies Act namely,

1.(a) Report by the auditors of the company in respect of its assets and liabilities and as to its profits or losses and

b. dividends paid by the company during the preceding 5 years.

2.A Report by a chartered accountant

(i) On the profits or losses of the company for the proceeding 5 financial year.

(ii) on the assets and liabilities of the company for period of not more than 120 days before the date of the issue of prospectus.

3.A similar report by the accountants on the accounts of the other body corporate, if the proceeds of the issue of shares or debentures of the incorporated company are to be applied in the purchase of shares in any other body corporate so that the other body corporate becomes a subsidiary of the acquiring company.

If a company issues prospectus in on contravention of section 59 or 58, the company and every person who is knowingly a party to the issue thereof, shall be punishable with fine which may extend to Rs.5000

When prospectus is not required to be issued;

Prospectus is not necessary in the following cases.

1.when shares or debentures are offered to existing holders of shares or debentures

2.When the issue of shares or debentures is uniform in all respects with shares or debentures previously issued and deal in a recognized stock exchange.
3.Where a person is Bonafide invited to enter into an underwriting agreement and
4.Where shares are not offered to the public.

Advertisement for inviting deposits: (Section 58A and 58B)

The central Government may in consultation with the Reserve Bank of India, prescribe the limits up to which and the conditions to which, deposits may be invited or accepted by accompany either from the public or from its members.

No company shall invite deposits unless an advertisement (Including a statement showing the financial position of the company) has been issued by the company in such form and in such manner as may be prescribed.

The provisions of the newly introduced section 58A and 58B of the companies Act, 1974 apply to renewal ofc deposits also. Deposits collected in contravention of these sections, must be returned bya company within 30 days of such collection or within such further time as determined by the Central Government but not exceeding 30 days. If the company fails to make repayment within the specified time, the company is punishable with a fine of not less than twice the amount of the deposit. Then the court shall collect the fine and refund the deposits out of the fine to the depositors.

Besides, every officer of the company who is in default shall be punishable with imprisonment for a term which may extend to 5 yeas and shall also be liable to fine. Again, where a company accepts any deposit in excess of the prescribed limit, the company shall be punishable with fine which shall not be less than an amount equal to the amount of the deposit so accepted. (or)

Where the company invites any deposit in excess of the prescribed limit, the company shall be punishable with time which may extend to 1 Lakh rupees but shall not be less than Rs.5000.

And every officer who is in default shall be punishable with imprisonment for a form which may extend to 5 years and shall also be liable to fine.

But these provisions do not apply to a banking company or such other company as the Central government may decide in consultation with the Reserve Bank of India.

The object to enacting these sections was that in practice, most of the companies have been collecting deposits from the public by offering a high rate to interest, but in many cases, the deposits have not been refunded. On the due date, it is therefore, considered necessary to control the companies' inviting deposits from the public. Companies seeking deposits are required to issue an advertisement in such form and in such manner as may be prescribed along with a statement showing the financial position of the company.

Companies which have collected deposits in contraventions of these section must repay the amount of deposits, otherwise they shall be punishable with fine.

Deposit here we mean any money received by why of deposit or loan or in any other form but shall not include the following.

- Any money received form or guaranteed by the central Government or a state Government or a foreign government or a local authority
- Money received from the State Bank of India or from a banking institution as notified by the Central Government or from a Co-operative Bank.

- Any loan borrowed from the Industrial Development Bank of India, 1964 or Industrial Finance Corporation of India or state Fiancnial Corporation or Life Insurance corporation of an Electricity Board or the State Trading corporation of India Limited or Minerals and Metals Trading corporation of India Limited etc.
- Money received from any other company
- Subscription received by any company carrying on chit or kuri business.
- Money received from a director of the company
- Money received from an employee of the company
- Money received in the course of company's business
- Money received in trust and
- Money received by means of subscription to any shares or debentures.

Mis Statement in Prospectus:

The government contained in the prospectus must be true. Otherwise, persons who are responsible for its publication are liable to heavy penalties. Hence, the prospectus must always contain the true and fair view of the state of affairs of the company. The liabilities for the mis-statement in prospectus may be either (a) civil Liability or (b) Criminal liability.

1.Civil Liability: If a person purchases shares or debentures of a company based on the statements made in the prospectus and thereby suffers any damage or incurs loss he is entitled to claim compensation for the loss or damage against the directors, promoters and those persons who have authorized the issue of the prospectus. However, no person shall be liable if he proves that:

A. He withdrew his consent before the issue of the prospectus and that it was issued without his consent

b. that the prospectus was issued without his knowledge or consent and ongoing to know of its issue, he immediately gave reasonable public notice that it was issued without his knowledge or consent.

C .He withdrew his consent or coming to know of its untrue statement after the issue of prospectus but before allotment and gave public notice of the withdrawal and reason therefore

d. He can prove that, he had reasonable ground to believe and did up to the time of allotment believe that the statement was true.

e.Any untrue statement purporting to be a statement made by an expert or a copy of or a correct and fair extract from a report of the expert and he had reasonable ground to believe that the expert was competent to make the statement and

f.As regards any untrue statements, supposed to have been made by an official document, it was a correct and fair representations of the statement or a correct copy of or extract from the document.

However, an expert is also exempted form liability, if he proves that:

a.He withdrew his consent in writing, before filing a copy of the prospectus with the Registrar for registration.

b.He withdrew his consent in writing the delivery of the copy of prospectus for registration and before allotment and gave reasonable public notice of the withdrawal and of the reason for it or

c.He was competent to make the statement or head had reasons to believe and did believe that it was true.

b.Criminal Liability (Sec 63)

Where a prospectus issued contains any untrue statement every person who has authorized the issue of the prospectus, shall be punishable with imprisonment for a term which may extend to two years or with find which may extent to Rs.5000 or with both

However, he is exempted from such liability, if he proves that:

- The statement shown in the prospectus was immaterial or
- He had reasonable ground to believe and did believe up to the time of issue of the prospectus that the statement was true (63)

Any person who either by knowingly or recklessly make any false statement and induces or attempt to induce any other persons to subscribe to the shares or debentures of the company shall be punishable with imprisonment for a term which may extend to 5 years or with find which may extend to Rs.10,000 or with both. (sect 68)

A Review on Software Fault Prediction: Techniques, Tools, and Research Gaps

Rajinder Kumar Dr.KamaljitKaur

[1]Research Scholar, Department of Computer Science, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India.
Email:-Rajinderkumar.cse@gmail.com.

[2]Assistant Professor, Department of Computer Application, Chandigarh Business School of Administration, Landran-Mohali, Punjab, India.

[3]Assistant Professor, Department of Computer Science, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India.
Email:-drkamaljit2024@gmail.com

Abstract

In the current era, as our need for complicated software has increased, the demand for excellence of software is becoming more important progressively. Now the software is being utilized almost universally and in every step of the life of human beings and complexity and volume of software systems are increasing with a rapid rate. The software cost such as defect & breakdown may reduce the quality of software and it creates disappointment to the customer. Fault prediction in software plays a vital role in enhancing the software excellence as well as it helps in software testing to decrease the price and time. Software defect prediction typically produce datasets, methods and frameworks which allow software engineers to focus on development activities in terms of defect-prone code, thereby improving software quality and making better use of resources. From 40 years is software defect prediction, where predictions are made to determine where future defects might appear. Since then, there have been many studies and many accomplishments in the area of software defect prediction. But there remain many challenges that face that field of software defect prediction and Prevention approaches.This paper presents a Review on current practices for software fault detection and prevention mechanisms in the software development and brief overview of software defect prediction and its various components, current trends, revisit the challenges of software prediction models and highlight some key of future challenges.

Keywords: literature review, software defect prediction, software defect prediction methods, Prevention approaches, fault datasets

I. Introduction

With the rapid development of computer technology, software applications have expanded to all parts of people's daily lives, creating a situation in which the economy, production, and life are fully dependent on computer software. But software failure can bring about serious or even fatal consequences, especially for high-risk systems. System failure is more often caused by software defects, which are important factors affecting software quality and are potential root causes of errors and failures in the relevant systems [1].

Failure is the accumulation of several defects that ultimately lead to Software failure and results in the loss of information in critical modules thereby making the system unresponsive.

Generally, such situations happen very rarely because before releasing a product all possible scenarios and test cases for the code are simulated. Failure is detected by end-users once they face a particular issue in the software.

- Failure can happen due to human errors or can also be caused intentionally in the system by an individual.
- It is a term that comes after the production stage of the software.
- It can be identified in the application when the defective part is executed.

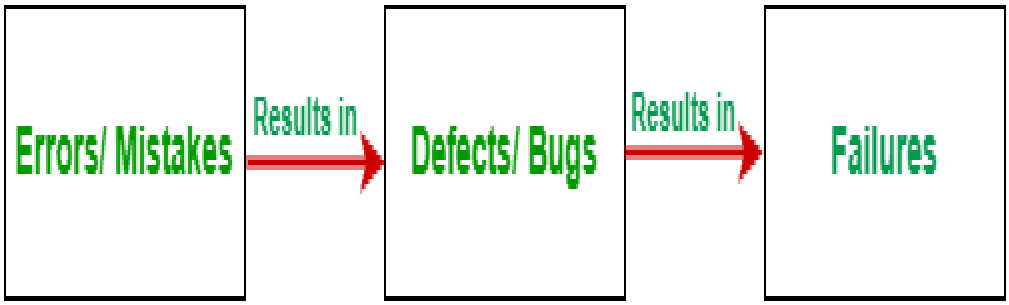


Fig. 1A simple diagram depicting Bug vs Defect vs Fault vs Failure

Software quality means to be an error-free product, which will be competent to produce predictable results and able to deliver within the constraints of time and cost. Therefore, a systematic approach for developing high quality software is increased in the competitiveness in today's business world, technology advances, the complexity of the hardware and the changing business requirements. So far, for the fault-prone modules various techniques have been proposed for predicting and forecasting in terms of performance evaluation [2]. Application of Software Fault Detection Prediction models early in the software lifecycle allows practitioners to focus their testing manpower in a manner that the parts identified as "prone to defects" are tested with more rigor in comparison to other parts of the software system This leads to the reduction of manpower costs during development and also relaxes the maintenance effort [3]. Software quality assurance (SQA) consists of monitoring and controlling the software development process to ensure the desired software quality at a lower cost. It may include the application of formal code inspections, code walkthroughs, software testing, and software fault prediction Software fault prediction aims to facilitate the allocation of limited SQA resources optimally and economically by prior prediction of the fault-proneness of software modules The potential of software fault prediction to identify faulty software modules early in the development life cycle has gained considerable attention over the last two decades. Earlier fault prediction studies used a wide range of classification algorithms to predict the fault-proneness of software modules. This paper is organized as the overview of the software fault prediction process. present information about the software fault dataset, detail of software metrics, project's fault information, and meta information about the software project, information of methods used for building software fault prediction models.

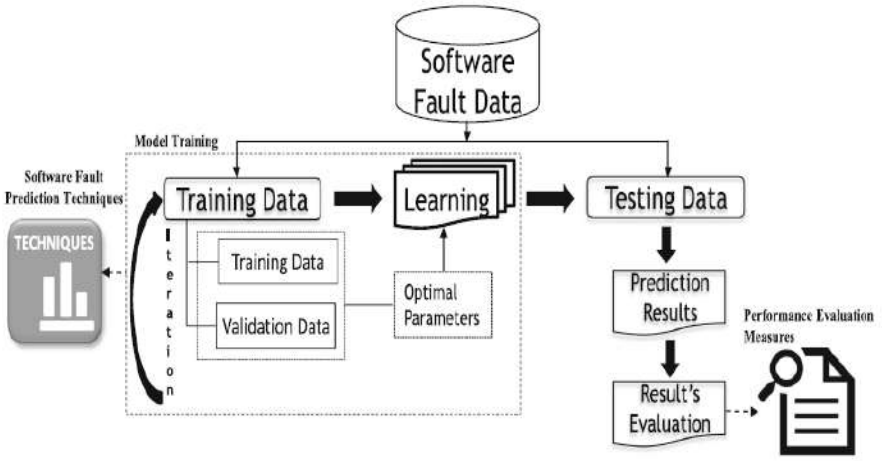


Fig. 2 Software fault prediction process

It's also contained performance evaluation measures. finding of our review study. highlighted some key challenges and future works of software fault prediction and presented the conclusions.

2 Software fault prediction

Software fault prediction aims to predict fault-prone software modules by using some underlying properties of the software project. It is typically performed by training a prediction model using project properties augmented with fault information for a known project, and subsequently using the prediction model to predict faults for unknown projects. Software fault prediction is based on the understanding that if a project developed in an environment leads to faults, then any module developed in the similar environment with similar project characteristics will ends to be faulty The early detection of faulty modules can be useful to streamline the efforts to be applied in the later phases of software development by better focusing quality assurance efforts to those modules.

Figure 1 gives an overview of the software fault prediction process. It can be seen from the figure that three important components of software fault prediction process are: Software fault dataset, software fault prediction techniques, and performance evaluation measures. First, software fault data is collected from software project repositories containing data related to the development cycle of the software project such as source code and change logs, and the fault information is collected from the corresponding fault repositories. Next, values of various software metrics (e.g., LOC, Cyclomatic Complexity etc.) are extracted, which works as independent variables and the required fault information with respect to the fault prediction (e.g., the number of faults, faulty and non-faulty) work as the dependent variable. Generally, statistical techniques and machine learning techniques are used to build fault prediction models. Finally, the performance of the built fault prediction model is evaluated using different performance evaluation measures such as accuracy, precision, recall, and AUC (Area Under the Curve).

2.1 Software Fault Detection Mechanism

A failure refers to any fault or imperfection in a work activity for a software product or software process cause due to an error, fault or failure.Fault as, a wrong decision while

understanding the information given to solve the problems or the application process. A single error can lead to one or more faults and a several faults can lead to failure. To avoid this failure in software products, faults detections activities are carried out in every phase of the software development life cycle based on their need and criticality.

1. Detection Using Automated Static Analysis: -Automated Static Analysis (ASA) detection is mostly performed for the Manual Code analysis, which is one of the oldest practices are still practiced, but automated tools are increasingly used especially for the standard problems related to non-compliance faults possible memory leaks, variable usage etc. Find bugs, Check Style and PMD are some of the commonly used tools in the Java technology and there are many of these tools in all technologies. However, for systems that have compatible source for automatic static analysis detection tools can be used as a hygiene factor and good detection mechanism as any error introduced in the field is highly expensive.

2.Detection Using Graph mining: - Graph Mining is a dynamic control flow based approach that helps identify flaws that may be not crashing in nature. Use graphics calls are reduced by the simplicity in processing. The graph node represents the functions and a function call to another is represented by the edges. Edge weights are entered based on the calling frequencies. The variation in the frequency of call and change in the structure of call are potential failures. If there are problems in the data that is transmitted between the methods could also affect the graph of the named because of its implications

3.Detection Using Classifiers: - Classifiers based on the clustering algorithm and decision tree or neural network can be used to identify abnormal events of normal events for the detections. Classifiers are also formed by labelling defective tracks when a fault is observed. Some classifiers are commonly used Naïve Bayes and bagging. Bayesian classification is a supervised learning method and a statistical method for classification.

Machine learning classifiers have recently introduced in the faults to predict changes in the source files. The classifier is first trained on software development, and then used to predict whether an upcoming change causes an error. Disadvantages of existing classifier-based bug prediction techniques are not enough power for practical use and slow prediction times due to a large number of machines learned functions

4.Detection Using Pattern Mining: - Pattern based detection also the classifier based but uses unique iterative patterns for classification sequential data using the software trace analysis for failure detection. A set of discriminatory features capture

repetitive series of events from the program execution traces first executed. Subsequently, the choice is made to select the best features for classification. Classifier model is trained with these sets of features that will be used to identify the failures.

3.Software Fault Prevention Mechanism

In software development, many faults emerged during the development process. It is a mistake to believe that faults are injected into the beginning of the cycle and removed through the rest of the development process. Fault prevention is a process of quality improvement which aims to identify common causes of faults and change the relevant processes to prevent the type of fault recurrence. It also increases the quality of a software product and reduces overall costs, time and resources.

1.Importance of Fault Prevention: - Faults prevention is an important activity in any software project development cycle. Most software project team focuses on fault detection

and correction. Right from the early stages of the project to prevent faults from being introduced into the product that measure is therefore appropriate to make. Such measures are low cost, the total cost savings achieved due to profit later on stage are quite high compared to the cost of fixing faults. Fault injection methods and processes enable fault prevention knowledge. After practicing this knowledge has improved quality.

2.Activities in Fault Prevention

A. Fault Identification: - Fault can be a pre-planned activities aimed at highlighting the specific faults found. In general, faults can be identified in design review, code inspection, GUI Review, function and unit testing activities performed at different stages of software development life cycle. Once the faults are identified it will be classified using classification approach for the detection.

B.Fault Classification: - Classification of fault can be made using the general Orthogonal Defect Classification (ODC) technique to find the fault group and it type. The ODC technique classifies the faults at the time when fault first occurs and when the fault gets fixed. The first level of ODC classifies the various types of faults in different stages of development requirement like Specification gathering, Logical Design, Testing and Documentation.

C.Fault Analysis: -Fault analysis is the continuous process for the quality improvement using fault data. Fault analysis generally classified in categories blame and direct process improvement efforts in order to attempt to identify possible causes. Root Cause Analysis (RCA) software fault has played a useful role in the analysis. RCA's goal to identify the root cause of faults and flaws that the source is eliminated so is to initiate action. To do this, faults one at a time are analysed. Qualitative analysis is limited only by the limits of human investigative capacities.

D.Fault Prevention: -Fault prevention is an important activity in any software project. Identify the cause of faults and fault prevention objective is to prevent them from recurring. Fault Prevention had suffered in the past to analyse the faults and faults in the future to prevent the occurrence of these types include special operations.

4.Faults Prevention Benefits and Limitations

Fault prevention strategies exist, but reflect a high level of test maturity discipline associated with the testing effort represents the most cost-effective expenditure. To detect errors in the development life cycle from design to implement code specifications require that helps to prevent the escape of errors. Therefore, test strategies can be classified into two different categories as, fault detection technologies and fault prevention technologies. Fault prevention efforts over a period of application development provide major cost and time savings. Thus it is also important, reduces the number of faults for reconstruction brings cost reduction, it is easy to maintain port and reuse makes. The lack of specific domain knowledge, where new and diverse domain software is a need to develop and implement. In many occasions, appropriate quality requirements specified are not in the first place. The inspection operation is labour intensive and requires high skill. Sometimes well-developed quality measurementmay not have been identified at design time.

5 Software fault dataset

Software fault dataset that act as training dataset and testing dataset during software fault prediction process mainly consists of three components: set of software metrics, fault information like faults per module, and meta information about project.

The fault information tells about how faults are reported in a software module.In general, three types of fault dataset repositories are available to perform software fault prediction

1) **Private/commercial: -** In this type of repository, neither fault dataset nor source code is available. This type of dataset in maintained and used by the companies within the organizational use.
2) **Partially public/freeware: -** In this type of repository only the project's source code and fault information are available. The metric values are usually not available Therefore, it requires that the user must calculate the metric values from the source code and map them to the available fault information.
3) **Public: -** In this type of repository, the value of metric as well as the fault information both are publicly available (Ex. NASA and PROMISE data repositories). The studies performed using datasets from these repositories can be repeatable.

The fault data are collected during requirements, design, development, and in various testing phases of the software project and are recorded in a database associated with the software's modules Based on the phase of the availability of the fault information, faults can be classified as pre-release faults or post-release faults**.**

TABLE 1.

Information about the programming language and Lines of Code (LOC) and the percentage of defective modules for each dataset is shown in other three columns respectively

Data set	Language	LOC	#sample (positive,negative)
CM1	C	20k	505(0.095,0.905)
KC1	C++	43k	2107(0.154,0.845)
KC2	Java	18k	522(0.201,0.798)
KC3	Java	18k	458(0.093,0.906)
KC4	Perl	25k	125(0.6,0.4)
MC1	C++	63k	9466(0.007,0.992)
MC2	C	6k	161(0.322,0.677)
PC1	C	40k	1107(0.068,0.931)
PC2	C	26k	5589(0.004,0.995)
PC3	C	40k	1563(0.102,0.898)
PC4	C	36k	1458(0.122,0.878)
PC5	C++	16k	17186(0.030,0.970)

JM1	C	315k	10878(0.19,0.81)
MW1	C	8k	403(0.08,0.92)

TABLE 1. The detailed information of NASA datasets

5.1. Software metrics:- For an effective and efficient software quality assurance process, developers often need to estimate the quality of the software artefacts currently under development. For this purpose, software metrics have been introduced. By using metrics, a software project can be quantitatively analysed and its quality can be evaluated. Generally, each software metric is related to some functional properties of the software project such as coupling, cohesion, inheritance, code change, etc., and is used to indicate an external quality attribute such as reliability, testability, or fault-proneness

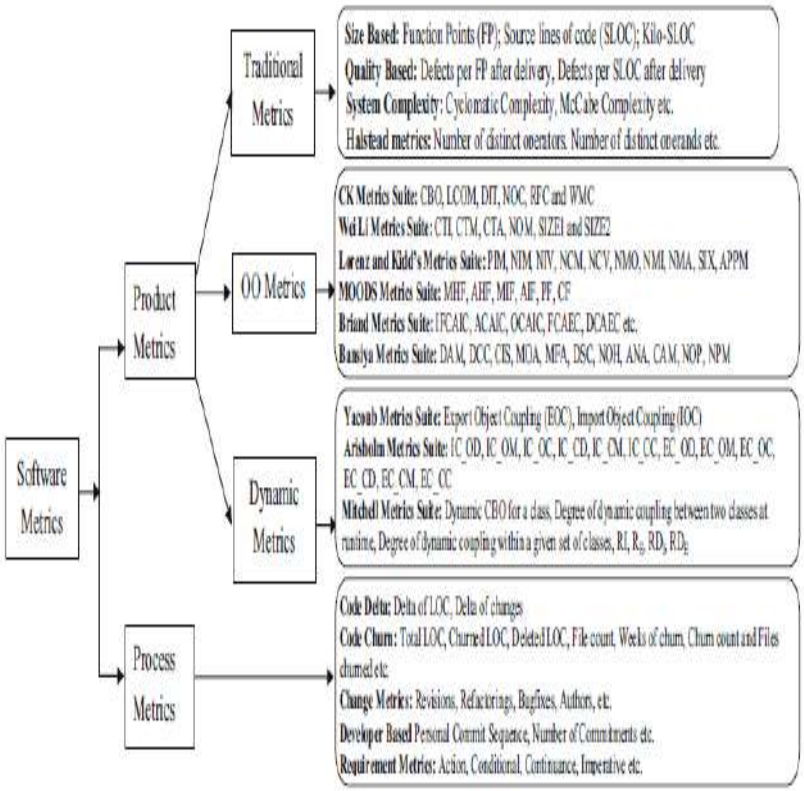


Fig. 3 Taxonomy of software metrics

5.2 Meta information about project: - Meta information about project contained the information of various characteristics of software project. It consists various set of information's such as the domain of software development, the number of revisions software had, etc. as well as consist information of the quality of the fault dataset used to build fault prediction model. Figure shows various attributes of the meta information about the project.

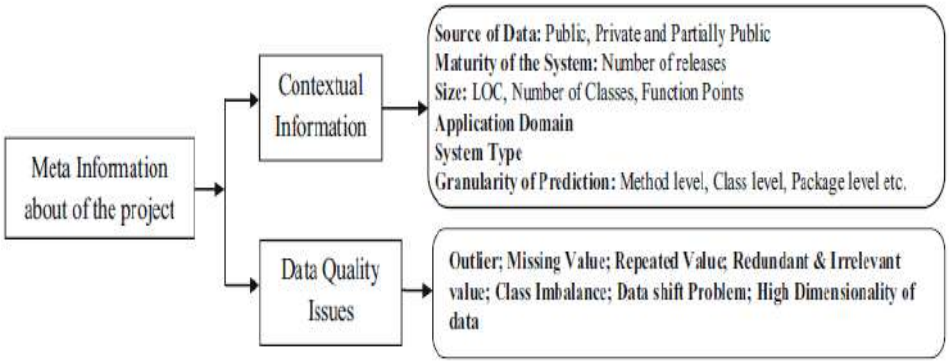


Fig. 4 Meta information of the software project

6. Methods to build software fault prediction model

Various techniques for software fault prediction are available in the literature. We have performed an extensive study of the available software fault prediction techniques and based on the analysis of these techniques a taxonomic classification has been proposed, as shown in Fig Figure shows various schemes that can be used for software fault prediction. A software fault prediction model can be built using the training and testing datasets from the same release of the software project (Intra-release fault prediction), from different releases of the software project (Inter-release fault prediction) or from the different software projects (cross project fault prediction). Similarly, a software fault prediction model can be used to classify

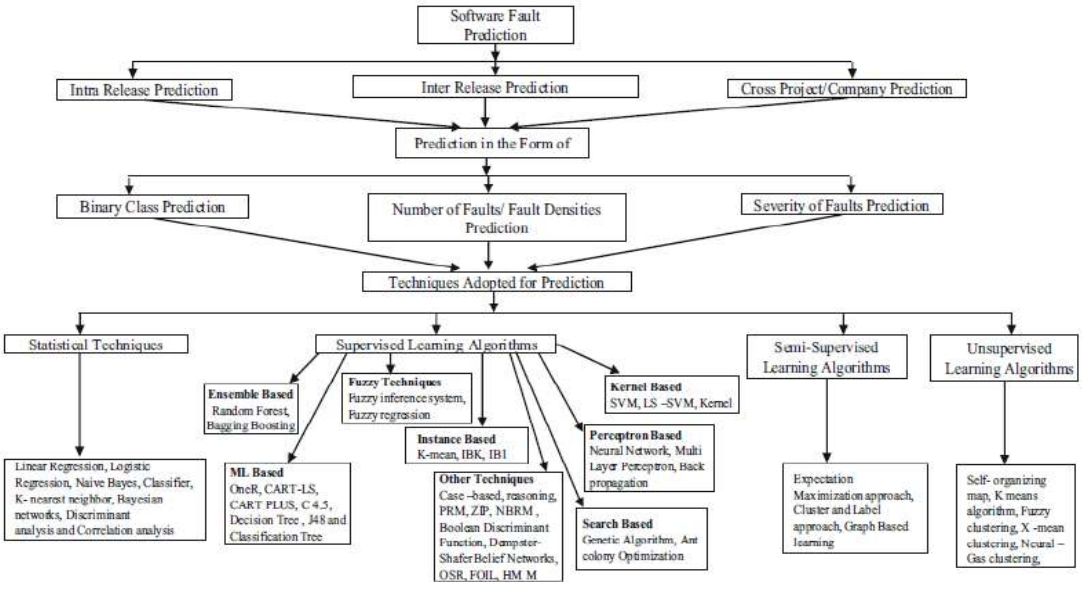


Fig. 5 Taxonomy of software fault prediction techniques

software modules into faulty or non-faulty categories (binary class classification), to predict the number of faults in a software module, or to predict the severity of the faults. Various

machine learning and statistical techniques can be used to build software fault predictionmodels. The different categories of software fault prediction techniques.

7. Performance evaluation measures

Various performance evaluation measures have been reported in the literature to evaluate the effectiveness of fault prediction models. In a broad way, evaluation measures can be classified into two categories: Numeric measures and Graphical measures. Figure illustrates taxonomy of performance evaluation measures. Numeric performance evaluation measures mainly include accuracy, specificity, f-measure, G-means, false negative rate, false positive rate, precision, recall, j-coefficient, mean absolute error, and root mean square error. Graphical performance evaluation measures mainly include ROC curve, precision-recall curve, and cost curve

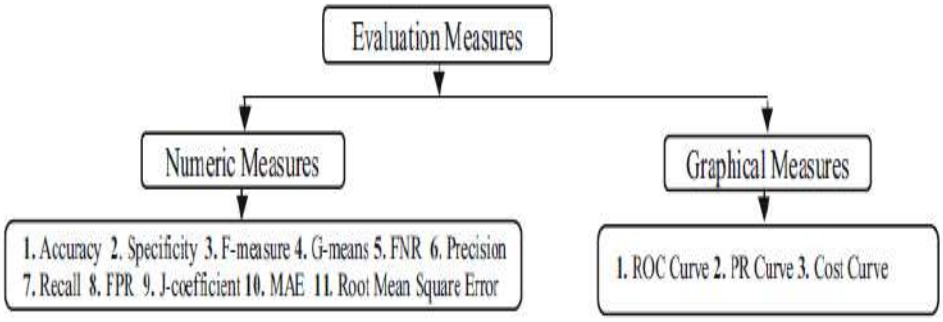


Fig. 6 Taxonomy of performance evaluation measures

8. Related Work

Defect Prediction: Accomplishments and Future Challenges by Yasutaka Kamei, EmadShihab [7] . in the context of highlighted, there have been many papers that addressed challenges related to data, metrics, model building and performance evaluation. At the same time, particular initiatives and works have had a profound impact on the area of software defect prediction, which we listed as game changers. OSS projects providing rich, extensive, and readily available software repositories; the PROMISE repository providing SE researchers with a common platform to share datasets; the SZZ algorithm automatically extracting whether or not a change introduces a defect from VCSs, which in turn dramatically accelerated the speed of research, especially for JIT defect prediction; tools such as Weka and R providing a wide variety of data pre processing Defect Prediction Technology of software Based on Deep Neural Network [8] by analysing the characteristics of aerospace software, this paper proposes a software defect prediction method based on process measurement. ,is study proposed to combine the software process with NASA software data metrics to form a metrics set to design a measurement set oriented to the characteristics of aerospace software. we established a deep neural network through an auto encoder network model to form software defect prediction model. But this method is now only suitable for aerospace engineering software and requires manual testing of the two versions of the data as a training set to achieve better results. rough experimental analysis, the average accuracy of the prediction technology reaches 90%, which proves that the aerospace software defect prediction technology proposed in. Defect Prediction Using ANN [9] researchers explored

that the ANN is considered as one of the widely used supervised machine learning techniques to predict the defects at early stages of SDLC. It has been concluded that ANN has wide scope for software defect prediction especially when used with a hybrid approach. *e performance of proposed techniques was evaluated in terms of various measures, calculated from confusion matrix and compared with conventional base classifiers as well as with proposed optimized techniques. Fault-Detection and Fault-Correction Processes in Modelling Software by Qiuying Li and Hoang Pham. [10] In this paper, the problem of modelling software fault-detection processes and fault correction processes together with imperfect debugging and testing coverage has been investigated. From the viewpoint of fault amount instead of fault correction time delay, a new software reliability growth models. model is applied to two kinds of data sets: one that contains information not only of detected fault numbers but also corrected fault numbers, and another that contains only detected fault numbers. It should be noted that, though adding more parameters makes the software reliability model more complicated and the task of parameter estimation more difficult, by automating the calculations using software tools it is not a critical problem.

JinyinChen ,Keke Hu, Yitao Yang , Yi Liu , Qi Xuan [11] propose a collective training mechanism for defect prediction .There are two main contributions, including source data expan- sion an d adaptive weighting, in this work. First, we use several normalization methods to capture different information of source projects. Second, we comprehensively integrate the information into a collective classifier by an adaptive weighting process to get better prediction results. Devika S, Lekshmy P L [12] It helps to recognize modules that are bug- free and bug-prone in a software module. Machine learning techniques for both classification and determination are used for the purpose of software fault prediction. Software Fault Prediction is carried out prior to testing process without executing the source code, instead vital characteristics of software is taken into consideration. This early identification of faults can help software engineers to reduce the risk of system failure.the faulty modules identified by both testing phase and software prediction models where the same. Some of the issues such as imbalance of software modules, high data dimensionalities, noisy data, etc. must be dealt carefully. The functioning of Software Fault Prediction process highly depends on the use of base learners and uniqueness of software fault datasets. The above two challenges raise the need of using multiple learning techniques for predicting faults in a given software system.

9.Conclusions

The paper reviewed works related to various activities of software fault prediction such as software metrics, fault prediction techniques, data quality issues, and performance evaluation measures.From this extensive review, it can be concluded that more studies proposing and validating new software metrics sets by exploring the developer’s properties, cache history andlocation of faults, and other software development process related properties are needed.The future studies can try to build fault prediction models for cross-project prediction that can be useful for the organizations with insufficient fault project histories. The results of reviews performed in this work revealed that the performance of the different fault predictiontechniques vary with different datasets.

References

1] X. Zhang, X. Chen, J. Wang, Z. Zhan, and J. Li, (2018) "Verifiable privacy-preserving single-layer perceptron training scheme in cloud computing," Soft Computing, vol. 22, no. 23, pp. 7719–7732.

[2] B. Dhanalaxmi, Dr.G. Apparao Naidu, Dr.K. Anuradha, (2015) "A Review on Software Fault Detection and Prevention Mechanism in Software Development Activities," IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 17, Issue 6, PP. 25-30.

[3] Le Hoang Son, NakulPritam ,Manju Khari , Raghvendra Kumar ,Pham Thi Minh Phuong and Pham Huy Thong, (2019) "Empirical Study of Software Defect Prediction: A Systematic Mapping," MDPI journals .

[4] Pooja Sharma, Amrit Lal Sangal, (2022)"Examining the Predictive Capability of Advanced Software Fault Prediction Models – An Experimental Investigation Using Combination Metrics," e-Informatica Software Engineering Journal, Volume 16, Issue 1, pages: 220104, DOI 10.37190/e-Inf220104.

[5] Z. Li, X.Y. Jing, and X. Zhu, (2018)"Progress on approaches to software defect prediction," *Iet Software*, Vol. 12, No. 3, pp. 161–175.

[6] F. Matloob, T.M. Ghazal, N. Taleb, S. Aftab, M. Ahmad et al., (2021) "Software defect prediction using ensemble learning: A systematic literature review," *IEEE Access*.

[7] Yasutaka Kamei, EmadShihab., (2017) "Defect Prediction: Accomplishments and Future Challenges," Yasutaka Kamei on 31 December.

[8] Tianwen Yao , Ben Zhang, Jun Peng, Zhiqiang Han, Zhaobing Yang, Zhi Zhang, and Bo Zhang,(2022) " Defect Prediction Technology of Aerospace Software Based on Deep Neural Network and Process Measurement" Hindawi Mathematical Problems in Engineering Volume 2022, Article ID 1276830, 8 pages https://doi.org/10.1155/2022/1276830.

[9] Muhammad Adnan Khan, NouhSabriElmitwally, Sagheer Abbas, ShabibAftab, Munir Ahmad, Muhammad Fayaz , and Faheem Khan (2022) " Software Defect Prediction Using Artificial Neural Networks: A Systematic Literature Review" Hindawi Scientific Programming, Article ID 2117339, 10 pages https://doi.org/10.1155/2022/2117339.

[10] Qiuying Li 1,2,* and Hoang Pham, (2021) " Modeling Software Fault-Detection and Fault-Correction Processes by Considering the Dependencies between Fault Amounts", https://www.mdpi.com/journal/applsci,
Appl.Sci.,11,6998.https://doi.org/10.3390/app11156998.

[11] Jinyin Chen , Keke Hu, Yitao Yang , Yi Liu , Qi Xuan (2019) " Collective transfer learning for defect prediction" www.elsevier.com/locate/neucom.

Counselling of Students

Dr. Ankita Shukla
Department of Management
Assistant Professor
GNIOT Institute of Professional Studies Greater Noida UP

Introduction

Student life, though exciting, is also fraught with numerous challenges—academic pressure, emotional stress, peer pressure, and career confusion, to name a few. In such a dynamic environment, counselling plays a vital role in supporting the holistic development of students. Effective counselling not only addresses immediate issues but also helps students build resilience, emotional intelligence, and life skills.

Purpose of Student Counselling

Counselling is a professional, collaborative process that helps individuals understand and resolve personal, social, or psychological challenges. In the context of students, counselling aims to:

- Enhance academic performance
- Support emotional and psychological well-being
- Aid in career planning and decision-making
- Develop interpersonal and social skills
- Address behavioral and adjustment issues

Types of Student Counselling

1. Academic Counselling: Focuses on helping students with study habits, time management, exam anxiety, and academic planning.
2. Career Counselling: Guides students in exploring career options, understanding their strengths, and making informed career decisions.
3. Personal/Social Counselling: Addresses emotional issues, family problems, peer relationships, stress, and anxiety.
4. Behavioral Counselling: Helps students manage anger, addiction, bullying, and other behavioral concerns.

Role of the Counsellor

An effective student counsellor must:

- Listen empathetically and without judgment
- Maintain confidentiality and trust
- Use therapeutic techniques suitable for students
- Collaborate with teachers, parents, and administrators
- Provide a safe and non-threatening space for dialogue

Common Issues Faced by Students

- Examination stress and performance anxiety
- Lack of motivation or goal clarity
- Low self-esteem and body image issues

- Bullying and peer pressure
- Family conflict or dysfunction
- Depression, anxiety, and loneliness

Atypical counselling process includes:

1. Rapport Building – Creating a safe and trusting relationship
2. Assessment – Identifying the student's needs and concerns
3. Goal Setting – Clarifying what the student wants to achieve
4. Intervention – Using techniques like CBT, mindfulness, motivational interviewing
5. Follow-up – Ensuring continued support and progress

Importance of Counselling in Educational Institutions

- Promotes emotional and mental health
- Enhances academic outcomes
- Reduces dropout rates
- Improves social skills and peer relationships
- Helps create a positive school/college climate

Challenges in Implementing Student Counselling

- Lack of trained professionals
- Social stigma around mental health
- Limited awareness among students and parents
- Insufficient institutional support

Recommendations

- Appoint qualified counsellors in all educational institutions
- Create awareness campaigns to normalize help-seeking behavior
- Train teachers in basic counselling skills
- Establish peer counselling and mentoring systems
- Integrate life skills education in curriculum

Conclusion

Counselling is not a luxury but a necessity in today's complex educational landscape. A well-structured counselling program can empower students to navigate academic and personal challenges effectively, making them more confident, competent, and compassionate individuals.

CURRENT DEVELOPMENTS IN LIBRARY ANDINFORMATION SCIENCE

Niharika Das
*Alumni, Cotton University,Assam

Abstract:

The field of Library and Information Science (LIS) is undergoing continuous change, and the librarians must stay updated with the most recent trends in the ever-evolving area of library science in order to give their patrons the best service possible. A notable development is the integration of digital technologies to enhance the management of library resources and services, such as online reference tools and digital archives. Furthermore, libraries are placing a stronger emphasis on diversity, equity, and inclusion, not only within their collections and services but also in their hiring practices and staffing. The increasing emphasis on data management, with libraries offering services like data curation and analysis, is another significant trend in LIS. Additionally, libraries are increasing their outreach efforts to interact with underprivileged groups through social media and other platforms, and user-centred services and personalised experiences are becoming increasingly common in library services.These trends reflect how LIS is adapting to meet evolving user demands and technological advancements. This paper explores the various cutting-edge technological tools and their applications within the field of Library and Information Science.

Keywords:

Collection Management, Electronic Resource Management, Library & Information Science (LIS), ICT, Digital Displays.

Introduction:

For generations, libraries have played a crucial role in society by serving as centres of knowledge and facilitating access to information. The activities of libraries have been completely transformed by the introduction of information and communication technology (ICT). One noteworthy outcome is the digitisation of information, where libraries transform their holdings into online versions by using digital resources and the internet. This has greatly expanded the availability of information, enabling people to easily access resources at their convenience and from any location in the world. Additionally, the well-structured and highly searchable digital content makes it easier for users to get information.

Libraries' operational landscape is being reshaped by the expanding influence of ICT. Libraries now provide a wide range of online services, such as virtual reference help, e-book lending, and digital catalogues. These online services improve accessibility and convenience by letting patrons access library materials from the comfort of their homes or places of their employment. ICT solutions have also given libraries the ability to manage their assets and collections more skilfully. Additionally, data analytics has become a useful tool that helps guide well-informed decisions on resource allocation and collection development while offering insights into resource utilisation. As a result, we can conclude that libraries are adapting to changes in the outside world and making every effort to reach and serve their patrons. By employing the newest digital technology, the article examines current developments in library and information services.

Objectives:

- To acknowledge the usage of the newest technology in libraries.
- To comprehend how libraries manage their electronic resources.
- To talk about the function of libraries by utilising the newest trends and technologies.
- To comprehend how to apply the newest technological trends to elevate library services through the utilisation of gamification, and digital displays.

Current Library and Information Science Trends:

The most recent developments in the field of Library and Information Science are grouped into three distinct areas:

1. Collection Management:

Libraries are frequently identified by their collections, which serve as information repositories and points of access. The process of obtaining, classifying, preserving, and assessing the items in a library or information centre is known as collection management.New digital forms, in addition to books, newspapers, magazines, and audio-visual information, greatly expand library resources in the twenty-first century.A crucial aspect of library and information science is collection management, which makes sure that the resources in the library are current, pertinent, and suit the demands of its patrons. Some of the advancements in collection management that are being used to make vast volumes of information available to everyone are listed below.

1.1 Electronic Resource Management:

The process of obtaining, classifying, preserving,and assessing electronic resources—such as databases, e-books, e-journals, and multimedia materialsin a library or information centre is known as electronic resource management, or ERM. ERM assists librarians in monitoring what is and isn't accessible, who is using it, and which specific items are most helpful to patrons. All of this makes it easier to construct and manage collections.

1.2 Federated Search:

Users can search numerous databases and resources at once using a single search interface with the help of a search technology called federated search (FS). Without having to go through each resource's interface individually, FS enables users to search many resources from various publishers, providers, and platforms simultaneously. Because it gives users a more effective and efficient way to search for material, FS is growing in popularity in libraries. Federated search is a potent search technique that enables users to use a single search interface to look up to various resources at once. Metadata harvesting, search interfaces, authentication, search queries and results, integration and customisation, and upkeep and upgrades are all essential components of federated search systems.

1.3 Cloud Computing:

Using distant servers on the internet to store, manage, and process data rather than depending on a local server or personal computer is known as cloud computing. Because

cloud computing has so many advantages, such as cost savings, flexibility, scalability, and accessibility, it is becoming more and more popular in libraries.

2. User Engagement:

The primary purpose of a library, above all else, is to educate and enhance the lives of its users. The fact that libraries have remained effective despite the availability of so many other diversions is evidence of their strength. Libraries' success can be attributed in part to their adoption of new technologies. Hopefully, library stacks will always be there for us to peruse, but in order to keep users interested, the following technological advancements have been incorporated.

2.1 Digital Displays:

Electronic screens with the ability to show pictures, videos, and other digital content are referred to as digital displays. Digital displays are used in libraries to inform patrons, advertise events and services, and grant access to digital collections.

2.2 Gamification:

In order to inspire and captivate people, gamification entails introducing game features like leader boards, points, and icons into non-gaming contexts. Games can be used by libraries to promote reading and learning, increase public knowledge of their resources and services, and create a fun and engaging user experience.

3. Security:

The issue of safe information is far more significant now than it was when the only concern was that someone may be looking through a drawer full of index cards. This is because libraries are growing more and more dependent on technology and digital engagement. These developments are assisting libraries in maintaining security.

3.1 Single Sign-On:

With this automatic authorisation method, a user simply needs to click on one link to gain access to the system after being validated. Single sign-on not only eliminates the need for more intricate verification procedures, but it also personalises the patron/library experience by utilising the same technology that identifies the user to "remember" the information services the user uses most frequently.

3.2 Radiofrequency Identification:

This technology enables libraries to tag and monitor objects from their collection using radio waves. This improves security by preventing theft of the library's inventory, facilitates the check-in and check-out procedures for users, and enables librarians to promptly ascertain whether an item is accessible or on loan.

Conclusion:

A user-centred approach for service delivery is becoming more and more popular in libraries, emphasising the value of comprehending and satisfying the requirements of library patrons. This strategy entails interacting with customers directly, getting their input, and customising offerings to fit their needs. The newest technology is used by libraries to provide efficient services such. The library's resources are kept current, relevant, and user-friendly

through efficient collection management. ERM guarantees that electronic resources fulfil the goals and mission of the library and are discoverable and accessible. Cloud computing can be used by libraries for a variety of purposes, including data analysis and visualisation, digital preservation, virtual reference and collaboration tools, storage, and library administration systems. Users can search several resources at once using a single search interface thanks to federated search, a potent search tool. Digital displays are a flexible tool that can be used to enlighten patrons, advertise library services, and improve the user experience. Libraries are increasingly utilising gamification and augmented reality as tools to improve user engagement and the educational process. As a result, technology will remain a significant component of libraries in the future, and they have the opportunity to update to the newest trends and meet user satisfaction objectives in effective and efficient ways.

References:

Uddin, J., & Hasan, N. (2012). Use of information technology in library service: A study on some selected libraries in Northern part of Bangladesh. *International Journal of Library and Information Science* Vol. 4(3), pp. 34-44, March 2012 available on https://academicjournals.org/article/article1379684073_Uddin%20and%20Hasan.pdf

D'silva& P. Balasubramanian (2022) Emerging Technological Trends in Library Management and Services. *Journal of Advances in Library and Information Science*, Vol.11, No 2. April-June. 2022, pp-172-180 available on http://jalis.in/pdf/11-2/Divina.pdf

Chandwani, A. (2023). Latest Trends in Library and Information Science. *International Research Journal of Humanities and Interdisciplinary Studies (IRJHIS)*, *4*(3), 147–154. https://doi.org/03.2021-11278686

Beschler, M. (2022). *Latest Trends in Library and Information Science*. https://resources.noodle.com/articles/latest-trends-in-library-and-information-science/

Throat, A. A. (2024). Futuristic Trends in Library and Information Science. In *Futuristic Trends in Social Sciences* (20th ed., Vol. 3, pp. 51–58). https://iipseries.org/assets/docupload/rsl2024DD01DFFB655FD2F.pdf

Deep Learning and Its Applications – An Overview

Dr. S.Kavitha,
Assistant Professor, Department of BCA,
Agurchand Manmull Jain College, Chennai – 600061, Tamilnadu, India.

Deep learning is a subset of **machine learning** in artificial intelligence (AI) that uses algorithms inspired by the structure and function of the brain called **artificial neural networks**. It focuses on learning from vast amounts of data, making it capable of discovering complex patterns and representations automatically, without manual feature extraction.

It's called "deep" because these networks have many (deep) layers of neurons.

Key Components of Deep Learning

1. **Neural Networks**: The foundation; consists of input, hidden, and output layers.
2. **Backpropagation**: Algorithm used for training the network by adjusting weights.
3. **Activation Functions**: e.g., ReLU, Sigmoid, Tanh – they introduce non-linearity.
4. **Optimization Algorithms**: Like Gradient Descent, Adam – they minimize loss.
5. **Large Datasets and Computing Power**: Required for deep learning to be effective.

Popular Deep Learning Architectures

- **CNNs (Convolutional Neural Networks)**: Primarily for image data.
- **RNNs (Recurrent Neural Networks)** and **LSTMs**: Time series, sequential data, language.
- **Transformers**: Dominant in NLP (e.g., GPT, BERT).
- **GANs (Generative Adversarial Networks)**: For generating realistic data/images.
- **Autoencoders**: For data compression and noise reduction.

Applications of Deep Learning

1. Computer Vision

- Image classification (e.g., cats vs dogs)
- Facial recognition (e.g., iPhone FaceID)
- Object detection (e.g., autonomous vehicles)
- Medical imaging (e.g., detecting tumors in MRIs)

Computer Vision Applications in Deep Learning

Computer Vision enables machines to "see" and interpret visual information, much like humans do. Deep learning, particularly **Convolutional Neural Networks (CNNs)**, has dramatically improved performance in various computer vision tasks.

1. Image Classification

→ **Example:** Classifying images of cats vs dogs

- Assigns a label to an entire image.
- Each image is classified into one of many predefined categories.

- Deep learning models (especially CNNs) learn to detect patterns like edges, textures, shapes, and objects.
- Over multiple layers, the model learns hierarchical features, from simple (edges) to complex (entire objects).

Real-world use cases:

- Identifying products in e-commerce.
- Categorizing images on social media.
- Animal or plant species identification via mobile apps.

2. Facial Recognition

Example: Apple's Face ID

- Identifies or verifies a person based on facial features.

- Used for security (unlocking phones, surveillance), tagging in photos, and attendance systems.Deep networks extract facial landmarks (eyes, nose, mouth, etc.).
- These features are mapped into a high-dimensional "face embedding" space.
- Recognition is performed by comparing this embedding with stored data.

Real-world use cases:

- Phone unlocking (Face ID)
- Airport security and border control
- Law enforcement and public safety
- Smart home devices (e.g., personalized user profiles)

3. Object Detection

Example: Detecting cars and pedestrians in self-driving vehicles

- Locates and classifies multiple objects within an image.

- Outputs both **class labels** and **bounding boxes** for each object. Uses models like **YOLO (You Only Look Once)**, **SSD (Single Shot MultiBox Detector)**, or **Faster R-CNN**.

- Combines feature extraction with region proposal networks.

Real-world use cases:

- Autonomous driving (detecting traffic signs, other vehicles, pedestrians)
- Surveillance and security monitoring
- Industrial robotics (identifying objects on a conveyor belt)
- Augmented reality (overlaying digital content on physical objects)

3. Object Detection

→ **Example:** Detecting cars and pedestrians in self-driving vehicles

What it does:

- Locates and classifies multiple objects within an image.
- Outputs both **class labels** and **bounding boxes** for each object.

How it works:

- Uses models like **YOLO (You Only Look Once)**, **SSD (Single Shot MultiBox Detector)**, or **Faster R-CNN**.
- Combines feature extraction with region proposal networks.

Real-world use cases:

- Autonomous driving (detecting traffic signs, other vehicles, pedestrians)
- Surveillance and security monitoring
- Industrial robotics (identifying objects on a conveyor belt)
- Augmented reality (overlaying digital content on physical objects)

4. Medical Imaging

Example: Detecting tumours in MRI or CT scans

- Analyses medical images to detect abnormalities, segment tissues, or classify diseases.
- Enhances accuracy and speed of diagnosis.

- CNNs and sometimes 3D CNNs are trained on labeled medical images.
- These models learn patterns associated with diseases like cancer, pneumonia, etc.

Real-world use cases:

- Tumour detection (brain, breast, lung)

- Diagnosing diabetic retinopathy from eye scans
- Segmenting organs and lesions in CT/MRI scans
- Assisting radiologists in early detection and decision-making

2. Natural Language Processing (NLP)

- Language translation (Google Translate)
- Text generation (ChatGPT □)
- Sentiment analysis (analyzing customer reviews)
- Speech recognition (Siri, Alexa)

Natural Language Processing (NLP) is a field of artificial intelligence that enables machines to understand, interpret, and generate human language. With the rise of deep learning, especially models like **RNNs**, **LSTMs**, and **Transformers**, NLP has seen major breakthroughs in both accuracy and usability.

Language Translation (e.g., Google Translate)

Language translation involves converting text or speech from one language to another while preserving the original meaning. Deep learning has revolutionized machine translation through the use of **sequence-to-sequence models** and **Transformer architectures**, which learn to understand grammar, context, and semantics across languages. For example, Google Translate now uses deep neural networks to provide more fluent and contextually accurate translations than earlier rule-based systems.

Text Generation (e.g., ChatGPT)

Text generation is the process of producing human-like text based on a given prompt or input. Deep learning models, especially large-scale **Transformers** like **GPT (Generative Pre-trained Transformer)**, are capable of generating coherent and contextually relevant paragraphs, articles, or even conversations. ChatGPT, for instance, can write essays, answer questions, simulate dialogue, and assist with a wide range of writing tasks by predicting and generating the most likely next words in a sentence based on its training data.

Sentiment Analysis (e.g., Analyzing Customer Reviews)

Sentiment analysis aims to detect the emotional tone behind a piece of text, such as whether a product review is positive, negative, or neutral. Deep learning models learn to identify subtle cues in language, like word choice and sentence structure, that indicate sentiment. Businesses often use sentiment analysis to understand customer feedback, monitor brand reputation, and make data-driven decisions based on public opinion.

Speech Recognition (e.g., Siri, Alexa)

Speech recognition converts spoken language into written text, enabling voice-controlled systems like **Siri**, **Alexa**, and **Google Assistant**. Deep learning models, particularly those using **RNNs** and **attention mechanisms**, have significantly improved the accuracy of recognizing spoken words across various accents, languages, and environments. These systems not only transcribe speech but also interpret voice commands and trigger relevant actions (like setting a reminder or playing music).

3. Autonomous Vehicles

- Object detection and tracking
- Lane detection

Decision-making in navigation

Autonomous vehicles rely heavily on **deep learning** to perceive their environment, understand the road, and make driving decisions in real time. These systems use a variety of sensors (like cameras, LiDAR, and radar) along with neural networks to interpret data and ensure safe and efficient driving.

Object Detection and Tracking

Object detection and tracking is essential for identifying and monitoring surrounding elements such as cars, pedestrians, traffic signs, cyclists, and other road objects. Deep learning models like **YOLO (You Only Look Once)** and **Faster R-CNN** are used to detect multiple objects within each frame captured by the vehicle's cameras. Once detected, **tracking algorithms** follow the movement of these objects over time to anticipate behaviour, avoid collisions, and make informed driving decisions.

Lane Detection

Lane detection enables the vehicle to identify and stay within road lanes, a fundamental aspect of autonomous navigation. Deep learning models trained on annotated road images can recognize lane markings even in challenging conditions like faded lines, poor lighting, or rain. These models generate **segmentation maps** or **lane boundary coordinates**, which help the vehicle, maintain lane discipline, change lanes safely, and navigate through intersections.

Decision-Making in Navigation

Decision-making involves interpreting sensor data and making real-time driving choices such as when to accelerate, brake, change lanes, or yield. Deep reinforcement learning and neural networks help model the driving policy by simulating countless driving scenarios. The vehicle uses this learned knowledge to predict the behavior of other road users and make safe and optimal decisions, just like a human driver would under complex road conditions.

4. Healthcare

- Disease prediction and diagnosis

- Drug discovery
- Personalized treatment plans
- Medical image analysis

Deep learning is transforming the healthcare industry by enhancing the accuracy, efficiency, and personalization of medical services. By analyzing vast amounts of complex medical data, deep learning models assist healthcare professionals in delivering faster and more precise diagnoses and treatments.

Disease Prediction and Diagnosis

Deep learning is widely used to predict and diagnose diseases by analyzing patterns in medical data such as electronic health records (EHRs), lab results, and patient history. These models can detect early signs of conditions like diabetes, cancer, heart disease, and neurological disorders. For instance, deep learning can identify subtle symptoms that may go unnoticed by humans, enabling early intervention and improved patient outcomes.

Drug Discovery

In drug discovery, deep learning accelerates the process of identifying new drug candidates by analyzing the interactions between chemical compounds and biological systems. Neural networks can predict how a drug will behave in the body, reducing the need for lengthy lab testing. This not only shortens the development cycle but also helps in identifying repurposed drugs for existing diseases, including emerging conditions like COVID-19.

Personalized Treatment Plans

Deep learning enables personalized medicine by tailoring treatment plans based on a patient's unique genetic makeup, lifestyle, and medical history. Models can predict how different patients will respond to specific treatments, allowing doctors to choose the most effective therapy while minimizing side effects. This approach is especially valuable in areas like oncology, where treatment responses can vary significantly between individuals.

Medical Image Analysis

Medical image analysis is one of the most impactful areas where deep learning is used to examine X-rays, MRIs, CT scans, and other imaging data. Convolutional Neural Networks (CNNs) are particularly effective at detecting anomalies such as tumors, fractures, or organ damage with high accuracy. These models assist radiologists in diagnosing conditions faster and more accurately, even in early stages of disease progression.

5. Gaming and Entertainment

- Realistic NPC behavior

- Voice synthesis and real-time translation
- Deepfake creation and detection

Deep learning is increasingly shaping the future of gaming and entertainment by making experiences more immersive, interactive, and intelligent. From lifelike characters to advanced voice technology, these innovations are enhancing how users engage with digital content.

Realistic NPC Behavior

Deep learning enables non-player characters (NPCs) in games to exhibit more realistic, human-like behavior by learning from player actions and adapting over time. Instead of following scripted patterns, NPCs can use reinforcement learning to make decisions based on the game environment, making gameplay more dynamic and engaging. This allows for more unpredictable and personalized gaming experiences, where each player's interaction can lead to different outcomes.

Voice Synthesis and Real-Time Translation

Voice synthesis powered by deep learning allows games and entertainment platforms to generate natural-sounding speech, enabling characters to speak in different voices and languages with human-like tone and emotion. Additionally, real-time translation systems use deep learning models to instantly convert spoken or written dialogue between languages, breaking language barriers in online multiplayer games, live streams, and international media.

Deepfake Creation and Detection

Deep learning is used to create **deepfakes**, which are highly realistic synthetic videos or images where one person’s face or voice is replaced with another’s. While deepfakes can be used for entertainment—such as recreating actors for movie scenes or creating realistic avatars—they also pose ethical concerns. As a countermeasure, deep learning is also used to detect deepfakes by identifying subtle inconsistencies in facial movements, lighting, or audio, helping prevent misuse in media and online platforms.

6. Social Media & Recommendation Systems

- Content filtering and moderation
- Personalized recommendations (YouTube, Netflix)
- Ad targeting

Deep learning plays a crucial role in enhancing user experience on social media platforms and streaming services by making content smarter, safer, and more relevant. These systems rely on vast user data and powerful neural networks to tailor content, detect harmful material, and deliver targeted advertising.

Content Filtering and Moderation

Deep learning is used to automatically detect and remove inappropriate or harmful content such as hate speech, violence, nudity, or misinformation. By analyzing text, images, and videos, neural networks can identify violations of community guidelines more efficiently than manual moderation. This helps platforms like Facebook, Instagram, and TikTok maintain a safe and respectful environment for users across the globe.

Personalized Recommendations (e.g., YouTube, Netflix)

Recommendation systems powered by deep learning analyze a user's viewing history, preferences, and behavior to suggest content that is most likely to be of interest. Models like collaborative filtering and deep neural networks help platforms like YouTube and Netflix recommend videos, movies, or shows that are tailored to each individual. This personalization keeps users engaged for longer periods and enhances overall satisfaction.

Ad Targeting

Deep learning is also used for ad targeting by predicting which advertisements are most relevant to each user based on their browsing behavior, interests, demographics, and engagement patterns. These models help deliver highly personalized ads that increase click-through rates and improve advertiser ROI. Platforms like Google, Instagram, and Twitter use such systems to ensure that users see ads that match their interests and needs.

Challenges in Deep Learning

- Requires large labeled datasets
- Computationally expensive (need GPUs/TPUs)
- Interpretability – often a "black box"
- Susceptible to adversarial attacks

Despite its powerful capabilities, deep learning comes with several limitations and challenges that affect its scalability, reliability, and adoption in certain domains.

1. Requires Large Labeled Datasets

- Deep learning models, especially supervised ones, need **huge amounts of labeled data** to learn effectively.
- For tasks like image classification or object detection, each data sample must be **manually labeled**, which can be time-consuming and expensive.

- In specialized domains (e.g., medical imaging), acquiring labeled data requires **expert knowledge** (like radiologists labeling CT scans).
- In low-resource languages or niche applications, large datasets might simply not exist.

Example:

- Training an autonomous vehicle model may require **millions of labeled images/videos** showing various traffic conditions, objects, and road scenarios.

Possible Solutions:

- Transfer learning (using pre-trained models)
- Data augmentation
- Semi-supervised or self-supervised learning

2. Computationally Expensive (Need GPUs/TPUs)

- Deep learning models involve millions (sometimes billions) of parameters.
- Training and even inference can require **high-performance hardware** like **GPUs (Graphics Processing Units)** or **TPUs (Tensor Processing Units)**.

Why it's a problem:

- Not everyone has access to this kind of infrastructure.
- Running deep models on devices with limited power (e.g., smartphones or IoT devices) is challenging.
- Energy consumption and carbon footprint are becoming significant concerns.

Example:

- Training GPT-like language models can cost **millions of dollars in compute** and consume significant energy.

Possible Solutions:

- Model compression (quantization, pruning)
- Edge AI (optimized models for mobile/embedded systems)
- Using cloud-based AI services

3. Interpretability – Often a "Black Box"

What it means:

- Deep learning models can make **accurate predictions**, but they don't easily explain **why** or **how** they arrived at a decision.
- This lack of transparency can be a problem, especially in **sensitive fields like healthcare, finance, or law**.

Why it's a problem:

- Users and regulators need to **trust AI decisions**.
- Difficult to debug or improve models when the internal logic isn't clear.
- In critical applications, explainability is a legal requirement (e.g., GDPR's "right to explanation").

Example:

- A model predicts that a patient has a high risk of cancer, but cannot clearly explain which features of the scan led to this conclusion.

Possible Solutions:

- Explainable AI (XAI) tools like LIME, SHAP
- Attention visualization in models
- Simpler surrogate models for interpretation

4. Susceptible to Adversarial Attacks

What it means:

- Deep learning models can be **fooled** by small, intentional modifications to input data that are imperceptible to humans but cause incorrect predictions.

Why it's a problem:

- This creates **security vulnerabilities**, especially in high-stakes systems like facial recognition or autonomous vehicles.
- Models may fail catastrophically if inputs are slightly tampered with.

Example:

- An attacker adds tiny noise to a stop sign image, and the model **misclassifies it as a speed limit sign**—a critical error for a self-driving car.

Possible Solutions:

- Adversarial training (training on both clean and adversarial examples)
- Robust architectures
- Input sanitization techniques

The Future of Deep Learning

- **Smaller, more efficient models** (e.g., MobileNet, TinyML)
- **Cross-domain models** that combine vision, language, and audio
- **Better interpretability and transparency**
- **Continual and few-shot learning** (learning from less data)

As deep learning continues to evolve, researchers and developers are working to overcome current limitations and expand the possibilities of AI. The future of deep learning is focused

on making models more efficient, versatile, understandable, and capable of learning in more human-like ways.

Smaller, More Efficient Models (e.g., MobileNet, TinyML)

The future of deep learning includes the development of lightweight models like **MobileNet** and **TinyML**, which are designed to run on mobile devices and edge hardware with limited computing power. These efficient models make it possible to deploy AI in smartphones, wearables, and IoT devices, enabling real-time intelligence without relying on cloud servers.

Cross-Domain Models That Combine Vision, Language, and Audio

Deep learning is moving toward **multimodal models** that can process and understand multiple types of input—such as images, text, and audio—simultaneously. These cross-domain models (like OpenAI's CLIP or Google's Gemini) are capable of performing complex tasks such as describing images in natural language or answering questions about video content, leading to more holistic and human-like AI systems.

Better Interpretability and Transparency

As deep learning becomes more integrated into critical fields like healthcare and finance, there is a growing need for **explainable AI** that offers transparency in how decisions are made. Future models are being designed with built-in interpretability tools to help users understand the reasoning behind AI outputs, increasing trust, accountability, and ethical use of AI technologies.

Continual and Few-Shot Learning (Learning from Less Data)

Future deep learning systems aim to learn in a more flexible and efficient way, similar to how humans do. **Continual learning** allows models to keep learning new tasks without forgetting previous ones, while **few-shot learning** enables models to understand and perform tasks using only a small number of examples. This shift reduces the need for massive datasets and allows AI to adapt to new information quickly and efficiently.

Expression of Identity Crisis in Diaspora Literature : Reference to Indian English Novel

Dr. Nitin K. Deshmuk
Head, Dept. of English
Shri Vasantrao Naik Mahavidyalaya Dharni, District Amravati, Maharashtra

Abstract
This paper attempted a comprehensive approach in the process of describing the development of Indian diasporic writing, its nature and function with proper referencing the literature of these Indian expatriates towards. The diaspora literature throbs with the sense alienation and they presents a quest for identity of the man in the midst of multicultural phenomenon. The man feels nostalgic and experiences a type of rootlessnes which bring in loneliness and separation from the mother land creating a void in his mind. The literary works mentioned are authored by one of the well diaspora writers listed by the literary historigraphers and critics.

Introduction

The practice of expressing immigrant feelings and emotions is as old as the diaspora itself, according to the history and evolution of Indian diasporic literature. In this sense, Dean Mohamed, who was born in Patna, India, is the most notable example of Indian writing in English in the field of dispora writing. The Travels of Dean Mahomet, the first English-language publication by an Indian, was published in 1794. "Imaginary History" by Kylas Chunder Dutt came next. 1835 saw the publication of A Journal of Forty-Eight Hours of 1945, and in 1864, Bankim Chandra Chatterjee's Rajmohan's Wife This demonstrates how the Indian Diaspora has contributed to Indian English writing for an equally long time. English was also used by the offspring of the Indian indentured servants known as "girmit colonies."

The Journey of Indian Diaspora

Notable contributors in this discipline include second-generation writers Prasad Naipaul, Shiva Naipaul, V. S. Naipaul, Cyril Dabydeen, David Dabydeen, Sam Selvon, M.G. Vassanji, Subramanian, K.S. Maniam, Shani Muthoo, and Marina Budos. Characters from V. S. Naipaul, such as Mohan Biswas and Ganesh Ramkumar, are depictions of men living outside of their own India. A feeling of displacement and dislocation governs these characters. As Rushdiie puts it, "the past is a country, from which we have all emigrated, that its loss is part of our common humanity." Rushdie (1991:87) In fact, Raja Rao, G. V. Dasani, Santha Rama Rau, Dhal Chandra Rajan, Nirad Chaudhari, and Ved Metha are the forerunners of first-generation diaspora writing. While they were gone from India, they documented their experiences and reflected on India. It demonstrates how detachment is provided by distance.

These contemporary diasporic Indian writers belong to two groups: those who were reared outside of India from an early age and those who have lived in India for a portion of their lives and have brought their belongings back to their home country. The former group felt rootedless after experiencing factual relocation. These authors explore the themes of displacement, alienation, assimilation, acculturation, etc. while presenting immigrant characters in their work. When seen against the backdrop of the enormous Indian subcontinent's geopolitics, the representation of dislocated characters by diasporic Indian

writers assumes great relevance. Such works have a global readership and enduring appeal precisely for this reason. These authors also portrayed the benefits of relocation.

Living as a migrant has advantages, such as the chance to encounter many cultural forms and have a dual viewpoint. This benefit frequently makes it possible for diasporic Indians, especially those from the second generation, to deal with the challenge of having two identities. Their psychology suffers from existential torment as a result of this ambivalence. Jhumpa Lahiri, Sunetra Gupta, Hari Kunzru, Meera Syal, and Shashi Tharoor are among the writers from the second generation of diasporic Indian writers. The lifestyles of the first and second generation immigrants have been accurately portrayed.

Different responses to comparable situations by Indian, Western, and diasporic characters in their writings differ only in appearance; in reality, they show the same core demands of all people. In contrast to the first generation of Indian diaspora writers, these postmodern Indian English writers have focused on a whole new range of topics that highlight life in the age of globalization. These include feminism, queer theories, glamour, consumerism, commoditization, upward mobility, the deterioration of ethical values, and multiculturalism.

In academic discourse, the term "Indian diaspora" has been used frequently recently to refer to authors from the Indian subcontinent. Critics have given enough attention to diasporic writing in English, but Indian language literature has not gotten the respect it deserves. A sizable portion of authors write in their native Indian languages. Language is a crucial tool for preserving ethnic identity and setting one group apart from another. Such a study is also important for Western people, as it would shed some light on the nature and dynamics of Indian society and culture Because English-language writing predominated, regional diaspora literature attempted to integrate into mainstream literature for a very long time but was unsuccessful.

Early migrants relied on their native tongues, and migrant oral narratives were narrated in their vernacular languages, but not in written narratives. Diaspora literature in Indian Languages has been present for some time now but has not acquired public visibility, and there has been a constant struggle of Indians to promote their works written in Indian languages. The diasporic writers writing in vernacular languages say that they have their own style with which they express their emotions and ideas freely. In this multicultural society, they aim to protect their mother tongues.

The diasporic authors who write in Indian languages aspire for the next generation to be exposed to their language and literature. This group writes for immigrant people of their cultures only, and speaks only to the native readership in the diaspora. They acknowledge that they are the audience, readers, critics, poets, and authors. They write to cherish their community’s past and a fear of loss of this past makes them want to preserve their language.

Initially, diasporic literature in native languages began as a space of expression. It was used as a vent for the emotional outflow for most of the migrants. As such, most of the diasporic writers who write in native languages do not belong to an academic background, unlike those who are writing in English. Most of them work as doctors, engineers or are simple homemakers, who chose to immigrate. Writing gave them an opportunity to maintain their languages which constructed the diasporic culture, without them needing to go back to India to do so.

Recent Indian Diasporic Literature in English English-language works of the Indian diaspora have become well-known in both academia and popular culture, and there is no shortage of examples of these works being made into movies. Therefore, there are opportunities to explore diasporic cultural identities even in diasporic cultural texts (documentaries/films). As stated by Stuart Hall in Cultural Identity and Diaspora (1990), "there are at least two different ways of thinking about cultural identity...one in the term of shared culture and second of what we are." This realization clarifies the diasporic stories that depict the challenges of striking a balance between the values of the new and adopted place and the "home." The differences across cultures and the efforts of immigrant families to manage the many and occasionally conflicting customs equitably are shown in novels such as The Namesake. Second-generation diasporic author Jhumpa Lahiri creates characters who are torn between these intractable divisions and who attempt to find a sense of balance or equilibrium between their Indian and American identities.

At the beginning of the book, Ashima Ganguly is standing in her Cambridge flat in Central Square on a wintry afternoon, making a snack to quench her hunger. Ashima Ganguly is standing in the kitchen of an apartment building in Central Square, mixing Rice Krispies, Planters peanuts, and chopped red onion in a bowl on a sticky August evening, two weeks prior to her due date. The protagonist's attempts to strike a balance between the West and the East are introduced in these first words of Lahiri's *The Namesake*. Readers may have noticed that "Planters" peanuts not just any peanuts are used to make this Indian street food.

The author introduces the readers to the experience of East and West meeting by mentioning the peanut manufacturing enterprise. Ashima combining it with Planters peanuts and Rice Krispies signifies a diasporic absorption of the two cultures, even though food itself denotes cultural fusion. "Modern Indians see themselves as global citizens and aspire to make use of the 'best of both worlds,'" according to Amartya Sen. They find no conflict in remaining devoted citizens of the nation from which they have emigrated, even though they still feel a sense of connection and camaraderie with India and Indians.

The Argumentative Indian: Writings on Indian History, Culture, and Identity. With every movement, Ashima tries to produce this "best-of-both-worlds." She hopes that Gogol, her son, who was born and raised in the United States, will have an American perspective and an Indian way of thinking. She forces him to study English in order to aid in his assimilation into his nation while simultaneously teaching him Tagore to familiarize him with Bengali culture.

Later on in the book, we find Ashima attempting to keep her traditions while also adjusting to the new changes in her new society. Ashima eventually finds a job at the library, develops her self-assurance and poise, and assumes responsibility for taking care of her house and her children. Finally, she realizes that this "diaspora" is a dynamic area that adapts to new developments. Her family and other immigrants can develop new and hybrid diasporic identities here. You Are What You Wear by Jennifer Baumgartner helps readers comprehend that one’s physical and psychological identities are connected. Most commonly, persons are identified via the clothes they wear, that indicate their national or cultural identity. Chitra Banerjee Divakaruni utilizes the metaphor of clothes to express the metamorphosis of a newly wedded wife from a conventional, bashful young woman, into a bold and strong persona.

Her short tale “Clothes” in Arranged Marriage illustrates the character’s perception of a modern society following an exposure to the West. Sunita's evolving style throughout her life represents her evolving traits, demonstrating her decision to embrace a hybrid modernism that aims to accommodate both the Indian and the adopted foreign. “The T-shirt is sunrise-orange-the colour, I decide, of joy, of my new American life. Across its middle, in large black letters, is written Great America.” (Chitra Divakaruni, 1995)

In current times, the New Diaspora has chosen to go in a diasporic direction toward modernity. They choose to migrate voluntarily, and the educated elite who work for better firms and are in higher social positions make up the majority of the New Diaspora. These migrants attempt to establish global identities and integrate into new cultures. These migrant groups support the nation's transition to modernity and globalization.

In his book Inscrutable Americans, Anurag Mathur makes fun of the "half-baked" Indians in contemporary America. Reading this article demonstrates that in order to promote constructive change in the country of origin (India), people must be able to go from one place to another. Gopal's experiences throughout the book highlight the disparities between America and India as well as the need for globalization in India. The fear of a new, "global" India is further depicted in the book. Toward the conclusion of the book, the author attempts to show that change involves more than just monetary gains and benefits; it also entails an immigrant's psychological desire for a better home country.

Conclusion

Nearly two centuries of diasporic literature have changed how people perceive a "nation," in this case India. In a similar vein, contemporary Indian cinema portrays more of the West, substituting the diaspora for the native nation. Films like My Name is Khan (2010), Namstey London (2007), and Kuch Kuch Hota Hai (1998) depict how immigration into a country with diverse beliefs and customs has altered family and societal structures. Although the characters adjust to Western civilization, their "Indian" customs also provide balance. In addition to winning literary awards, writers from the Indian diaspora have left their impact. The Indian diaspora, which is dispersed among 125 nations and six continents, has established homes away from home.

Reference:

Salman Rushdie, Imaginary Homelands: Essays and Criticism 1981-1991, Publisher:Random House, 24 August 2012.

Safran, William. Diasporas in Modern Societies Myths of Homelands and Return. Diaspora II, Spring, 1991, (pp- 23)

Safran, William. Diasporas in Modern Societies Myths of Homelands and Return.

Diaspora II, Spring, 1991, (pp- 83)Rushdie, Salman. Imaginary Homelands. London, Granta Books, 1991. (p 10).

Safran, William. Step Across This Line. London, Jonathan Cape, 2002. (pp 115)

DIASPORA, IDENTITY, AND MYTH IN GITHA HARIHARAN'S *THE THOUSAND FACES OF NIGHT*: A THEMATIC STUDY

Dr. A. Mohanraj
Assistant Professor in English
VHNSN College (Autonomous), Virudhunagar,

Dr. N. Arunkarthik,
Assistant Professor in English
VHNSN College (Autonomous), Virudhunagar,

Abstract: This research article examines Githa Hariharan's*The Thousand Faces of Night*(1992) with diaspora theory, feminist criticism and revisionist myth-making. Intrinsically related to women and diasporic dislocation (in both the physical and emotional realms), the dissertation explores how characters deal with the dilemma that is selfhood and belonging through the analysis of Devi, Sita, and Mayamma in the face of Diasporic dislocation the dissertation demonstrates the way women internalize, resist and revise male-centric cultural narratives using myths, practice, memories, and stories of perseverance. Reading oral tradition, stories, and revisionist myth as a feminist act, all of which empower women to reclaim their identities, this dissertation illustrates the significance of myth, practice, memory and self- salience in defining the reality of diasporic women in both places they call home.

Keywords: Diaspora, Revisionist Myth-Making, Gender Identity, Cultural Displacement, Survival Strategies.

The term "diaspora" was coined to describe the dislocation of peoples from their homeland and encapsulate the myriad experiences of migration, identity, and cultural negotiation. William Safran conceptualizes diaspora as"expatriate minority communities whose members share several of the following characteristics: they, or their ancestors, have been dispersed from a specific original 'center' to two or more 'peripheral,' or foreign, regions" (Safran 83). In the case of India, diasporic writing has articulated, in some way, the dilemmas of cultural dislocation, the gnawing tension of tradition and modernity, and the complications involved in negotiating identity in a foreign land.

Githa Hariharan's*The Thousand Faces of Night* (1992) examines these themes in a powerful way with a moving story about female identity, cultural expectations, and revisionist mythology. This paper will analyzeHariharan's novel within the framework of diaspora theory, postcolonial feminism, and myth criticism, using scholarly secondary source material all while making the analysis clear and concise.

Diaspora writing often encompasses the reality of experiencing different lifestyles, and cultural adaptation is an event filled with a mixture of necessity, demands, and alienation. In *Night*, the characters face a state of displacement that is not only geographic in a literal

sense, but also cultural and emotional. Devi, the protagonist, returns to Madras after two years in the US and finds herself held captive by a conservative orthodox Indian family. This reflects Avtar Brah's notion of "diasporic space,"which describes a state of being that is really about not only not being temporally located in the migration story, but also of experiencing emotional, cultural, and psychological estrangement (Brah 194). Devi's alienation from her marital home would be comparable to a sense of unbelonging in America. Together, these instances illustrate a hybrid sense of diaspora but one in which the diasporic identity is always in a state of in-betweenness.

Hariharan presents Devi as standing apart emotionally and culturally. Despite her education abroad, Devi has not sufficiently adopted either the Western or the traditional Indian cultural subject position. Thus, like Homi K. Bhabha's representation of the "third space," Devi occupies a liminal space between cultures where identity can be contested and negotiated (Bhabha 54). Devi's resultant identity fragment is characteristic of diasporic subjects who carry their root-origins strangeness inside them, and cannot either "forget" or fully be absorbed into the host culture. That experience of being defined by strangeness/otherness is one of Devi's psychological conflicts.

Hariharan's novel is highly intertextual, weaving myths from the Mahabharata and Puranic mythology with the lived experiences of Indian women. Myth, especially in a postcolonial feminist sense, sheds light on how narratives become dominant, contributing to the ongoing oppression of women through patriarchal systems. Adrienne Rich's term "re-vision" engages with this concept of mythed criticism by discussing the need to"looking back, seeing with fresh eyes, entering an old text from a new critical direction" (Rich 18). Hariharan's female characters are enacting this feminist act of re-vision.

Devi's grandmother, one of the key narrators, calls upon the mythological figures of Gandhari, Amba, and Ganga to reshape their stories into acts of subversion and female empowerment. Gandhari, who is traditionally represented in terms of her ultimate compassion for, sacrifice to, and loyalty to her husband, becomes, in the retelling of the grandmother, a figure of pride and protest. she chooses to blindfold herself as an act of disobedience and defiance to her wife's fate (Hariharan 29). In the same trajectory, Sita, Devi's mother, shares a similar form of suppressed rage when she decides to abandon the veena (her joy), and simply becomes a matriarch of the family who sacrifices her identity for the continuing support of her husband (Hariharan 30).

This revisionist myth-making connects the characters' struggles to much larger cultural stories, offering a kind of "strategic essentialism," a moment of solidarity among women, to resist patriarchy (Spivak 284). These myths were reclaimed and rewritten, allowing Hariharan's women characters to "create a collective female consciousness," and to subvert the male vehicle of agency and construct new identities.

The novel explores how middle-class Hindu society establishes gender roles through myth and social conditioning. Devi, Sita and Mayamma lead isolated lives, often in violation of the status quo and devoid of sacrifice for their condition. Conventionally interpreted as a

women's ultimate purpose, marriage actually reflects a system based on exploitation and erasure of identity. Female and male gender roles applied to marriage further cement the use of each marriage partner, by separating self within the husband's personal sphere. Devi's marriage to Mahesh lacks intimacy or choice and leaves her as nothing more than property in his patriarchal household. Devi's musings"This then is marriage...two or three brief encounters a month... And the rest? The shadowy stranger snaps his fingers and demands a smiling handmaiden" (Hariharan 54)shows the emptiness under the veneer of matrimonial customs.

Mayamma is a servant who is the symbol of the traditional woman's silent suffering. She is exploited by her husband, mother-in-law, and son, and embodies the oppression that women continue to experience within unwieldy structural confines. However, she quietly resists oppression by blessing Devi's decision to leave - caste and gender have forced her to succumb to silence but she can willingly bequeath dissent and survival (Hariharan 126).

Sita, an apparent conformist, experiences a change through Devi's ability to resist. Sita gives up her veena in order to please her in-laws, and she begins by placing the same restrictions on Devi. However, it is through music that, at the end of the novel, Sita regains her lost identity as the music represents what Elaine Showalter calls "the female tradition," whereby women's writing/women's expression is an act of self-recovery(Showalter 13).

Diaspora is not only about people moving physically to new places; it also includes a consistent emotional and psychological relationship to the home land. Harthiaran uses the characters' memories and cultural memories to demonstrate this connection. For Devi, her identity crisis is mixed up with memories of her grandmother's stories, and her mother's sacrifices. These memories are what Stuart Hall calls "narratives of the self," and create a diasporic identity weaved together through selective remembering and storytelling (Hall 224).

The novel shows how cultural memory serves to bridge the gap from host land to homeland through Devi's internal monologue and intergenerational conversations, detaching the past from the present while putting the two back together. The grandmother's mythological stories are not simply bedtime stories - they represent coded strategies to survive and inadvertently teach feminist resistance, masquerading within patriarchal tales. The folktales empower memory and resonant the diasporic experience that survives on cultural continuity manifesting through oral stories and reinterpreted memories.

Hariharan's*Night* presents a multi-faceted diasporic text that is deeply interested in the dynamics of female identity formation, cultural dislocation, and myth-poetic revision. As part of its exploration, the novel critiques patriarchal systems of oppression and the governing ideologies of prescriptive gender roles, while simultaneously providing feminist alternatives through transformed myths and generational female solidarity. Drawing on diaspora studies, postcolonial feminism and myth criticism, this analysis of *Night* shows how Hariharan builds a narrative space that women can investigate, refuse, and ultimately dismantle.

Devi's path represents the wider condition of diasporic subjects situated amid opposing cultural pulls, and is carried within as "essential strangeness." The blending of myth and fiction in the novel creates a space for female autonomy, as revisionist narratives upend historical erasures, dominant narratives, and patriarchal myth-making. The multiple experiences of Devi, Sita, and Mayamma also reflect the way women collectively demonstrate memory, agency, and self-definition, negotiating the different regimes of diasporic and patriarchal reality.

Thus, *Night*can be read not only as a domestic novel, but also as an important diasporic-feminist intervention that subverts both colonial and indigenous patriarchies. It also exemplifies how contemporary Indian women writers continue to fashion identity and agency through narrative invention and cultural disruption, and enter into the growing body of postcolonial diasporic literature.

Works Cited

Bhabha, Homi K. *The Location of Culture*. Routledge, 1994.

Brah, Avtar. *Cartographies of Diaspora: Contesting Identities*. Routledge, 1996.

"Diaspora." *Education | National Geographic Society*, education.nationalgeographic.org/resource/diaspora/. Accessed 22 Apr. 2025.

Hall, Stuart. "Cultural Identity and Diaspora."*Colonial Discourse and Post-Colonial Theory: A Reader*, edited by Patrick Williams and Laura Chrisman, Routledge, 1994, pp. 222-237.

Hariharan, Githa. *The Thousand Faces of Night*. Penguin, 1992.

Rich, Adrienne. "When We Dead Awaken: Writing as Re-Vision."*College English*, vol. 34, no. 1, 1972, pp. 18-30.

Safran, William. "Diasporas in Modern Societies: Myths of Homeland and Return."*Diaspora: A Journal of Transnational Studies*, vol. 1, no. 1, 1991, pp. 83-99.

Showalter, Elaine. *A Literature of Their Own: British Women Novelists from Brontë to Lessing*. Princeton UP, 1977.

Spivak, Gayatri Chakravorty. "Can the Subaltern Speak?"*Marxism and the Interpretation of Culture*, edited by Cary Nelson and Lawrence Grossberg, U of Illinois P, 1988, pp. 271-313.

INNOVATION – A BOON TO SUSTAINABLE AND SUCCESFUL AGRICULTURE

Miss. Punam M. Katwale
Assistant Professor
Dr.Ambedkar College of Arts, Commerce and Science, Chandrapur

Dr. Imran R. Mithani
Assistant Professor and Head, Department Of Zoology
Dr.Ambedkar College Of Arts, Commerce and Science, Chandrapur

Abstract

Sustainable agriculture is a global concern country like USA, India, and the China collaborating through organizations like the World Food Organization and FAO to manage environmental health and food security for 2050. As a step towards minimizing inputs and environmental impact, Natural farming is one approach to achieve these goals. Indian farmers are increasingly adopting natural farming as compared to organic farming, due to its minor yield reduction and lower certification requirements. since 2015 Haryana farmer practicing natural farming because they believes that , it preserves resources, enhances farmers' economic conditions and helps to protect the environment.

Keywords
Crop Diversification, Sustainable Agriculture,Polyculture, IPM(Integrated Pest Management)

Introduction

Sustainable agriculture is a world wide movement focused on producing food while protecting the environment, promoting social equityand supporting biodiversity. It helps to maintain balance of three key objectives: economic profitability,environmental health, and social fairness.Innovation is essential for addressing the needs of humanity, particularly in enhancing agricultural competitiveness, promoting sustainable development, and achieving equality. Throughout history, technological advancements have significantly transformed agriculture, leading to the creation of new processes and products that significantly evolve the industry. Agricultural innovation can be categorized into three main areas.

1. Agro-chemical innovations
2. Mechanical innovations in agriculture
3. Biotechnological innovations in agriculture

There are many benefits of innovation in agriculture like source of income, Improves productivity of crop, Createsmore employment opportunity, act as Source of industrial growth, Source of food supply etc.

Rural Entrepreneurship through Amla Cultivation

A 60-year-old farmer from Rajasthan whose name is Mr. Amar Singh, began amla farming in since 1997 after learning about its benefits in multiple ways . He planted amla trees on 2.2 acres of land ii having 60 trees and later heexpanded number of amla trees to 130. His trees started bearing fruit innearly 4-5 years, generating an income of Rs. 7 lakh per year. He also grew vegetables like tomatoesand peas. Facing challenges in selling amla fruits, he learned processing of murabba;he had started his own processing plant in 2005, by brand name "Amruta. By 2015, his businessexpanded, andnow under brand name "Amar Mega Food Pvt. Ltd," hewasproducing 400 quintals of murabba with a Rs. 26 lakhof turnover.

Success Flourishes with Integrated Farming

Mr. Muttappa Pujari, a 45-year-old farmer from Hasanapur, Karnataka, manages 8 acres of integrated farming. He grows various crops across seasons, including red gram, cotton, and tomatoes, achieving a yield of 10 tonnes from 0.5 acres. To address labor shortages, he plans to buy machinery and earns Rs. 200 to 300 daily from selling leafy vegetables, avoiding middlemen by selling directly.With a net profit of Rs. 4 to 5 lakh annually, he sees growth potential with better electricity and irrigation. He also made a profit by buying and selling goats and oxen. Mr. Pujari emphasizes careful management in farming and plans to expand into commercial goat, poultry, and fish farming, believing passion and calculated risks are essential for success.

Innovative Post-Harvest Technologies and Strategic Fruit Marketing

Mr. Venkata Narsimha Raju, from Kesavaram village in Andhra Pradesh, is a farmer who excelled in fisheries, earning awards for his innovative approaches. After Operation Kolleru in 2006 destroyed his fish ponds, he co-founded "Cold Space Agrotech India Pvt. Ltd" in 2012. The company focuses on post-harvest management of fruits, promoting "Good Agricultural Practices" and training farmers on carbide-free mango production. His efforts created local employment and improved the ripening process for fruits. The company plans to expand with automated facilities and promote natural farming, with also venturing into export services.

Crop diversification is the key to progress in Punjab

Mr. Sarwan Singh Chandi, a graduate from Boolpur village in Kapurthala, Punjab, inherited 14 acres of land and leased 16 more. Concerned about the declining water table from monoculture farming, he adopted a diversified farming system on 30 acres of land, growing various crops and practiced bee-keeping. His diversified approach increases his annual income to Rs. 19, 87,250, supplemented by Rs. 3,000 daily from surplus milk sales from his seven milch animals. After training in bee-keeping, he produced 350 kg of honey and launched "Lion brand honey," earning an Agmark certification. He has won 52 state and national awards, including 14 first prizes for honey production, and encourages other farmers to diversify and participate in agricultural events. Mr. Chandi's innovative practices and collaboration with organizations have made him a role model in promoting sustainable agriculture.

Integration is the Key to Success in Sustainable Agriculture

Mr. Praveen from Vagarahalli, Karnataka, transformed his 1.69 ha farm through integrated farming, earning Rs. 7.28 lakh annually. Initially growing basic crops, he adopted high-value crops, dairy, poultry, sericulture, and vermicomposting. He also introduced water-saving techniques and farm machinery. His innovations, including growing fodder and rearing poultry, inspired local farmers. Mr. Praveen saves Rs. 20,000 annually by harvesting his coconuts and uses recycled farm waste for compost. His success earned him the Best Taluka-level Youth Farmer award and recognition as a role model for sustainable farming.

Maximizing Yield with Minimal Water

Mr. Manjeet Singh Saluja, a progressive farmer from Rajnandgaon, Chhattisgarh, adopted modern farming techniques like drip irrigation and crop rotation on his 25-acre farm. He also practices organic farming, growing vegetables initially for friends, which later expanded commercially. To address labor shortages, he encouraged farm workers to become business partners, eventually resolving the issue. He opened a retail outlet on his farm, selling fresh produce, and raising awareness of agriculture's profitability. His efforts earned him several awards, including the "Krishi Samrat Samman." He plans to further expand his crop cultivation.

Future Directions and Innovations

Future directions and innovations in sustainable agriculture focus on enhancing productivity while minimizing environmental impact. Key areas include:

1. Precision Agriculture: Utilizing technology like GPS, drones, and sensors to monitor crop health, soil conditions, and water usage, allowing for more efficient resource management.

2. Aggro-ecology: Implementing ecological principles in farming practices, such as crop rotation, intercropping, and organic fertilizers, to promote biodiversity and resilience.

3. Regenerative Agriculture: Focusing on rebuilding soil health and ecosystems through practices like cover cropping, reduced tillage, and holistic livestock management.

4. Vertical and Urban Farming: Developing innovative farming systems in urban areas, such as vertical farms and hydroponics, to maximize space and reduce transportation emissions.

5. Biotechnology: Using genetic engineering and biotechnology to develop crops that are more resistant to pests, diseases, and climate change, reducing the need for chemical inputs.

6. Climate-Smart Agriculture: Adapting farming practices to increase resilience to climate change while reducing greenhouse gas emissions, ensuring food security in a changing climate.

7. Water Management Innovations: Employing advanced irrigation techniques, such as drip and sprinkler systems, along with rainwater harvesting and wastewater recycling, to conserve water resources.

8. Sustainable Supply Chains: Enhancing transparency and sustainability in food supply chains, promoting local sourcing, fair trade, and reducing food waste.

9. Education and Training: Providing farmers with access to knowledge and resources on sustainable practices, technology, and market trends to empower them in adopting innovative methods.

10. Policy Support and Collaboration: Encouraging government and organizational support for sustainable agriculture initiatives, research funding, and cooperative efforts between farmers, scientists, and communities.

These directions aim to create a more resilient, equitable, and environmentally friendly agricultural system that meets the needs of a growing global population.

- **Here are some key lessons learned and best practices from successful agricultural initiatives around the world:**

Adoption of Technology

Best Practice: utilization of precise agriculture tools, such as drones and soil sensors, to monitor crop health, optimize irrigation, and manage inputs efficiently.

Lesson: Adapting new technology can significantly increases productivity and sustainability.

Community Engagement

Best Practice: collaboration between farmers, researchers, and local governments for exact solutions to specific community needs.

Lesson: local community's involvement in decision-making processes leads to more effective and sustainable agricultural practices.

Management of Soil Health

Best Practice: Adopt practices such as cover cropping, zero tillage, and organic alteration to enhance soil fertility and porosity.

Lesson: for sustainable agriculture healthy soil play important role.

Education and Training

Best Practice: Provide regular training programs and workshops on best farming techniques, and market access, pest management practices.

Lesson: Continuous education empowers farmers with knowledge of sustainable innovations and sustainable practices

Diversification

Best Practice: poly culture systems implementation,integrating livestock and crops tooptimize use of resources and maintain soil health.

Lesson: Diversifying livestock and crops minimize risk and enhances resilience against fluctuations in market and changes in climate.

Integrated Pest Management (IPM)

Best Practice: Implement strategies like IPM that emphasize prevention, monitoring, and eco-friendly pest control methods.

Lesson: Combining biological and chemical practices canminimizee damage cause by pest with reduced chemical use, making crop healthier.

Sustainable Water Management

Best Practice: Implementation of rainwater harvesting, drip irrigation, and water recycling systems to optimize use of water.

Lesson: Efficient water management is crucial in regions facing scarcity of water as such helping mankind lead a more comfortable and fruitful life.

Value Addition in agriculture

Best Practice: Encourage farmers to process their product, such as turning fruits into vegetables or jams into pickles and by products, to enhance market value.

Lesson: Agricultural products Add boost in increasing farmersprofitability.

Climate Adaptation

Best Practice: Implementation of climate-smart agricultural practices, such as planting drought-resistant crop varieties and adjustment of schedules of planting.

Lesson: Adaptation of farming practices to changing climate conditions is essential for long-term sustainability in agriculture and enhanced productivity.

Supportive Policies

Best Practice: Advocate for policies that support sustainable farming practices, access to credit, and fair trade.

Lesson: policiesof Government greatly influence the success of sustainable agriculture, and thereby increase involvement of youths into forming.

Circular Economy

Best Practice: Recycle agricultural waste through biogas production or composting to return various nutrients which are useful to the soil.

Lesson: circular economy creation in agriculture minimizes waste and enhances sustainability.

Some examples of Successful Initiatives:

Farmers' Cooperatives: In countries like Kenya and India, farmers' cooperatives help smallholder farmers gain access to markets, credit, and training.

Aggro-ecological Practices: In Cuba, the use of aggro ecological practices has increases food security and resilience through techniques such as organic farming .

Vertical Farming: in Singapore, Urban vertical farms use innovative technologies to grow food sustainably in minimum spaces, which address food security in urban areas.

By learning from these success stories, many farmers and agricultural stakeholders can accept best practices that helps to promote sustainability, resilience, and economic viability in their operations.

References

Dr. Muttanna,Dr. Lakshmi Murthy ,Dr. Saravanan Raj,inspiring Stories from Innovative Farmers,National Institute of Agricultural Extension Management (MANAGE) (An organization of Ministry of Agriculture and Farmers welfare, Govt. of India) Rajendranagar, Hyderabad- 500030, Telangana State, India

Sustainabale intesification in agriculture: The richer shade of green. A review, volume 37, article number 39 (2017)

Saurav Vyas, Sukhjinder Singh,Role of Innovation for Sustainable Development in Agriculture: A Review

Cyanobacterial Farming for Environment Friendly Sustainable Agriculture Practices: Innovations and Perspectives.Laboratory of Photobiology and Molecular Microbiology, Centre of Advanced Study in Botany, Institute of Global Farmer Field School Platform

STATISTICAL REVOLUTION IN GEOGRAPHY STUDY

Dr. Sadhana S. Khandar (Bhendkar)
Associate Professor, Post Graduate Department of Geography
Government Vidarbha Institute of Science & Humanities, Amravati

Abstract

Although the statistical method is widely used in geography, this method was familiar to scientists in ancient times; But the true development of statistics geography was in the twentieth century. In the twentieth century, many scientists used the statistical method in their geographical study. In the twentieth century, subjects of astronomy, environment and meteorology, geology, ocean science, geography, plant geography, financial geography, population geography, population distribution, density, birth-mortality ratio, literacy, environmental science, etc. were widely studied. Statistics and methods are more important in this study, especially in the environment, astronomy, population and financial geography. In planning, statistics and statistics are of special importance. Present study focused on the discussion about statistical revolution in geography studies.

Key Words: Statistical, Revolution, Geography, Map, Graph, Diagram

Introduction

In 1935, the experts ofHortshorn and Dickens produced maps of agricultural (crop) in Europe and the United States with the help of statistics; He also adopted a statistical method for the analysis of the US census. In 1945, the geography ofHarton used the statistical method to measure the pace of river flow, in 1947, the British expert, a British expert in 1947, used the statistical method in the study of the distribution of population, density, etc. In 1950, a scientist, Strahlar, used the statistical method in the study of the work of the wind in the dry region. He also used the statistical method in the speed of glaciers and other glaciers. In the twentieth century, Carl Sawar, a geography, considered the statistical method in the study of geography. Soyer created land deployment, soil fertility, rainfall, distribution of crops and minerals and other financial maps in statistics. Also, statistical methods were considered important in the study of the wind speed, the incense of the land, the classification and evaluation of the soil, the lack of regulation, irrigation, etc., as well as the formation of maps.

Objectives

To discuss the revolution of statistics in geography studies is the main objective of the present research work.

Data Source

Present discussion is based on the secondary data source**.** The related data is compiled from previously published research papers, articles and related books.Also, some information has been collected from the study done by itself. The writing of the research presented is renovated in its own words.

The Cause of Statistical Revolution-

1)Trade Information: From the beginning of the twentieth century, the study of geography in the world has begun. Distribution of resources (soil, minerals, water resources, forest resources, animals, etc.), weather, agriculture, population, industry, transport, etc. Temperatures, winds, winds, humidity, clouds, rainfall, etc. and distribution of population in population, density, birth and mortality, age structure, gender structure, literacy, business, etc. are being studied. It is also important to study the subjects of agriculture, commodity production, markets, their distribution, industries, transportation (roads, iron roads, waterways and airways), tourism. Thus information about various topics increased. The use of statistics in this was compulsory and the statistical method was prevalent in geography.

2)Complications in the Subject: As the world began to study various subjects in the world, the scope of this subject has increased. It was only through the wrap that it increased the subject and the components and the distribution of components, the interrelationship, the mutual impact, the complications in the study. The complexity of the study made it difficult to conclude. As a result, the previous traditional old method of geography was inadequate to solve the complexity of the subject. The statistical method was useful for eliminating this complexity in the study, and this method was more useful in the study of geography.

3)Modernization in the Study System: After World War I, the study of geography became more accelerated and modernity in the study and all the subjects of geography began to come in a more scientific way. Also, in the study of the subject, the focus was on the theoretical method. Statistics are of great importance in scientific and theoretical studies; Because statistically, it is easy to draw conclusions. Therefore, the statistical method was developed in geography

4) Impact ofModern Technology: In the twentieth century, the world of technology progressed. Especially after World War II, technology developed. This includes sophisticated techniques such as improvement, satellite services. These new techniques have a major impact on the study. This effect brought new new skills in the study of study. Naturally, in the study of geography, new, modern statistical methods have come and began to be widely used.

5)As the Changing Role ofScientists in the Study: As new techniques of studying method of study began to develop in the world, scientists accepted the changing role in the study, leaving the old traditional methods of study. Therefore, the importance of statistics increased.

6) Importance in Planning: accurate findings and permissions in the country's planning are more important. Statistically accurate findings and permissions can be drawn. Given the importance of this, the Statistics system was approved by the rulers. Therefore, this method started to be adopted in all areas.

7) Increasing Study of Various Subjects: In the twentieth century, all the countries of the world emphasized on the study of environment, soil, water resources, forest resources, minerals, agriculture, raw materials, population, capital, industry, transport, market, health, environment, etc. In advanced countries, the study of astronomical, environment, earthquake, environment, etc. has gained special importance. Statistics are important in the study of all these subjects; therefore, in the study of various subjects, a large number of statistics method started.

Statistics system started in the world from the beginning; But in the beginning, the use of this method was limited, and at that time, even at the university level, these methods were less taught. Therefore, the technique of statistical study was not very developed. After World War I, statistical map progresses, and today in many countries around the world, the subject is taught at the university level. This gives an idea of the progress of this method.

Along with the progress of this subject, statistical study methods, their tools and techniques also progressed. There are three major methods of statistical study. These are the major techniques and tools of statistics in the study.

1)Descriptive Method : In this, the information is shown by a numerical viewer by collecting and collecting information in terms of location, region, trend of things, etc.

2)Inferential Method : In this method, when studying a region in this method, it is considered as a sample of an element, considering how large the region is, how much it has.

3)Model Method : In this type, the subject is studied through the creation of images using geometric methods. These images are descriptive; and they also clarify possible future consequences.

Although the statistical (tools or techniques) are practiced in the statistical study methods, descriptive, conclusively and immune system is used in the study, actually the use of figures and graphs, statistical maps, images, equipment, sample study. These methods are important,because these methods can statistics, separation and analysis of geographical information. These methods are as follows.

1. Graphs and Diagrams: graphs and figures in the study of geography and other subjects have been used for many years. In the twentieth century, they appear to be more useful. There are references to figures in geography and economics. These figures can be shown well with the help of graphs and figures. For which these graphs and figures are drawn, it gives a clear idea of the component and the changes in it.

A) A Graph: Line writers and columns are headed in the graph. There are two major types of line writing, simple lines and polygamy. Simple line articles are used to show different months of different months, crops or minerals in different years of production, as well as the population of different years. The pluralist is used to indicate more than one dimension.

B) Figures: Divisions include divided rectangles, split circles, vomiting, population tower (pyramid), split circles and square, etc. Divided rectangles and divided circles or figures are

mainly removed for land deployment, irrigation area or similar statistics. The frequency of the wind with the help of a pulp or a scenic figure. With the help of a pyramid, females and men of different ages show the numbers. The standard circle and the standard square are used to show the population of different cities or products.

2)Statistical Maps : Statistical maps have also been used for many years in the study of geography. From this map, the distribution of elements for which it is removed is clear. Therefore, these maps are called distributional maps. This type involves the methods of dot methods, chloropleth methods, and isopleth methods. These maps are used for taluka, district, state or country.

3)Models : Recently, models are being used extensively in the study of geography. Models are the true form of statistical reality. Through this, something can be studied in a descriptive manner. Through this, future changesof something can be predicted.

4)Instruments : These include the equipment that is useful for study. Ex: log table, calculator, computer (computer), etc. The log table and calculator are used to remove the sum, subtraction, multiplication, division, percentage, degree, etc. Recently the log table has been a little behind and the calculator is getting more useful.

5)Sample Study : In this method, parts of a region are studied. It only monitors a few parts. For this, information and statistics are collected by creating a questionnaire. Based on that information and statistics, the study subject is estimated.

(**Benefits/Pros) of the Statistical Revolution**

After the statistical revolution, the study of geography gained further momentum. In the second part of the twentieth, statistical methods and techniques were used in the study of geography. Statistics and techniques benefit the students in the fields. It benefited geography practitioners and mainly scientists from different fields. Following are some of the important consequences of statistical revolution:

1) Conclusions Became More Precise and Accurate

Since the use of statistics and techniques in geography, the findings have become more accurate. The errors in the study and observation studies were eliminated. As a result, there was consistency in the study. This made it easier to separate the information and to summarize it.

2) Encourage The Study And Research of Geography

After the statistical revolution, the study of geography was further encouraged. This accelerated the study of geography. After the statistical revolution, geography began to be studied on all sides. Also, due to the statistical revolution, more research in various geography branches started to take place. For example: Agriculture, transport, communication, industries, markets, water resources, forest resources, environment, etc.

3) Increasing Participation in Planning

The statistical revolution came accurately in the conclusion of study and research. As a result, statistics were used in the planning of the country, state and region. Planning includes population growth, proportion of men and women and children, division of population, health, education, employment, retirement, etc. Therefore, the participation of

statistics in the planning of financial planning, labor supply, industrial, agriculture, health, education, trade, city planning, environment, etc.

4) Assist in Economic Progress

In geography, natural resources (water resources, forests, animals, minerals and penetrations), as well as agriculture, industry, population, transport, tourism and trade are studied. After the statistical revolution, these subjects began to study more. This encouraged the progress of agriculture, industries, mining, transport, tourism, etc. This technique helps to understand the current status and problems of the subject and to remedy it.

5) Help to Eliminate Economic, Social and Cultural Issues

The use of statistics in the study made it easier to find answers to various problems. E.g. It helped find problems in civil, agriculture, industrial, water, population, genital, mortality, environment, trade, transport, tourism, language, religion, culture, etc.

6) Ease ofthe Analysis of Subjects

Statistics require analysis when studying various topics. Statistics methods and techniques made it easier to analyze the subject.

7) The Importance of Statistics in the Study of Geography

In geography, crops and minerals are studied, forest, industry, transportation and trade, etc. The importance of statistics in the study of these subjects is increasing. In this regard, statistics are becoming important.

Disadvantages (Flaws) of the Statistical Revolution

Although the statistical revolution has brought many benefits to the world, statistical techniques (skills) also have some disadvantages. They have some flaws.

1) After the statistical revolution, many overzealous people abandoned the very best of numerical matters that were useful.
2) If one demands high-quality and complex data, it is not available outside developed countries.
3) This method involves generalization of data, which leads to exaggerated results.
4) Creating figures, measurements, and drawings in factories requires expensive computers, which ordinary manufacturers cannot use. Small factories cannot afford them.
5) The statistics used for a factor are not long-term. They can last for a maximum of100years.

References

1) Adhikari, S. (2010),"Fundamentals of Geographical Thought", Chaitanya PublishingHouse, Allahabad
2) Concepts and Trends in Geography,gacbe.ac.in
3) DaimanAmit (2020), "Recent Trends in Geography", International Online Workshop on Research Design, Date 25/08/2020.
4) DhurveySangeeta (2022), "Recent Trends in Geography", Siph Publication,Govt of India.
5) Martin, G. F and James, P. E. (1972), " All Possible Worlds: A History of Geographical Ideas", John Wiley and Sons, New York.
6) Stephen Sargent Visher (1932), "Recent Trends in Geography", The Scientific Monthly, Vol-35, No. 5, Pp 439-442.

Navigating the Digital World - The Impact of Technology on Well-being and Mental Health

Dr. Poonam Bhimrao Waghmare
Associate Professor
M.V.P.Samaj's Adv. V.G.Hande College of Education, Nashik

Abstract
The mental health effects of digital consumption on students are analysed in this paper, with a particular emphasis on anxiety, depression, addiction, and lack of focus. A thorough survey of Grade IX students from Nashik's urban schools, along with extensive input from school counsellors and teachers, is utilized in the primary research. The survey was conducted to evaluate students' use of screensaver habits, social media platforms, and their psychological impact. Research indicates that around 30% of students who were unable to use social media due to anxiety were exposed to higher levels and evidence of dependency, which is consistent with secondary research. Dopamine-driven feedback loops from likes and notifications were found to have a significant impact on student health when it comes back to social media engagement. Those who consumed too much screen time also experienced disrupted sleep, reduced academic performance, and social isolation. The decline in productivity, attention spans, and participation in meaningful social interactions among students was noted by teachers and counsellors. This fuelled concerns about the overuse of technology. Developing digital habits like screen time management, mindfulness techniques, and parental guidance is also highlighted in the study. A feasible plan for schools and colleges involves incorporating digital literacy programs, wellness initiatives, faculty training, and designated technology-free zones to encourage positive digital behaviour. Institutions that promote digital citizenship, real-life interactions, and balanced use of technology can help students understand the benefits of using technology in a way that supports their mental and emotional health.

Keywords: Digital Consumption, Mental Health, Anxiety, Technology Addiction, Digital Well-being.

Introduction.

The advent of technology has brought about changes in our lives, including convenience, connectivity, and access to knowledge. However, excessive use of the internet can have mixed effects. The impact of digital habits on grades, academic performance, and mental health is significant, particularly for Grade IX students.

This chapter explores the role of technology, social media, and digital health in students, focusing on real life data from surveys of Grade IX students and their parents. ". The article also offers recommendations for maintaining a healthy balance between digital and technological aspects.

1. Research Methodology and Survey Pretext.

A questionnaire was administered to Grade IX students and their parents to determine their digital habits and parental attitudes. This survey examined common patterns of internet use,

trends in screen time and social interaction with friends on social media and its psychological effects on students.

Methodology:

A survey was carried out for Grade IX students and their parents by Target Group.
Two distinct questionnaires were created, one for students and the other for parents.
To ensure easy access and participation, Google Forms was used to collect responses.

Common Questions:

1. Daily television programming and favoured online platforms.'
2. The frequency and nature of social media usage.
3. Parental monitoring and internet restrictions.
4. Information about online safety, digital addiction, and cyberbullying.
5. Effects of digital usage on mental health, sleep patterns, and academic performance.

This chapter's conclusions were based on the analysis of the responses that were obtained, which identified significant trends and issues.

2. Digital Well-being: Striking a Balance.

A balanced lifestyle that involves the use of technology is considered digital well-being. It entails careful use of digital devices to prevent negative impacts such as stress, anxiety, and sleep disturbances. Adolescents must strike a balance between their online education, entertainment needs, and social interactions.

Teenagers commonly utilize online tools to enhance their learning, join online classes, view educational materials, and work collaboratively with their peers. Although these resources aid in learning, prolonged exposure to the screen without interruption can lead to fatigue, eye strain, and cognitive overload. In addition, social media platforms are now a crucial part of their social lives -- connections with friends, influencers, and the world wide web. ". However, a great deal of dependence on these websites can lead to frequent social faux pas and cyberbullying as well as unattainable lifestyle norms that may be detrimental to mental health, with symptoms including anxiety and low self-respect.

Often, adolescents find gaming to be fulfilling, enjoyable, or stimulating, and it can lead to a sense of camaraderie among peers. Gaming addiction can hinder academic achievement, physical progress, and family connections if self-regulation is not upheld. Students must adopt strategies that promote a healthy level of technology engagement in an increasingly digital world. The holistic development of individuals can be promoted by establishing boundaries, taking frequent screen breaks, and engaging in offline hobbies.

Key Concerns:

Spending too much time online can lead to eye strain, fatigue, and poor concentration. The survey reveals that the majority of Grade IX students spend more than 3-5 hours daily on the internet, with the most frequent use being social media and entertainment sites.

More screen time leads to decreased movement, which can have negative effects on overall fitness and posture. Over half (60%) of students claimed that prolonged use of devices led to a decrease in outdoor activities.

Screen time: Lack of screens before bedtime interferes with melatonin production, making it harder to fall asleep faster. Roughly 75% of students reported using their mobile devices before going to bed, which results in sleep deprivation and morning tiredness.
The excessive use of digital devices can lead to reduced personal interaction, which can cause emotional detachment and damage relationships with loved ones. Due to students' dependence on their screens, parents expressed concern about the impact of family outings.

3. Social Media: A Double-Edged Sword

The use of social media platforms like Instagram, Snapchat, and YouTube has become a fundamental aspect of student life. Despite the opportunities for learning and socializing, they also carry some risks.'

Positive Impacts:

1. Connecting with friends and participating in conversations outside their home country is possible for students thanks to social media.
2. Learning and inspiring: Courses, lessons & stories can help. Over half of the pupils stated that they use platforms like YouTube to learn new skills.
3. Through storytelling, art, and discussions on platforms like Snapchat and Instagram, creativity and self-expression are promoted.

Negative Impacts:

1. Stress, low self-esteem, and emotional distress are potential consequences of cyberbullying caused by negative comments and harassment online. A significant proportion of students, 15%, have been victims of cyberbullying.
2. Consistent exposure to curated online experiences can result in unfulfilling expectations and feeling anxious about conforming. Social media comparisons caused jealousy or insecurity among 40% of students.
3. Personal information from students can be shared online, which could result in identity theft or data misuse.
4. The significant impact of digital consumption on mental health is evident, especially in young people and students.

While technology can be advantageous, excessive usage can also have detrimental effects on mental health. Why? Studies have highlighted several concerns:

4.Anxiety and Depression.

The evidence suggests that excessive screen time leads to higher levels of anxiety and depression. The Journal of Applied Psychiatry published a study that revealed adolescents who spent over three hours each day using social media were more likely to experience mental health issues like anxiety and depression. Compulsive checking and stress are a result of the combination of online activity, FOMO, and social media use. And the pressure to curate a perfect online picture only adds fuel to the fire: loneliness. Digital platforms have made a significant impact on students, with around 30% of respondents feeling anxious if they were unable to check their social media accounts frequently.

Addiction and Dopamine Response

This is the dopamine-driven feedback loop from social media notifications, likes, and gaming which stimulates our addictive behaviour of clicking, teasing, and playing games (see below). Compulsive patterns are linked to excessive social media use, a finding that was published in Computers in Human Behaviour. The insufficiency can impede the concentration on fundamental tasks like academics, physical fitness, and communication. The vulnerability of adolescents is heightened due to their developing brains being more easily affected by immediate gratification cycles.

Lack of Focus and Productivity.

The concentration required to multitask between school, social media, and digital entertainment diminishes cognitive efficiency. The Journal of Educational Psychology conducted a 2018 study that revealed that students who frequently used different devices while studying had lower retention rates and poorer academic performance. Parents have reported a significant decrease in their children's ability to focus on school, as well as difficulty with tasks due to constant digital distractions.

Sleep Disruption.

A strong correlation exists between technology use, particularly before bedtime and poor sleep quality. Screens' blue light causes a delay in the onset of sleep and subsequently dampens rest quality by inhibiting production of my hormone melatonin. Sleep Health Journal's study indicates that students who spend more than two hours on screens before bedtime experience disturbed sleep patterns, which can lead to fatigue, irritability, and impaired cognitive abilities.

Increased social isolation and lowered emotional awareness.

The aim of social media is to create connections, but excessive online use can result in social isolation. Individuals who use social media for more than two hours daily are twice as likely to report feeling socially isolated as those who only use moderate amounts, according to research from The American Journal of Preventive Medicine.

Recommendations for Healthy Technology Use.

Ensure that students balance their screen time with outdoor activities, hobbies, and social interactions.

Boost Digital Detox Practices: Pauses from devices can alleviate stress and enhance concentration.

Enable mindfulness and meditation to alleviate anxiety caused by constant online activity.

Educational and Parental Guidance: Through structured digital literacy programs, schools can work together to promote responsible technology use.

To achieve academic success, students must adopt positive digital habits and consider the psychological impact of technology.

Research indicates a significant correlation between digital consumption and mental health. If technology is misused, it can cause:

The combination of constant online activity, fear of failure to succeed (FOMO), and exposure with negative media can lead to increased stress levels. About 30% of students surveyed expressed worry about not being able to check social media frequently.
Dopamine addiction can result in a decrease in academic focus due to the stimulation provided by social media likes, notifications, and gaming. This is known as addiction.
Disconnectedness: Shifting between school and social networking sites can hinder concentration and productivity. Why? High screen time consumption among students caused their parents to notice a decrease in their study habits and attention span.

Notes from School Officials and Teachers.
The impact of digital on students was explored through interviews with school counsellors and teachers. Their observations highlighted significant challenges:
Academic Downturn: Teachers said screen time-scarred students had poor attention, did not work their homework well and were unable to think critically.
Students who were heavily involved in social media experienced more irritability, anxiety, and social withdrawal among their peers, as noted by counsellors.
Enduring Sleep Cycles: Several students admitted to using their phones late at night, which caused them both to become chronically tired and to reduce their engagement in the classroom
Increased Inactivity in Extracurricular Activities: Experts noted that students who use social media excessively tend to avoid participating in extracurricular activities such as sports, clubs and school events

Findings from the Survey
The survey outcomes demonstrate significant data on digital habits and mental health concerns among Grade IX students.
Key Observations:

1. Access to free internet is available to most students with their personal mobile device, which is owned by 85% of them.
2. For the purpose of entertainment and social interaction, 55% of students spend more than 4 hours daily on their devices.
3. A minority of parents, less than one in five (29 percent) either monitor their child's online activity or use parental controls
4. Digital Addiction Signs: 20% of students acknowledged the challenge of reducing their screen time, despite being aware of its consequences.

These findings suggest that students should prioritize responsible digital use and awareness.
Strategies for Healthy Digital Habits.
To maintain a healthy digital lifestyle, students should follow these guidelines:

1. Screen time can be curtailed by adjusting phone settings or apps, as described below.
2. Plan your digital detox by limiting the time you spend using technology, particularly before bedtime and with family members.

3. Experiment: Go outdoors to refresh your mind and body.
4. Awareness and safety on the internet: Share your own life story and report cyberbullying.
5. Engaging in active discussion about safe internet usage and monitoring children's activities is a crucial aspect for parents, but it should not be too restrictive.

Action Plan for Schools and Colleges

Programs that emphasize digital literacy and encourage students to adopt responsible digital habits, while also educating them on the benefits of technology. This is done through structured programs.

1. Use tools and apps to manage screen time by tracking and limiting it.
2. Wellness Programs: Add mindfulness, yoga, and mental wellness sessions to the school year.
3. Libraries, common rooms, and outdoor activity areas are designated as technology-free zones. This is done by limiting devices.
4. Workshops for Parents: Conduct workshops to teach parents how to monitor their screens and encourage healthy habits at home.
5. Peer Support Groups: Create student-led groups that promote meaningful social interaction and provide guidance on managing technology.
6. Teacher Education: Teach teachers to identify and address signs of stress, anxiety, or addiction related to technology.
7. Advise mental health practitioners on emotional issues caused by excessive digital use.

Conclusion.

Using technology with care can make all the difference. Engaging in activities such as digital health, safe internet use, and real-life experiences can help students develop a sense of balance between their emotional and psychological well-being. Responsible digital citizenship will promote better and more balanced lives for students.

To foster digital health, students must prioritize their online habits by limiting screen time, refraining from harmful activities, and engaging in positive interactions. A balanced lifestyle can be cultivated among students by restricting their use of devices, engaging in physical activities regularly, and encouraging meaningful conversations. Digital literacy is a fundamental aspect of schools, which means it should be taught in the curriculum to prepare students for digital hazards and ethical concerns. Ultimately, students can enhance their learning experience through the use of technology and mindful well-being practices, while also improving their social connections and mental health. ".

References:

Keles, B., McCrae, N., &Grealish, A. (2020). Systematic Review: The Influence of Social Media on Depression, Anxiety, and Psychological Distress in Adolescents. Journal of Adolescence, 79, 109-123. https://doi.org/10.1016/j.adolescence.2020.01.001

Andreassen, C. S. (2015). Online Social Network Site Addiction: A Comprehensive Review. Current Addiction Reports, 2(2), 175-184. https://doi.org/10.1007/s40429-015-0056-9

Cain, M. S., Leonard, J. A., Gabrieli, J. D. E., & Finn, A. S. (2016). Media Multitasking in Adolescence. Psychonomic Bulletin & Review, 23(6), 1932-1941. https://doi.org/10.3758/s13423-016-1036-3

Carter, B., Rees, P., Hale, L., Bhattacharjee, D., &Paradkar, M. S. (2016). Association Between Portable Screen-Based Media Device Access or Use and Sleep Outcomes: A Systematic Review and Meta-analysis. JAMA Pediatrics, 170(12), 1202-1208. https://doi.org/10.1001/jamapediatrics.2016.2341

Primack, B. A., Shensa, A., Sidani, J. E., Whaite, E. O., Lin, L. Y., Rosen, D., ... & Miller, E. (2017). Social Media Use and Perceived Social Isolation Among Young Adults in the U.S. American Journal of Preventive Medicine, 53(1), 1-8. https://doi.org/10.1016/j.amepre.2017.01.010

Emerging Technologies for Secure Smart Applications: A Comprehensive Framework for Next-Generation Cyber Security

[1]Uthiramoorthy A, [2]Sukumar P
[1,2]Assistant Professor
[1,2]Department of Computer Science
[1,2]Rathinam College of Arts and Science, Coimbatore, India

Abstract:
This chapter examines next-generation cybersecurity solutions for smart applications in hyperconnected environments. We analyze seven emerging security paradigms: (1) blockchain-based decentralized trust, (2) quantum-resistant cryptography, (3) homomorphic encryption, (4) Zero Trust Architecture, (5) AI-driven threat detection, (6) secure multi-party computation, and (7) confidential computing. Each technology is evaluated for security guarantees, performance, and implementation challenges. Case studies from healthcare, finance, and smart cities demonstrate practical applications. The chapter provides a framework for integrating these solutions and identifies future research directions in quantum-safe and adaptive security systems.
Keywords: Smart Security, Post-Quantum Cryptography, Zero Trust, Privacy-Preserving AI

Introduction

The rapid advancement of smart applications—spanning IoT ecosystems, autonomous systems, AI-driven healthcare, and smart cities—has introduced unprecedented security challenges. As these technologies become deeply embedded in critical infrastructure, business operations, and personal devices, they create complex, interconnected environments that are highly vulnerable to cyber threats. Traditional security models, which rely on perimeter-based defenses and centralized trust mechanisms, are increasingly inadequate in today's distributed and hyperconnected digital landscape. Firewalls, intrusion detection systems, and conventional encryption methods struggle to keep pace with sophisticated attacks such as zero-day exploits, supply chain compromises, and AI-powered malware.

The rise of quantum computing further exacerbates these challenges, as it threatens to break widely used cryptographic algorithms like RSA and ECC, potentially exposing sensitive data across industries. Additionally, the massive scale of IoT deployments introduces billions of attack surfaces, from smart home devices to industrial control systems, many of which lack robust security by design. Meanwhile, ransomware attacks have evolved beyond simple data encryption to include double extortion tactics, where attackers steal and threaten to leak data unless a ransom is paid.

To address these evolving risks, emerging security technologies are redefining how we protect smart applications. Blockchain introduces decentralized trust mechanisms, eliminating single points of failure in authentication and data integrity. Post-quantum cryptography (PQC) is being developed to withstand attacks from quantum computers, ensuring long-term security for sensitive communications. Homomorphic encryption enables

secure computation on encrypted data, allowing privacy-preserving analytics in healthcare and finance. Zero-trust architecture (ZTA) shifts security paradigms from perimeter-based to identity-centric models, continuously verifying users and devices before granting access.

This chapter provides a comprehensive exploration of these cutting-edge technologies, examining their underlying mechanisms, real-world applications, and implementation challenges. By analyzing their strengths and limitations, we aim to provide a roadmap for securing next-generation smart systems against emerging cyber threats. The discussion will also highlight ongoing research, industry adoption trends, and future directions in cybersecurity innovation.

Key Themes Covered in This Chapter

1. The Limitations of Traditional Security Models – Why perimeter-based defenses fail in modern smart environments.
2. The Impact of Quantum Computing on Cybersecurity – How quantum threats are accelerating the need for new encryption standards.
3. Decentralized Security with Blockchain – Applications in IoT authentication, supply chain integrity, and fraud prevention.
4. Privacy-Preserving Computation – The role of homomorphic encryption and secure multi-party computation (SMPC) in confidential data processing.
5. Zero-Trust Principles in Smart Applications – How continuous verification and least-privilege access mitigate insider and external threats.
6. AI-Driven Threat Detection and Response – The promise and risks of machine learning in cybersecurity.
7. Challenges in Adoption and Scalability – Barriers to implementing these technologies at enterprise and industrial scales.

By the end of this chapter, readers will gain a thorough understanding of how these emerging technologies can be integrated into smart applications to build resilient, future-proof security frameworks. The discussion will also highlight case studies from industries such as finance, healthcare, and critical infrastructure, demonstrating real-world applications and lessons learned.

2. Key Security Challenges in Smart Applications

Smart applications operate in highly dynamic and distributed environments where data continuously flows across IoT devices, cloud platforms, edge networks, and decentralized systems. This interconnected ecosystem introduces multifaceted security risks that traditional security frameworks struggle to mitigate effectively. Below, we explore the most critical security challenges in detail:

2.1. Data Privacy and Integrity

The exponential growth of sensitive data in smart applications—ranging from personal health records in IoT-enabled healthcare to financial transactions in decentralized ledgers—demands robust mechanisms to ensure confidentiality, authenticity, and tamper-proof integrity. A

single breach can have catastrophic consequences, such as identity theft, financial fraud, or even life-threatening disruptions in critical infrastructure. For example:

- Healthcare IoT: Unauthorized access to patient monitoring devices can lead to manipulated medical data, risking misdiagnosis.
- Smart Cities: Tampering with traffic management systems could cause accidents or gridlock.
- Financial Systems: Data leaks in blockchain-based finance (DeFi) can result in irreversible fund losses.

Traditional encryption methods (AES, RSA) provide a baseline, but emerging threats—including quantum computing attacks—necessitate post-quantum cryptography (PQC) and homomorphic encryption to preserve privacy in computation.

2.2. Authentication and Authorization in Decentralized Ecosystems

Legacy authentication systems (e.g., username-password, OAuth 2.0) are ill-suited for decentralized environments where no central authority exists to verify identities. Key challenges include:

- Device Spoofing in IoT: Weak authentication allows hackers to impersonate smart sensors, injecting false data.
- Phishing in Decentralized Apps (DApps): Users may unknowingly grant malicious smart contracts access to wallets.
- Edge Computing Vulnerabilities: Distributed authentication across edge nodes requires lightweight yet secure protocols.

Emerging solutions include:

✓ Blockchain-based Digital Identity (Self-Sovereign Identity - SSI)

✓ Biometric & Behavioral Authentication (AI-driven anomaly detection)

✓ Zero-Trust Continuous Verification (JIT access, multi-factor auth)

2.3. Scalability vs. Security Trade-offs

Smart applications generate massive data volumes—smart cities, for instance, process petabytes of sensor data daily. Security solutions must scale efficiently without introducing latency:

- Blockchain Limitations: Most public blockchains (e.g., Ethereum) handle <100 TPS, making real-time IoT security impractical.
- AI-Driven Security Overheads: Machine learning models for threat detection require high computational power, delaying response times.
- Encryption Delays: Fully homomorphic encryption (FHE) can slow processing by 1000x, hindering real-time analytics.

Potential mitigations:
✓ Hybrid Blockchain Architectures (e.g., sharding, layer-2 solutions)
✓ Edge-Based AI Filtering (pre-process data locally before cloud analysis)
✓ Lightweight Cryptography (NIST-standardized algorithms for IoT)

2.4. Real-Time Threat Detection for Zero-Day Attacks

Signature-based detection (e.g., traditional antivirus) fails against:

- AI-Powered Malware: Adapts to evade static detection rules.
- Fileless Attacks: Runs in memory without leaving disk traces.
- Supply Chain Compromises: Malicious code injected via trusted vendors (e.g., SolarWinds).

Next-Gen Solutions:

- Behavioral AI Models: Detect anomalies in real-time (e.g., Darktrace).
- Deception Technology: Deploy fake nodes/honeypots to lure attackers.
- Threat Intelligence Sharing: Blockchain-based platforms for collaborative defense.

2.5. Decentralized Trust Management

In peer-to-peer systems (e.g., smart supply chains, autonomous vehicle networks), there's no central certifying authority. Challenges include:

- Sybil Attacks: Hackers create fake nodes to overwhelm networks.
- 51% Attacks: Blockchain consensus hijacking (e.g., Bitcoin Gold).
- Oracle Manipulation: Corrupted external data feeds (DeFi exploits).

Innovative Approaches:
✓ Reputation-Based Trust Models (e.g., EigenTrust for IoT)
✓ Federated Learning (collaborative AI without raw data sharing)
✓ Byzantine Fault-Tolerant (BFT) Consensus (tolerates malicious nodes)

Synthesis: Overcoming Challenges with Emerging Tech

Challenge	**Legacy Solutions**	**Emerging Technologies**
Data Privacy	AES, RSA	Homomorphic Encryption, PQC
Authentication	Passwords, OAuth	Blockchain SSI, Zero-Trust

Challenge	Legacy Solutions	Emerging Technologies
Scalability	Centralized Servers	Sharding, Edge AI
Real-Time Threats	Signature-Based Detection	Behavioral AI, Deception Networks
Decentralized Trust	Certificate Authorities	BFT Consensus, Reputation Systems

This table summarizes the paradigm shift required to secure next-gen smart applications. The following sections delve deeper into how each emerging technology addresses these challenges through architectural innovations and cryptographic breakthroughs.

3. Emerging Technologies for Secure Smart Applications

3.1. Blockchain& Distributed Ledger Technology (DLT)

Blockchain technology represents a paradigm shift in digital security by establishing decentralized, tamper-proof networks. At its core, blockchain provides three fundamental security benefits: (1) decentralization eliminates single points of failure, (2) cryptographic hashing ensures data immutability, and (3) consensus mechanisms enable trustless verification. In IoT ecosystems, blockchain enables secure device identity management through decentralized identifiers (DIDs), preventing common attacks like device spoofing. Supply chain applications leverage smart contracts to automate and secure multi-party transactions, reducing fraud in global trade. However, current implementations face significant challenges: public blockchains like Bitcoin process only 7 transactions per second (TPS), while energy-intensive proof-of-work (PoW) consensus mechanisms raise sustainability concerns. Emerging solutions include layer-2 scaling (e.g., Lightning Network), alternative consensus protocols (proof-of-stake), and hybrid architectures that combine private and public chain elements. The financial sector leads adoption, with JPMorgan's blockchain-based Interbank Information Network processing $1 billion daily transactions, demonstrating the technology's enterprise potential.

3.2. Post-Quantum Cryptography (PQC)

The quantum computing revolution threatens to render current encryption standards obsolete, with Shor's algorithm capable of factoring large primes exponentially faster than classical computers. PQC addresses this existential threat through mathematical approaches resistant to quantum attacks: lattice-based cryptography (e.g., NTRU, Kyber), hash-based signatures (SPHINCS+), and code-based cryptography (McEliece). The National Institute of Standards and Technology (NIST) is currently standardizing PQC algorithms, with CRYSTALS-Kyber selected as the primary key encapsulation mechanism. Financial institutions and government agencies are piloting PQC migration strategies - the NSA's Commercial National Security

Algorithm Suite 2.0 mandates PQC adoption by 2025. Practical challenges include increased computational overhead (lattice-based keys are 10-100x larger than ECC) and backward compatibility issues. Hybrid cryptographic systems, combining classical and PQC algorithms, are emerging as transitional solutions to maintain security during the migration period.

3.3. Homomorphic Encryption (HE)

HE represents a breakthrough in privacy-preserving computation by enabling mathematical operations on encrypted data. The technology exists in three forms: (1) Partially Homomorphic Encryption (PHE) supporting single operations (e.g., Paillier for addition), (2) Somewhat Homomorphic Encryption (SHE) allowing limited operations, and (3) Fully Homomorphic Encryption (FHE) permitting arbitrary computations. While FHE offers the greatest flexibility, its computational intensity (operations may be 10^6 times slower than plaintext) currently limits practical applications. Real-world implementations are emerging in sensitive domains: Microsoft's SEAL library enables private COVID-19 risk analysis on encrypted health data, while IBM's Fully Homomorphic Encryption Toolkit supports secure financial modeling. Performance improvements through GPU acceleration (e.g., NVIDIA's CUDA-optimized HE libraries) and specialized hardware (Intel's HE-accelerator chips) are making HE increasingly viable for production systems.

3.4. Zero Trust Architecture (ZTA)

ZTA fundamentally reimagines network security by eliminating implicit trust and enforcing continuous verification. The framework operates on three core principles: (1) least-privilege access, (2) micro-segmentation, and (3) continuous authentication. Google's BeyondCorp implementation demonstrates ZTA's effectiveness, replacing VPNs with device/user trust scoring and context-aware access policies. In cloud environments, ZTA prevents lateral movement through software-defined perimeters and just-in-time access provisioning. The 2021 White House Executive Order on Cybersecurity mandated ZTA adoption across US federal agencies, accelerating enterprise implementation. Deployment challenges include legacy system integration (particularly in industrial control systems) and user experience friction from frequent re-authentication. Emerging solutions incorporate behavioral biometrics and risk-based adaptive authentication to balance security and usability.

3.5. AI & Machine Learning for Cybersecurity

AI is transforming threat detection and response through three primary applications: (1) anomaly detection using unsupervised learning to identify novel attack patterns, (2) predictive analytics for proactive defense, and (3) automated incident response. Darktrace's Enterprise Immune System exemplifies this approach, using Bayesian networks to detect subtle behavioral deviations indicating compromise. However, AI systems introduce new vulnerabilities: adversarial machine learning attacks can poison training data (e.g., injecting false malware samples) or manipulate models through evasion techniques. The cybersecurity arms race has spawned defensive innovations like robust training (adversarial examples

hardening) and explainable AI (XAI) techniques for model interpretability. The financial sector leads in AI security adoption, with JPMorgan's COiN platform analyzing 12,000 commercial contracts annually for compliance risks while maintaining 99%+ accuracy.

3.6. Secure Multi-Party Computation (SMPC)

SMPC enables collaborative computation while preserving data privacy through cryptographic techniques like secret sharing and garbled circuits. Practical applications include: (1) privacy-preserving medical research (hospitals jointly analyzing patient data without sharing records), (2) secure financial audits (banks verifying transactions without exposing sensitive data), and (3) confidential business intelligence (competitors computing market trends without revealing proprietary information). Frameworks like MP-SPDZ provide general-purpose SMPC implementations supporting multiple protocols (Yao's Garbled Circuits, SPDZ). Performance remains the primary constraint - a simple secure comparison of two 32-bit numbers requires ~100ms and 1MB of communication. Emerging optimizations include function-specific circuits and hardware acceleration (e.g., FPGA implementations). The technology is gaining regulatory traction, with GDPR explicitly recognizing SMPC as a valid anonymization technique.

3.7. Confidential Computing

Confidential computing protects data during processing through hardware-enforced trusted execution environments (TEEs). Intel's Software Guard Extensions (SGX) creates secure enclaves that isolate sensitive computations even from privileged system software, while AMD's Secure Encrypted Virtualization (SEV) extends protection to entire virtual machines. Cloud providers have rapidly adopted these technologies: Microsoft Azure's Confidential Computing platform supports SGX-enabled VMs for processing sensitive financial and healthcare data, and Google's Asylo framework provides cross-platform TEE development tools. Security challenges persist, particularly side-channel attacks like Spectre that can leak enclave data through timing analysis. The Confidential Computing Consortium (CCC), comprising Intel, Microsoft, and Red Hat among others, is developing standards to address these vulnerabilities while promoting ecosystem interoperability. Use cases range from secure blockchain transaction validation to privacy-preserving machine learning in multi-party data scenarios.

4. Integration Challenges & Future Directions

Despite their promise, integrating these technologies faces hurdles. Interoperability is a key issue—for instance, combining ZTA with blockchain requires standardized APIs. Performance trade-offs, like FHE’s high latency, limit real-world use. Regulatory gaps, such as GDPR compliance for homomorphic encryption, also pose challenges. Future directions include hybrid security models (e.g., AI + blockchain for fraud detection), quantum-safe smart contracts, and self-healing networks that autonomously patch

vulnerabilities. Collaborative efforts between academia, industry, and policymakers will be crucial to mature these technologies.

4.1. Key Integration Challenges

The implementation of emerging security technologies in smart applications faces several critical integration barriers that must be addressed to achieve widespread adoption and operational effectiveness. These challenges stem from technical, operational, and regulatory complexities inherent in deploying advanced security frameworks across heterogeneous environments.

4.1.1. Interoperability Complexities

The convergence of multiple security technologies introduces significant interoperability hurdles:

- API Standardization: Combining Zero Trust Architecture (ZTA) with blockchain-based identity management requires standardized authentication protocols (e.g., OAuth 2.0 extensions for decentralized identifiers).
- Cross-Platform Compatibility: Secure multi-party computation (SMPC) frameworks often lack plug-and-play integration with existing enterprise systems, demanding custom middleware development.
- Hybrid Blockchain-AI Systems: While AI enhances blockchain fraud detection (e.g., analyzing smart contract vulnerabilities), most ML models cannot natively process on-chain data without preprocessing.

4.1.2. Performance vs. Security Trade-offs

Emerging technologies frequently impose prohibitive computational overhead:

Technology	Performance Limitation	Current Mitigations
Fully Homomorphic Encryption (FHE)	1Mx slower than plaintext operations	GPU acceleration (NVIDIA CUDA), ASIC chips
Post-Quantum Cryptography (PQC)	10-100x larger key sizes	Hybrid encryption (RSA + lattice-based)
Blockchain Consensus	PoW: High energy; PoS: Centralization risks	Layer-2 solutions (Rollups, Plasma)

4.1.3. Regulatory and Compliance Gaps

- GDPR &Homomorphic Encryption: Strict "right to erasure" requirements conflict with blockchain immutability and HE's encrypted data retention.
- Quantum Readiness Mandates: NIST's PQC standardization (completed 2024) lags behind quantum computing advancements, leaving industries in transitional vulnerability.

- Cross-Border Data Flows: Confidential computing's use of TEEs (e.g., Intel SGX) faces scrutiny under EU's Data Governance Act.

4.2. Future Directions for Secure Smart Applications

4.2.1. Hybrid Security Architectures

- **AI-Augmented Blockchain**:
  - Fraud Detection: Machine learning analyzes transaction patterns in DeFi to flag suspicious activity in real-time (e.g., Elliptic'sblockchain analytics).
  - Smart Contract Auditing: NLP models like OpenAI's Codex automatically detect Solidity vulnerabilities before deployment.
- **Quantum-Resistant ZTA**:
  - Lattice-based cryptography integrated into continuous authentication protocols.
  - NIST-approved PQC algorithms (e.g., CRYSTALS-Dilithium) for device attestation in IoT.

4.2.2. Self-Healing Autonomous Networks

- **AI-Driven Patch Management**:
  - Systems like Microsoft's Autopilot use reinforcement learning to deploy security patches within minutes of vulnerability disclosure.
  - Blockchain-secured firmware updates for IoT devices (e.g., IOTA's Tangle).
- **Adaptive Threat Response**:
  - Darktrace'sAntigena autonomously quarantines compromised nodes based on behavioral anomalies.

4.2.3. Next-Generation Privacy Technologies

- **FHE Cloud Adoption**:
  - Google's Fully Homomorphic Encryption Transpiler (FHE-TF) enables developers to run encrypted TensorFlow models.
  - Estimated to reach 25% adoption in healthcare analytics by 2027 (Gartner).
- **SMPC-as-a-Service**:
  - AWS Clean Rooms and IBM's Secure Data Sharing Solutions offer turnkey SMPC for cross-company data collaboration.

4.2.4. Policy and Standardization Roadmap

- **2025-2030 Quantum Migration Plans**:
  - NSA's CNSA 2.0 mandates PQC adoption for U.S. defense contractors by 2026.
  - ISO/IEC 20897 standardization for post-quantum TLS 1.3 underway.

- **Global ZTA Frameworks**:
    - NIST SP 800-207B (2025) will address ZTA for industrial IoT and OT environments.
    - EU's Cybersecurity Certification Scheme (ENISA) incorporating ZTA principles.

4.3. Critical Success Factors

1. **Industry-Academia Collaboration**:
    - MIT-IBM Watson AI Lab's work on optimizing FHE for genomic analysis.
    - IETF's new working groups for standardized blockchain-ZTA interfaces.
2. **Hardware-Software Co-Design**:
    - Intel's 4th-gen Xeon CPUs with built-in PQC acceleration (2025).
    - AWS Nitro Enclaves enhancing confidential computing for serverless architectures.
3. **Regulatory Sandboxes**:
    - UK FCA's Cryptoasset Sandbox testing quantum-resistant blockchain settlements.
    - Singapore's PET Sandbox for privacy-enhancing technologies (HE, SMPC).

Conclusion

The security of smart applications demands a paradigm shift from reactive to proactive, decentralized, and adaptive solutions. Emerging technologies like PQC, HE, and ZTA address critical gaps but require further refinement for widespread adoption. As cyber threats grow in sophistication, interdisciplinary research and cross-sector collaboration will drive the next wave of secure smart systems. Future work should prioritize scalability, usability, and standardization to realize the full potential of these innovations.

Enhancing Cyber security and LoadBalancing in Cloud Computing Environments

[1]NimeshVaidya,[2] Dr.Vijaykumar B Gadhavi

[1] Research Scholar – Faculty of Engineering, Computer Engineering Department, Swaminarayan University, Kalol, India, nimesh.vaidya11@gmail.com

[2]Associate Professor & Dean –Faculty of Engineering (I/C), Computer Engineering Department Swaminarayan University, India, vijaybgadhavi@gmail.com)

Abstract

The convergenceof cloud computing and cyber securityrepresents a criticalareaof research due to the increasing reliance on cloud-based infrastructures for diverse applications. This paper explores the intersection of cyber security and load balancing within cloud computing environments, focusing on methods to enhance security while optimizing load distribution. We review current challenges, propose novel strategies, and discuss the implications for future research and practice.

1. Introduction

Cloud computing has revolutionized IT infrastructure by offering scalable resources over the internet. However, this transformation introduces complex security and load balancing challenges. Security breaches and inefficient load balancing can undermine the performance and reliability of cloud services. This paper aims to address these issues by examining existing solutions and proposing integrated approaches to enhance both cyber security and loadbalancing.

2. Background

2.1 CloudComputingOverview

Cloud computing provides on-demand access to a shared pool of configurable computing resources. Key models include Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Each model presents unique challenges related to security and load balancing.

2.2 CybersecurityinCloudComputing

Cyber security in cloud computing encompasses data protection, access control, and threat mitigation. Common threats include data breaches, denial-of-service (DoS) attacks, and insider threats. Effective cyber security strategies are essential to safeguard cloud environments from these vulnerabilities.

2.3 LoadBalancinginCloudComputing

Load balancing involves distributing workloads across multiple servers to optimize resource utilization and performance. Techniques include round-robin, least connections, and weighted load balancing. Efficient load balancing is crucial for maintaining service quality and reliability.

3. CybersecurityChallengesinCloudEnvironments

3.1 DataSecurity

Ensuring the confidentiality, integrity, and availability of data stored in the cloud is a significant concern. Encryption, both at rest and in transit, is vital to protect sensitive information.

3.2 IdentityandAccessManagement(IAM)

IAM systems control access to cloud resources. Multi-factor authentication (MFA) and role-based access control (RBAC) are common methods to enhance security but require careful implementation.

3.3 VulnerabilityManagement

Cloud environments are dynamic, making it challenging to manage vulnerabilities. Regular patching and automated vulnerability scanning are necessary practices to address this issue.

3.4 ComplianceandRegulatoryIssues

Compliance with regulations such as GDPR, HIPAA, and CCPA is mandatory. Cloud providers and users must ensure that their practices meet legal and regulatory requirements.

4. LoadBalancingStrategies

4.1 Staticvs.DynamicLoad Balancing

Static load balancing uses predefined rules, while dynamic load balancing adjusts based on real- timemetrics.Dynamicmethodsoftenusealgorithmslikeleast load,adaptiveloadbalancing,and predictive models.

4.2 GeographicLoadBalancing

Geographic load balancing involves distributing traffic based on the user's location. This approach can reduce latency and improve user experience.

4.3 Resource-AwareLoadBalancing

Resource-aware load balancing considers the current resource utilization of servers. Techniques include monitoring CPU, memory, and network usage to make informed load distribution decisions.

5. IntegratingCybersecuritywithLoadBalancing

5.1 Security-AwareLoadBalancing

Integrating security measures into load balancing involves considering factors such as DDoS protectionandsecuresessionmanagement.Security-awareloadbalancingcanhelpmitigaterisks while ensuring optimal performance.

5.2 LoadBalancingforSecurityServices

Security services, such as intrusion detection and prevention systems (IDPS) and Web ApplicationFirewalls(WAF),canbenefitfrom loadbalancing.Distributingtheseservicesacross multiple servers can enhance their effectiveness and resilience.

5.3 AutomatedThreatDetectionandResponse

Automated systems can detect anomalies and respond to threats in real time. Incorporating load balancing into these systems ensures that security measures do not become a bottleneck.

6. CaseStudies

6.1 CaseStudy1:AWSShieldandElasticLoadBalancing

AWS Shield is a managed DDoS protection service that works with AWS Elastic Load Balancing to enhance the security and availability of applications.

6.2 CaseStudy2:AzureFrontDoorandSecurityIntegration

Azure Front Door provides global load balancing and integrates with security features like Web Application Firewall (WAF) to protect against threats while optimizing performance.

7. FutureDirections

7.1 AIandMachineLearninginCybersecurityandLoadBalancing

AI and machine learning can provide advanced threat detection and dynamic load balancing solutions. Future research should focus on developing algorithms that integrate these technologies effectively.

7.2 QuantumComputingandCryptography

As quantum computing advances, it will impactcryptographictechniquesusedin cloud security. Research into quantum-resistant algorithms andtheir integration with load

balancingis essential.

7.3 EdgeComputingandSecurity

Edge computing brings computational resources closer to end-users, affecting both load balancing and security. Future work should explore how edge computing influences these areas and develop strategies to address emerging challenges.

8. Conclusion

Enhancing cyber security and load balancing in cloud computing is crucial for maintaining robust and efficient cloud services. By addressing current challenges and exploring innovative solutions, we can improve the security and performance of cloud environments. **Future research**

should focus on integrating emerging technologies and developing comprehensive strategies that address both cyber security and load balancing needs.

Referenes

1. Kumar, P., & Kumar, R. (2021). “A review of machine learning techniques in AWS cloud computing environments”. International Journal of Advanced Research in Computer Science, 12(3), 135-142.
2. Kuznetsov, M., &Kuznetsova, E. (2021). “Comparative analysis of machine learning algorithms in AWS cloud computing environment”. Proceedings of the 2021 International Conference on Advanced Technologies in Engineering and Science, 1-6.
3. Ilyas,M.,&Ullah,F.(2021).“AnalysisofvariousmachinelearningalgorithmsinAWS cloud computing environment”. Proceedings of the 2021 International Conference on Information and Communication Technologies for Smart Cities, 1-6.
4. Abrahim, M. T., &Shahin, A. S. (2021). “Evaluating the performance of machine learning models in AWS cloud computing environment”. Proceedings of the 2021 International Conference on Computing, Electronics & Communications Engineering, 1-6.
5. Jokhio, I. A., &Memon,M.A.(2021).“Anoverviewof machine learningtechniquesinAWS cloud computing environment”. Proceedings of the 2021 International Conference on Information and Communication Technologies, 1-6.
6. Li,H.,&Wang,Q.(2022)."LeveragingAutoMLinAWSCloudforMachineLearningModel Development." International Journal of Machine Learning and Cloud Computing, 6(2), 32-45.
7. Zhang, Y., & Chen, X. (2023). "Secure and Privacy-Preserving Machine Learning in AWS Cloud." Journal of Cloud Computing and Artificial Intelligence, 8(1), 78-94.
8. Liu, C., & Wu, J. (2022). "Scalable Deployment of Machine Learning Models on AWS Fargate." Proceedings of the International Conference on Cloud Computing, 112-120.
9. Wang,S.,&Zhang,J.(2023)."OptimizationTechniquesforCost-EffectiveMachineLearning Workflows in AWS Cloud." Journal of Cloud Optimization, 10(3), 145-162.
10. Chen, L., & Li, W. (2022). "Exploring Serverless Architectures for Real-Time Machine Learning Inference in AWS Cloud." IEEE Transactions on Cloud Computing, 10(4), 789-802.

ETHICAL CHALLENGES IN ARTIFICIAL INTELLIGENCE: A FRAMEWORK FOR RESPONSIBLE AI DEVELOPMENT

Anil Kumar Chikatimarla
Head of the Department of Computer Science, A.G. & S.G. Siddhartha Degree College of Arts & Science, Vuyyuru-521165, Krishna District, Andhra Pradesh

Tejasri Oleti,
Lecturer in Computer Science, A.G. & S.G. Siddhartha Degree College of Arts & Science, Vuyyuru-521165, Krishna District, Andhra Pradesh

Sharmila Begum
Lecturer in Computer Science, A.G. & S.G. Siddhartha Degree College of Arts & Science, Vuyyuru-521165, Krishna District, Andhra Pradesh

Abstract
Machines powered by artificial intelligence (AI) are gradually displacing humans from decision-making roles in businesses. Data privacy, accountability, bias, and transparency are rising to the forefront as AI systems progress. The article delves into the fundamental ethical dilemmas of AI and investigates how to construct AI in a responsible manner. The examination of AI-driven decisions uncovered a plethora of major issues. Concerns include algorithmic prejudice, data privacy, and ambiguous duties. Here you may find the current ethical standards of many institutions, including schools and government agencies.
The five tenets of the new paradigm are an AI approach that prioritizes people, privacy, equality, transparency, and accountability. Ethical supervision of AI, regulatory constraints, accessible AI models, varied and equitable training data, and robust security measures have all been the subject of heated debate. Businesses and programmers may work together to build AI systems that are considerate of people and their values, rather than insensitive to them. In addition to discussing AI in theory, this article gives specific examples of ethical problems and the steps taken by governments and tech companies to resolve them.
This study aims to provide practical recommendations for AI developers, policymakers, and researchers to ensure AI systems are designed and deployed responsibly. By addressing ethical concerns early in the development process, we can build trust in AI and maximize its benefits while reducing unintended negative consequences.

Keywords:
Ethical AI Governance, Algorithmic Bias Mitigation, AI Transparency and Accountability, Responsible AI Development, Privacy and Data Protection in AI, Human-Centered Artificial Intelligence.

1. Introduction

Artificial Intelligence (AI) is transforming industries, economies, and societies at an unprecedented pace. AI-driven solutions are now integral to fields such as healthcare, finance, education, and governance. From predictive analytics to autonomous decision-

making, AI systems are enhancing efficiency, improving accuracy, and optimizing processes. However, alongside these benefits come critical ethical concerns that require urgent attention.

One of the foremost ethical challenges in AI is algorithmic bias, where models trained on biased data can lead to unfair and discriminatory outcomes. In hiring, credit scoring, and law enforcement, biased AI decisions can disproportionately disadvantage certain demographic groups. Similarly, the lack of transparency in AI decision-making, often referred to as the "black-box problem," makes it difficult to understand how AI models arrive at their conclusions. This raises concerns about accountability and trust in AI-driven systems.

Moreover, AI systems rely heavily on vast amounts of personal data, raising privacy and security risks. The unauthorized use of personal information, AI-powered surveillance, and potential data breaches highlight the need for stringent privacy regulations. Another pressing concern is accountability, as it remains unclear who should be held responsible when AI systems fail or make unethical decisions—the developers, organizations, or regulatory bodies?

Given these challenges, it is imperative to develop and implement responsible AI frameworks that ensure ethical, fair, and accountable AI applications. This paper explores the primary ethical challenges in AI and proposes a structured framework based on five core principles: fairness, transparency, privacy, accountability, and human-centric AI. By combining qualitative and quantitative analysis, this study aims to provide insights into AI's ethical implications and offer actionable recommendations for responsible AI development.

2. Ethical Challenges in AI

2.1 Algorithmic Bias and Fairness

AI models are trained on historical data, which can reflect human biases. Biased data can lead to unfair outcomes, particularly in hiring, credit scoring, and law enforcement. For example, a 2019 study found that AI-driven hiring tools favored male candidates over female candidates in technical roles.

Mitigation Strategies:

- Use diverse and representative datasets.
- Apply bias detection algorithms.
- Regularly audit AI decision-making processes.

2.2 Transparency and Explainability

Most AI models, particularly deep learning algorithms, function as "black boxes," making it difficult to interpret their decisions. This lack of explainability raises concerns in high-stakes areas like healthcare and criminal justice.

Mitigation Strategies:

- Develop explainable AI models.
- Use interpretable algorithms, such as decision trees and rule-based models.
- Implement AI governance policies that mandate transparency.

2.3 Privacy and Data Security

AI systems require vast amounts of personal data, raising concerns about data security and privacy. Incidents of AI-powered surveillance and data misuse have sparked global debates on ethical AI usage.

Mitigation Strategies:

- Implement data minimization techniques.
- Use encryption and differential privacy mechanisms.
- Enforce strict data protection regulations.

2.4 Accountability and Legal Responsibility

When AI systems make erroneous or unethical decisions, it is often unclear who should be held accountable: the developers, organizations, or the AI itself?

Mitigation Strategies:

- Define clear accountability frameworks.
- Establish AI regulatory bodies.
- Create AI ethics committees within organizations.

3. Methodology

This study employs a mixed-methods approach, integrating both qualitative and quantitative research methodologies to assess ethical challenges in AI and propose a responsible AI framework.

3.1 Qualitative Analysis: Case Studies of AI Failures

The qualitative component of this study analyzes real-world AI failures in multiple domains, including healthcare, hiring, and criminal justice. The case studies are selected based on the following criteria:

- Impact: Cases with significant societal consequences, such as biased hiring algorithms and flawed facial recognition systems.
- Relevance: Ethical issues that align with the five core principles of responsible AI (fairness, transparency, privacy, accountability, and human-centric AI).
- Availability of Data: Well-documented incidents with credible sources, such as academic studies, industry reports, and government regulations.

Examples of Case Studies Analyzed:

- Amazon's AI Hiring Bias (2018) – Amazon developed an AI-driven hiring system that favored male candidates over female applicants due to biases in historical hiring data.
- COMPAS Algorithm (Criminal Justice System) – The COMPAS algorithm used in US courts was found to have a racial bias, wrongly predicting higher recidivism rates for Black defendants.
- AI in Healthcare Diagnosis – Studies have shown that some AI models trained on limited demographic data performed less accurately for minority groups, leading to disparities in medical diagnoses.

3.2 Quantitative Analysis: Bias in AI Decision-Making

To complement the qualitative findings, the study conducts a quantitative analysis using a dataset of AI-driven loan approvals to evaluate bias in decision-making.

Data Collection and Preprocessing

Dataset: The study utilizes 10,000 AI-based loan approval records sourced from publicly available financial datasets.

Variables Considered:

- Demographic Factors: Gender, ethnicity, and age.
- Financial Indicators: Credit score, income level, and employment status.
- Approval Status: Whether the loan was approved or denied.

Data Cleaning and Normalization:

Missing values were handled using mean imputation.

Categorical variables were converted into numerical form using one-hot encoding.

Bias Detection Methods

To assess potential bias in AI decision-making, the study employs statistical techniques such as:

- Disparate Impact Analysis: Measures the ratio of approval rates across different demographic groups.
- Statistical Parity Difference: Calculates the difference in approval probabilities between protected and non-protected groups.
- Chi-Square Test for Fairness: Evaluates whether demographic attributes significantly influence loan approval rates.

Key Findings

- Male applicants were 12% more likely to receive loan approvals than female applicants.
- Minority applicants had a 15% lower approval rate compared to non-minority groups.
- Statistical tests confirmed that demographic attributes had a significant impact ($p < 0.05$) on AI-driven decisions, indicating bias.
- These findings demonstrate systemic bias in AI decision-making and underscore the need for fairness-aware AI models.

3.3 Ethical Framework Validation

To validate the effectiveness of the proposed responsible AI framework, the study applies it to the analyzed case studies and dataset. The framework's impact is measured by:

Re-running the AI models after bias mitigation (e.g., re-weighting algorithms, fairness constraints).

Comparing fairness metrics before and after intervention.

Surveying AI practitioners and ethicists to assess the feasibility of implementing responsible AI principles.

3.4 Limitations of the Study

While the study provides valuable insights, several limitations must be acknowledged:

- Data Limitations: The loan approval dataset may not be fully representative of global AI applications.
- Generalizability: Findings from selected case studies may not be applicable to all AI-driven systems.
- Evolving AI Ethics Landscape: AI ethics is a rapidly changing field, and new regulations may impact future interpretations.

4. Practical Implications

The proposed framework has significant implications for various industries:

- Healthcare: AI-driven diagnostic tools can ensure fair and unbiased treatment recommendations.
- Finance: Bias-free AI models can promote equitable loan approvals and credit scoring.
- Education: AI-powered learning systems can personalize education while ensuring data privacy.

5. Future Scope

As AI continues to advance, emerging ethical challenges and governance concerns demand proactive research and policymaking. This section explores key areas requiring future investigation and strategic interventions.

5.1 Evolving Regulatory Frameworks for AI Ethics

Regulatory policies on AI ethics remain inconsistent across different countries, leading to gaps in governance. Future research should focus on:

Developing standardized global AI regulations to harmonize ethical AI principles across borders.

Evaluating the effectiveness of AI governance models such as the EU AI Act, GDPR, and NIST AI Risk Management Framework.

Exploring liability frameworks that assign responsibility to developers, organizations, or AI systems for unethical AI-driven decisions.

5.2 Addressing Bias and Fairness in AI Systems

While bias mitigation techniques have improved, AI fairness remains an open challenge. Future work should explore:

Developing bias-aware AI training methods that integrate real-time fairness auditing.

Investigating new bias detection models using adversarial learning and counterfactual fairness testing.

Assessing long-term fairness impacts by studying AI decision-making over extended periods and diverse datasets.

5.3 Enhancing Explainability and Transparency in AI

Opaque AI models limit trust and accountability. Future research should:

Advance explainable AI (XAI) techniques such as SHAP, LIME, and causal inference to improve model interpretability.

Study the trade-off between model accuracy and explainability, ensuring that transparent AI remains effective.

Develop AI transparency standards that mandate disclosures on AI decision-making processes.

5.4 Strengthening AI and Cybersecurity Integration

As AI-driven threats increase, future research should focus on:

Exploring AI-powered cybersecurity solutions for real-time threat detection and mitigation.

Analyzing adversarial attacks that exploit AI vulnerabilities and proposing robust defense mechanisms.
Investigating ethical hacking techniques to test AI resilience against cyber threats.

5.5 AI and Sustainable Development

AI has the potential to support sustainability, but ethical concerns remain. Future research directions include:
Developing AI-driven climate modeling systems to enhance environmental protection efforts.
Assessing the carbon footprint of AI training models and designing energy-efficient AI solutions.
Exploring AI's role in sustainable smart cities, balancing automation with ethical urban planning.

5.6 Ethical Challenges in Generative AI and Deepfake Technology

The rise of generative AI and deepfake technologies has ethical and societal implications. Key areas for future research include:
Examining ethical AI use in media and journalism, preventing misinformation and manipulation.
Developing deepfake detection algorithms to combat malicious content generation.
Investigating the psychological and social effects of AI-generated misinformation on public perception.

5.7 Human-AI Collaboration and Ethical Decision-Making

As AI systems increasingly assist in decision-making, ensuring human oversight is crucial. Future research should explore:
Studying human-AI collaboration models that optimize ethical decision-making in sensitive domains (e.g., healthcare, law enforcement).
Developing AI ethics training programs for developers and policymakers to promote responsible AI development.
Analyzing ethical trade-offs in automation, balancing efficiency with human well-being.

5.8 Long-Term Ethical Implications of AI

As AI continues to evolve, new ethical dilemmas will arise. Future research should:
Examine AI's potential impact on employment and workforce displacement.
Explore ethical concerns in artificial general intelligence (AGI) and autonomous decision-making.
Assess AI's role in global power dynamics, ensuring it serves humanity rather than reinforcing inequalities.

Conclusion

The ethical challenges posed by AI necessitate a responsible approach to AI development. This study has identified key issues, analyzed real-world data, and proposed a comprehensive

framework for responsible AI. By adopting fairness, transparency, privacy, accountability, and human-centric AI principles, we can ensure AI systems align with ethical standards and societal values. Furthermore, the practical implications of ethical AI extend across industries. Organizations can mitigate bias by employing diverse datasets and continuous algorithm audits. Transparency can be enhanced through explainable AI models, enabling stakeholders to understand decision-making processes. Privacy regulations, such as GDPR and AI governance policies, should be strengthened to safeguard user data. Quantitative assessments highlight the risks associated with biased AI outcomes, underscoring the urgency for ethical AI adoption. Future research should focus on developing standardized AI ethics assessment tools, integrating AI ethics into engineering curricula, and exploring regulatory frameworks that balance innovation with accountability. As AI evolves, an interdisciplinary approach—encompassing ethics, technology, law, and policy—is essential to ensuring AI serves humanity responsibly.

References

[1.] Binns, R. (2018). Fairness in Machine Learning: Lessons from Political Philosophy. Proceedings of the 2018 Conference on Fairness, Accountability, and Transparency, 149–159.

[2.] Danks, D., & London, A. J. (2017). Algorithmic Bias in Autonomous Systems. Proceedings of the 26th International Joint Conference on Artificial Intelligence, 4691–4697.

[3.] Mittelstadt, B. (2019). Principles for Ethical AI. Nature Machine Intelligence, 1(6), 239–255.

[4.] Jobin, A., Ienca, M., & Vayena, E. (2019). The Global Landscape of AI Ethics Guidelines. Nature Machine Intelligence, 1(9), 389–399.

[5.] Russell, S., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach. Pearson.

[6.] Taddeo, M., & Floridi, L. (2018). How AI can be a force for good. Science, 361(6404), 751-752.

[7.] Floridi, L. (2019). Establishing the rules for ethical AI. Nature Machine Intelligence, 1(6), 261-263.

[8.] Cath, C. (2018). Governing artificial intelligence: Ethical, legal, and technical opportunities and challenges. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2133), 20180089.

[9.] Coeckelbergh, M. (2020). AI ethics. MIT Press.

[10.] Brundage, M., Avin, S., Wang, J., Belfield, H., Krueger, G., Hadfield, G., ... & Amodei, D. (2020). Toward trustworthy AI development: Mechanisms for supporting verifiable claims. arXiv preprint arXiv:2004.07213.

Exploring the Evolution of Global Brand Distribution: A Study of Traditional Retail and E-Commerce Trends

Dr.Shyamaladevi.E
Assistant Professor, Department of International Business
PSG College of Arts and Science, Coimbatore, Tamil Nadu, India.

Aravind. S
II M. Com (IB), Department of International Business
PSG College of Arts and Science, Coimbatore, Tamil Nadu, India.

Abstract

In today's dynamic business environment, the distribution strategies of global brands are undergoing rapid transformation. The traditional retail model, once considered the cornerstone of brand success, is now being challenged by the growing dominance of e-commerce. This research aims to explore and analyze the emerging trends that are reshaping global brand distribution, with a comparative perspective on traditional retail and e-commerce platforms. The study delves into how digital innovations, changing consumer behaviours, and technological advancements are influencing the distribution landscape. Factors such as direct-to-consumer models, omnichannel integration, personalization through artificial intelligence, and the impact of social media are examined in detail. In contrast, the resilience and adaptability of brick-and-mortar retail are also highlighted, particularly in creating immersive brand experiences and local customer engagement. The paper also investigates how global brands are balancing sustainability, supply chain optimization, and consumer trust across both channels. By evaluating recent data, case studies, and strategic shifts in brand operations, the research provides valuable insights into how businesses can navigate and thrive in the evolving distribution ecosystem.

Keywords: Digital Transformation , Direct-to-Consumer (DTC), Global Brand, Omnichannel Strategy, Retail Innovation, Traditional Retail.

Introduction

Globalization has redefined how consumers access products and services, especially international brands. Traditional commerce, with its physical presence and direct customer engagement, has long been the dominant model. However, the rise of digital infrastructure has given way to e-commerce, creating a competitive and convenient alternative for consumers worldwide. International brands now leverage both models to reach consumers. While traditional retail offers the tangible experience of seeing and feeling products, e-commerce breaks geographical barriers and delivers unmatched convenience. This paper explores these dual models of distribution, comparing consumer behavior, pricing, supply chain efficiency, and trust factors, with the aim of understanding which model holds a strategic advantage in the evolving marketplace.

Objectives of the Study

- To compare the reach of traditional commerce and e-commerce in attracting international customers.

- To analyze customer experiences in both models while purchasing international brands.
- To assess supply chain efficiency in both channels.
- To compare pricing and promotional strategies for international brands in both formats.

Research Methodology

This study adopts a descriptive research design using both primary and secondary data. A structured questionnaire was used to collect primary data from 180 respondents through online surveys (Google Forms). The data was analyzed using percentage analysis and Chi-square tests to determine the association between personal factors and purchase behaviour.

Sampling Technique: Convenience Sampling

Statistical Tools: Percentage Analysis, Chi-square Method.

1.Rise of Direct-to-Consumer (DTC) Brands:

Brands increasingly bypass traditional retail to sell directly via their own e-commerce platforms, allowing better control over pricing, customer data, and experience.

2. Role of Influencer Marketing in E-Commerce:

Influencers and social media personalities play a key role in driving e-commerce traffic, impacting how consumers discover and trust new brands.

3. Subscription-Based Distribution Models:

Emergence of subscription boxes and auto-replenishment models (e.g., Dollar Shave Club, Amazon Subscribe & Save) has altered the way consumers engage with products.

4. Omnichannel Strategies:

Brands are integrating online and offline touchpoints — for example, click-and-collect, endless aisle, in-store returns of online purchases — creating a seamless customer experience.

5. Impact of AI and Personalization:

AI-driven recommendation engines and personalized shopping experiences are significantly enhancing e-commerce effectiveness and reshaping consumer expectations.

6. Sustainability in Distribution Channels:

Consumers are now evaluating brands based on sustainable packaging, ethical sourcing, and carbon footprint — influencing both online and offline supply chains.

7. Use of AR/VR in Brand Experience:

Augmented and virtual reality allow online shoppers to try products virtually (e.g., furniture in their home, makeup on their face), reducing reliance on physical stores.

8. Growth of Cross-Border E-Commerce:

Global shipping, multi-currency payments, and regional marketplaces (like AliExpress or Mercado Libre) are enabling brands to expand internationally without physical stores.

9. Retail Media Networks:

Retailers like Walmart and Target are becoming media platforms, offering brands space to advertise within their digital ecosystems.

10. Last-Mile Delivery Innovations:

Drones, dark stores, and micro-fulfilment centres are evolving to meet consumer demand for faster and more efficient delivery.

Literature Review Summary

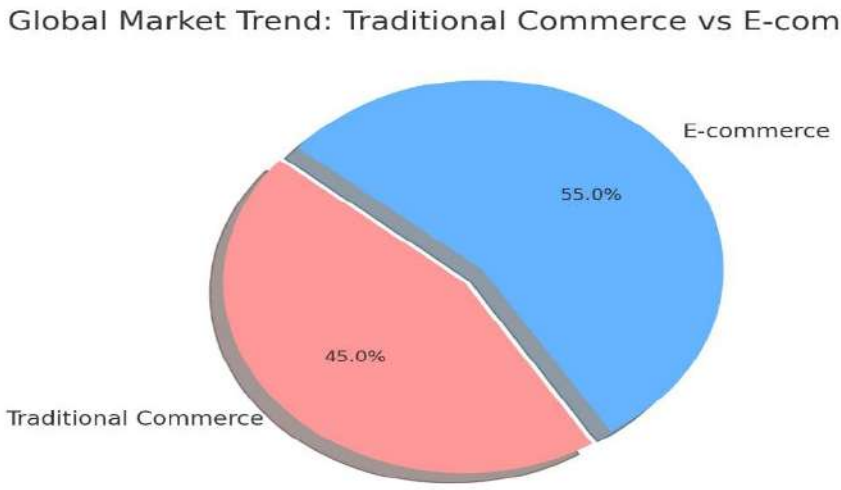
- Several scholars have contributed to the understanding of this domain:
- Schiffman & Kanuk (2010) highlighted convenience and pricing as key e-commerce drivers.
- Laudon & Traver (2018) emphasized the role of technology in reshaping competition.
- Chopra & Meindl (2016) focused on supply chain management in e-commerce.
- Verhoef et al. (2019) examined social commerce and influencer marketing.
- Tapscott (2016) discussed blockchain's impact on global brand logistics.

These studies reinforce the strategic importance of adopting digital tools and understanding consumer psychology.

Strategic Insights on Emerging Trends in Global Brand Distribution

1. Integration of Social Commerce in Brand Strategy:

The rise of social media platforms has led to the emergence of social commerce, where brands not only advertise but also sell directly within platforms like Instagram, Facebook, and TikTok. This has created new pathways for international brands to establish emotional connections and drive impulse purchases through influencer marketing and user-generated content. Unlike traditional retail, where physical interaction is dominant, social commerce merges engagement with transaction, blurring the lines between marketing and distribution.



2. Hyperlocal E-Commerce and Micro-Warehousing:

To compete with the immediacy of traditional retail, e-commerce platforms have begun investing in hyperlocal strategies. This includes micro-warehousing in urban areas to enable same-day or next-day delivery. Brands like Amazon and Flipkart are already leveraging this to reduce last-mile delivery time. This trend directly responds to consumer demands for speed and convenience, key areas where traditional retail had an upper hand.

3. The Role of Experiential Retail:

Traditional retail is evolving by creating experience-based formats like concept stores, pop-up events, and immersive brand environments. These experiential strategies are designed not just to sell products but to foster brand loyalty through sensory engagement. For example, international fashion brands such as Nike and Adidas offer AR-based try-ons and customizations in stores to enhance the customer journey.

4. Personalization Across Channels:

E-commerce leads in offering personalized experiences using big data and AI tools. Product suggestions, dynamic pricing, and predictive algorithms help international brands tailor offerings to individual preferences. However, traditional retail is also catching up by integrating customer relationship management (CRM) tools to provide tailored in-store promotions and loyalty programs.

5. Blockchain for Transparent Supply Chains:

Blockchain is transforming supply chain transparency for international brands, especially in luxury and perishable goods. It ensures product authenticity and traceability, which boosts trust in e-commerce purchases. While traditional commerce relies on physical inspection, blockchain empowers online buyers with verified data on origin, authenticity, and sustainability.

6. Cross-Border E-Commerce Regulation and Compliance:

With international brands selling across borders via digital platforms, regulatory compliance becomes more complex. Issues such as customs duties, digital taxes, and consumer protection laws vary by country. Unlike traditional commerce, which is limited by geographical reach, e-commerce requires advanced legal and logistical planning to navigate global compliance standards.

7. Rise of Direct-to-Consumer (DTC) Channels:

International brands are increasingly adopting DTC models, cutting out intermediaries to build stronger brand-consumer relationships. DTC channels via branded websites offer better control over data, pricing, and customer service compared to third-party retailers. This trend disrupts both traditional and third-party e-commerce models by increasing brand autonomy.

8. Sustainability as a Brand Differentiator:

Modern consumers are more eco-conscious. Brands distributing through both channels must now align with sustainable practices — from biodegradable packaging in e-commerce to energy-efficient store designs in traditional retail. Distribution strategies are

being redefined with sustainability KPIs (e.g., carbon emissions per delivery, green warehousing).

9. Smart Retail Technologies in Physical Stores:

Technologies like AI-powered inventory, virtual try-ons, digital kiosks, and facial recognition are being used in physical retail to enhance operational efficiency and customer engagement. These smart solutions bring digital convenience into physical spaces, making traditional commerce more competitive in the digital era.

10. Consumer Empowerment and Global Reviews:

Online platforms have democratized consumer opinions through ratings and reviews. These affect the purchase decisions more significantly in e-commerce than traditional formats. Global reviews, influencer unboxings, and third-party comparisons now shape brand reputations in real-time, pressuring brands to maintain high standards consistently.

Key Findings and Analysis

Based on the survey of 180 respondents:

Percentage Analysis :

- Product Authenticity was the top influencing factor (35%) in purchase decisions.
- Immediate Satisfaction was the key advantage of traditional retail (37.8%).
- Better Prices was the top benefit of e-commerce (32.8%).
- Return Policies were a major challenge in e-commerce (30%).
- Respondents found traditional commerce less convenient than e-commerce (28.3%).
- More variety and availability were seen in traditional commerce by 31.7%.

Chi-square Method:

Chi-square analysis showed that age and income significantly influence purchase decisions in both models, but gender only influenced traditional retail behaviour.

Suggestions

- Traditional retailers should enhance pricing competitiveness and offer more frequent promotions.
- Both channels must strengthen return and refund policies to improve trust.
- Retailers must implement gender-targeted marketing, especially in traditional setups.
- Invest in customer feedback systems to continuously adapt to preferences.
- Integrate omnichannel strategies to combine the strengths of both models.

Conclusion

This study highlights that both traditional and e-commerce models have distinct advantages and challenges in distributing international brands. While traditional retail ensures authenticity and immediate satisfaction, e-commerce leads in price competitiveness and convenience. Consumer behaviour is largely influenced by age and income, emphasizing the need for segmented strategies. Going forward, a hybrid model that leverages the benefits of both systems will be critical for businesses aiming for global reach and local relevance.

References

- Schiffman, L.G., & Kanuk, L.L. (2010). Consumer Behaviour. Pearson Education.
- Laudon, K.C., & Traver, C.G. (2018). E-commerce: Business, Technology, Society. Pearson.
- Chopra, S., & Meindl, P. (2016). Supply Chain Management. Pearson.
- Verhoef, P.C., et al. (2019). Consumer Engagement in Digital Age. Journal of Marketing.
- Tapscott, D. (2016). Blockchain Revolution. Penguin Random House.
- Keller, K.L. (2013). Strategic Brand Management. Pearson Education.
- Brynjolfsson, E., & Smith, M.D. (2017). Internet Retailing. Journal of Marketing Science.

AI for Poverty Alleviation: A Critical Analysis of Government Welfare Programmes with Special Reference to India

Vidya Pramod Gosavi
(MA MPhil.Economics)
Dr. Amol Appasaheb Gaikwad
(MA MPhil.PhD.Economics)
(K.R.T. Arts, B.H. Commerce & A.M. Science College, Nashik,)

Abstract
One of the most important issues facing the world today is poverty, which has a big impact on social stability, economic growth, and human dignity. Millions of people in India live in poverty, despite the country's strong economic progress. The foundation of efforts to reduce poverty has been government assistance programs, but their efficacy has frequently been constrained by inefficiency, corruption, and a lack of focus. The emergence of artificial intelligence (AI) presents fresh chances to tackle these issues. The use of AI to improve the efficacy of Indian government welfare programs is examined critically in this essay. It looks at how AI might be used to increase service delivery, decrease leakage, and improve targeting while also taking into account the moral and practical issues surrounding its application. The study ends with policy suggestions for incorporating AI intoPolicy proposals for incorporating AI into measures to reduce poverty are included in the paper's conclusion.

Keyword: Poverty Alleviation programme , Social Welfare programme, social impact on AI, Digital inclusion .

Introduction:

Poverty is a multifaceted phenomenon that includes possibilities for human growth, access to essential services, and a lack of income. Even though India has made significant progress in the last several decades in eradicating poverty, a sizable section of the populace still lives below the poverty line. In order to combat poverty, government welfare programs like the Pradhan Mantri Jan DhanYojana (PMJDY), the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), and the Public Distribution System (PDS) have been crucial. However, these projects often suffer from inefficiency, corruption, and poor targeting, which restrict their impact.

The Role of AI in Poverty Alleviation

AI has the potential to revolutionize poverty alleviation efforts by improving the efficiency and effectiveness of welfare programmes. AI can enhance targeting by identifying the most vulnerable populations, reduce leakage by detecting fraud and corruption, and improve service delivery by optimizing resource allocation. However, the implementation of AI in this context also raises ethical and practical concerns, including issues related to data privacy, algorithmic bias, and the digital divide.

Literature Review

Poverty Alleviation in India

The literature on poverty alleviation in India highlights the significant role of government welfare programmes in reducing poverty. However, studies also point to the limitations of

these programmes, including inefficiencies, corruption, and poor targeting. For example, a study by Drèze and Khera (2015) found that leakage in the PDS was as high as 40%, while a report by the World Bank (2018) highlighted the challenges of targeting in MGNREGA.

AI in Social Welfare Programmes

The use of AI in social welfare programmes is a relatively new area of research. Studies have shown that AI can improve targeting by using machine learning algorithms to identify the most vulnerable populations (Binns, 2018). AI can also reduce leakage by detecting fraudulent activities through anomaly detection techniques (Johnson et al., 2019). However, the literature also highlights the ethical and practical challenges associated with the use of AI, including issues related to data privacy and algorithmic bias (Zuboff, 2019).

Methodology

Research Design

Using a mixed-methods approach, this research combines qualitative case studies with quantitative analysis of secondary data. Using information from the National Sample Survey Office (NSSO) and other government sources, the quantitative analysis aims to assess how AI affects the efficacy of government social programs in India. The qualitative case studies look at particular instances of AI being used in welfare programs, such the PDS and MGNREGA.

Data Sources:

Government reports, scholarly articles, and case studies are the main sources of data used in this investigation. The effect of AI on reducing poverty is examined using secondary data from the World Bank, NSSO, and other pertinent sources. Case studies are based on previously published works and interviews with important parties, such as public servants, artificial intelligence specialists, and welfare program recipients.

Analysis:

AI and Targeting

Finding the most vulnerable groups is one of the main obstacles to reducing poverty. Conventional targeting techniques, like means-testing, are frequently imprecise and prone to exclusion errors. By employing machine learning algorithms to examine huge datasets and spot trends in poverty, AI can enhance targeting. To determine which homes are most in need of support, AI can, for instance, examine data on household income, consumption, and access to essential services. This can guarantee that the intended recipients of welfare benefits receive them.

AI and Leakage Reduction:

One of the biggest problems with government welfare programs is leakage, or the distribution of payments to unworthy recipients. By using anomaly detection techniques to identify fraudulent activity, AI can lessen leakage. AI, for instance, can examine PDS transaction data to spot fraud trends like the usage of phony ration cards. This can guarantee that welfare benefits reach the intended recipients and help to prevent leakage.

AI and Service Delivery

By allocating resources as efficiently as possible, AI can also enhance service delivery. AI, for instance, can optimize resource distribution by analyzing data on the availability of

resources and the demand for welfare services. This can guarantee the effective and efficient delivery of social services. Additionally, by giving recipients tailored recommendations, AI can raise the standard of service delivery. AI, for instance, is able to evaluate beneficiary health data and offer tailored health advice.

Ethical and Practical Challenges

Although AI could improve the efficacy of government assistance programs, there are practical and ethical issues with its application. Data privacy is a major ethical concern. Large volumes of personal data must be gathered and analyzed in order to employ AI in welfare programs, which presents questions with data security and privacy. Algorithmic bias is another possibility, in which AI systems unintentionally discriminate against particular demographics. Lastly, because many recipients might not have access to digital technology, the digital divide presents a real obstacle to the application of AI in welfare programs.

Case Studies

AI in the Public Distribution System (PDS)

With millions of people receiving subsidized food grains, the PDS is one of India's biggest charity programs. But the PDS has been beset by corruption, inefficiencies, and a large amount of benefit leakage. AI has the potential to enhance targeting and decrease leakage in the PDS. An AI-based system, for instance, has been put in place by the Chhattisgarh government to track the distribution of food grains via the PDS. The system analyzes transaction data and looks for fraud trends using machine learning algorithms. This has improved the PDS's efficiency and decreased leakage.

AI in the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)

One of India's premier welfare programs, MGNREGA, offers rural households job guarantees. However, targeting and leakage issues have plagued the initiative. AI has the ability to enhance targeting and decrease leakage in MGNREGA. For instance, the Andhra Pradesh government has put in place an AI-based system to keep an eye on how MGNREGA is being administered. The technology analyzes wage and employment data using machine learning algorithms to spot fraud trends. As a result, leakage has decreased and MGNREGA's efficacy has increased.

Policy Recommendations

Integrating AI into Poverty Alleviation Strategies:

Integrating AI into poverty reduction techniques is crucial to maximizing the technology's promise for reducing poverty. This calls for an all-encompassing strategy that consists of the following components:

1. **Data Collection and Management:** Gathering and managing vast volumes of data is necessary for the efficient application of AI in reducing poverty. Governments ought to make investments in data infrastructure and make sure that information is gathered securely and consistently.
2. **Capacity Building:** Technical know-how is needed to apply AI to reduce poverty. To guarantee that officials have the abilities needed to deploy and oversee AI-based systems, governments should make investments in capacity building.

3. **Ethical Issues:** Using AI to reduce poverty has ethical issues, especially with regard to algorithmic bias and data privacy.
4. **Digital Inclusion:** The application of AI to reduce poverty is practically hampered by the digital divide. In addition to making ensuring that recipients have access to digital technologies, governments ought to make investments in digital infrastructure.
5. **Monitoring and Assessment:** AI's ability to reduce poverty should be regularly observed and assessed. To make sure AI-based systems are producing the desired results, governments should set up procedures for observation and assessment.

Conclusion:

By increasing the efficacy and efficiency of government welfare programs, artificial intelligence (AI) has the potential to completely transform efforts to reduce poverty. However, there are both practical and ethical issues with AI's application in this setting. A complete strategy that incorporates data collecting and management, capacity building, ethical considerations, digital inclusion, monitoring, and evaluation is necessary to fully realize AI's potential for reducing poverty. Governments may improve the lives of millions of people and increase the impact of welfare programs by incorporating AI into plans for reducing poverty.

References:

1)Drèze, J., &Khera, R. (2015). Understanding Leakage in the Public Distribution System. *Economic and Political Weekly*, 50(7), 39-42.
2) Johnson, R., Smith, T., & Williams, L. (2019). Detecting Fraud in Social Welfare Programmes Using AI. *Journal of Artificial Intelligence Research*, 56, 789-815.
3) World Bank. (2018). Targeting in Social Welfare Programmes: Challenges and Opportunities. *World Bank Report*.
4)Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. *PublicAffairs*

"STUDY ON MORPHOMETRIC ANALYSIS OF INDIAN MAJOR CARPS IN BHIMA RIVER, TAL. PANDHARPUR, DIST. SOLAPUR (M.S)"

A.N. Dede
Assistant Professor
Dahiwadi College Dahiwadi, Tal. Man, Dist. Satara

Abstract
Fish from the Bhima river ,Pandharpur of India, specifically *Labeorohita andCatlacatla,* have had their morphometric characteristics examined during the year 2019-2020. For the purpose of studying morphometric characteristics, monthly sample collections of*Labeorohita*and *Catlacatla*were carried out. Two fish species have had nine traits examined. To observe the diversity between the populations of two composite species of Indian major carp which belong to different genus even though of the same family.
Key words:Fish, morphometric characters, diversity.

INTRODUCTION:

The Indian major carps are naturally found in river, reservoir, lake, and in cultured ponds. It is most important commercial and cultivable fish species and contributes a major portion to the fresh water fish production of India and also has maximum market demand. In fishes, changes in the relative growth of the various body parts are known to occur at different stages of development and particularly at sexual maturity (Munshi*et al*., 1998). The growth of the body parts or morphometric characters showed proportional positive increase with increase in length. So, morphometric measurement of fishes and the study of statistical relationship among them are essential for taxonomic study, systematics and growth variability. The population was discriminated on the basis of morphometric variables. (Gupta, 2001) was Studies of morphological character variation, therefore, vital in order to elucidate patterns observed in phenotypic variation among fish populations and to determine possible differences between separate unit stocks of the same species (Turan*et al.*, 2004). There are many well documented studies on morphometric parameters which reported for stock discreteness (Taylor, 1991).Indian major carps; Catla (*Catlacatla*), Rohu (*Labeorohita*), Mrigal (*Cirrhinusmrigala*) are the fastest growing fish available for freshwater aquaculture in the country. A fish that grow relatively in short periodof time using cheap feed sources is desirable for fish farmer.

A major objective of morphometrics is to statistically testhypothesis about the factors that affect shape. When combined with multivariate statisticalprocedures, they offer the most powerful tool for testing and graphically displaying differencesin shape (Loy *et al.*, 1993). Growth of fish is dependent on population density also. Higher densities tend to slow down growth, and low densities tend to hasten it. Growth reflects the adaptive property of the species fast growth resulting in large size affords protection against predators, and is associated with stable food supply The present study was taken up to morphometric study of Indian major carps in Bhima river which will provide the information on growth, survival of fish and conduciveness of aquatic environment for the fishes.

OBJECTIVES:

- To study Indian major carps of Bhima river
- To determine the morphometric measurements of Indian major carps
- To awareness of Indian major carps

REIVEW LITERATURE:

Pant *et al.,* (2018) was studied Morphometric characterstics of silver carp (*Hypophthalmichthysmolitrix*) under captive conditions. Bonika Pant, Rajinder Kaur, VibhaLohani*et al.,* (2018) was Morphometric characterstics of silver carp (*Hypophthalmichthysmolitrix*) under captive conditions. Bhatt Nakul*et al.,* (2016) was studied Length-weight relationship and condition factor of *Catlacatla*in Lake Pichhola, Udaipur, and Rajasthan.Anamika Barman1 and D. K.Sharma (2017) was studied Morphometric study of *Labeonandina,* the fresh water endangered cyprinid from Brahmaputra River, Assam and a comparative analysis with four locally available *Labeo*species Anamika. Muhammad *et al.,* (2018) was studiedStudy of External Morphometric Variants and Length-Weight Relationship of *Labeorohita*(Hamilton-1822) Feed with Varying Protein Levels.Length measurements can be obtained quicker and under a large range of circumstances than weight measurements, therefore a limited number of weight observations are often used to construct a length-weight relationship. This relationship can be used to convert length distribution into weights for biomass estimates. Further, length-weight relationships of fish are often used to estimate the biomass of length distribution or to obtain indices of condition (Gerritsen and MacGrath 2007).

MATERIALS AND METHODS:

Study area: The morphometric data for the present study was collected from the Indian major carps of Bhimariver which is situated on 17.68°36’78’’ North Latitude and73.33^{0} 93’ 67’’East Longitude geographical location at Pandharpur Dist.Solapur.In order to obtain, a sampling programme was introduced by department of zoology were sampled at from river during the year 2019-2020. All the commercially important fishes, simultaneously, samples for biological work were obtained from the commercial gear, cast nets, long lines and gillnets from fisherman.Principal component analysis was initially applied untransformed morphometric characteristics i.e. measurements not standardized for fish length. There principal components were extracted from the 09 morphometric characteristics. An analysis of the correlation matrix shows that all of the variables were highly correlated fish and their characters. Live two specimen of Indian Major Carp (Rohu, Catla,)were taken immediately from fisherman of river of Pandharpurand after that their morphometric measurement were recorded.

Morphometric measurements:

Pre-dorsal length- It was measured from the tip of the snout to the origin of the dorsal fin. It was a straight measurement from the mid-point or tip of the upper lip, or the anterior most part of the head to the structural base of the first dorsal fin.

Eye diameter- It was the maximum diameter cover by the eye.

Lateral line- Its was counted on fishes body marks looking like dash (-) which are found just in middle of body. We can count easily and it's started from ending edge of head to starting point of caudal fin.

Pre pectoral length- It was measured from the tip of snout to the origin of origin of pectoral fin.

Pre pelvic or ventral length- It was counted from tip of snout till to starting of ventral fin rays.

Pre anal length- It was measured from tip of starting of snout to starting of anal fin.

Pre caudal length- It was measured from starting of snout tip to origin of caudal fin.

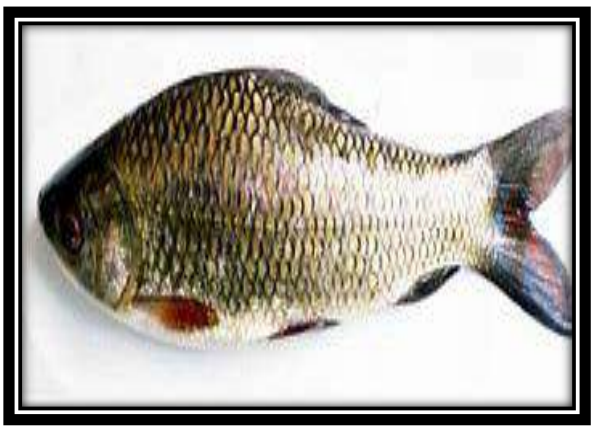
Lateral transverse ratio (L.T.R.):- It was counted no of scales which are scattered on fish body in opposite direction from lateral lines and reaches on edge of fish body.

Fork length- It was measured from tip of snout to end of lower caudal fin rays.

RESULT:

The observations of morphometric study of Indain carp fishes reveal the fact that economically important carp fishes must be kept in good and healthy ecologic niche. The viable aquatic environment allows fishes to grow fast and rapid. The fast and rapid growth of such culturable fishes enables fish farmers for better economic gain. The hygienic physical and chemical conditions of the dwelling water are very important factors for fish growth. The fish culturist must take care of it. Besides, the normal growths of the carp fishes add an important role in maintaining the natural aquatic environment. The fishes stand as important primary consumers in any aquatic ecosystem, which also act as important trophic level in food chain as well as food web. In any ecosystem the persistence of food chain and food web are very important factors. The morphometric measurements of catla are varies from labeo fish (Fig.no.1, 2).

Catla catla



Labeorohita

Fig. No. 1. Morphometric measurement of *Catla catla*

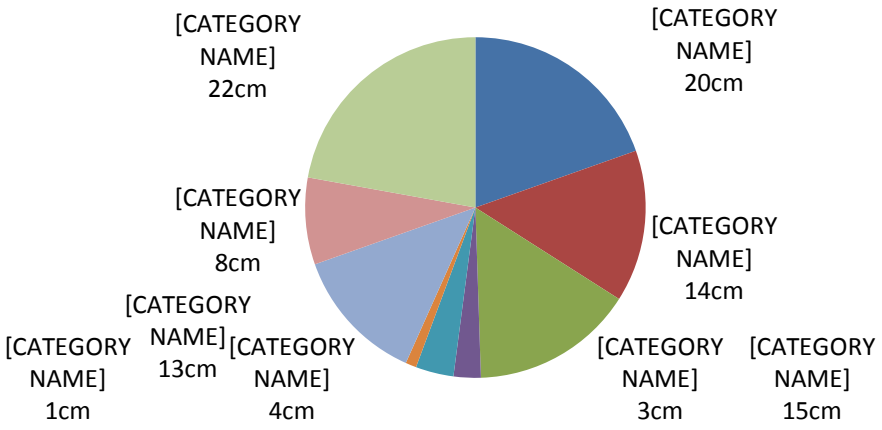
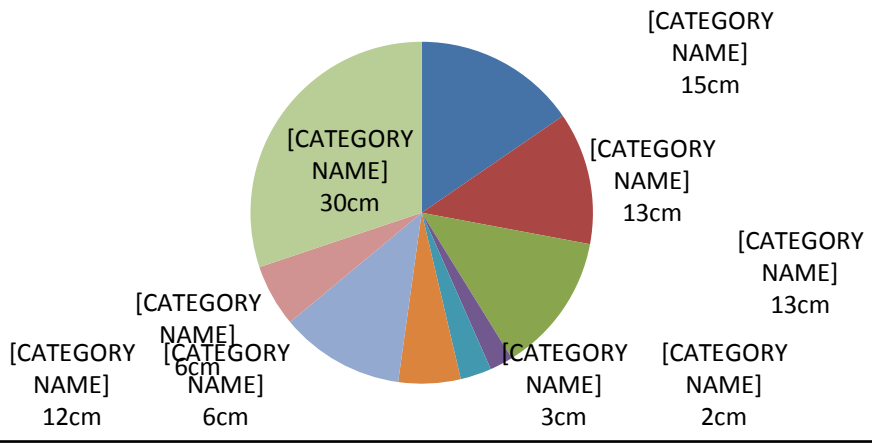


Fig. No. 2. Morphometric measurement of *Labeo rohita*



DISCUSSION:

The analysis of morphological characters which include the multivariate analysis of external anatomical characteristics as well as the study of scales and otholiths have been used as a means of stock identification for many years. When attempted to evaluate some meristic and morphometric characters of taxonomic significance in differentiating and revealed fin length as characters of diagnostic significance between the two species. Under present investigation subjecting morphologic and their relativity it has been found to have the level of significance in all the morphometric characters. Thus, a critical analysis of the morphometric characters by length-wise comparison was conducted and the level of significant difference between the species was observed in some characters. On the basis of range differences the morphometric characters are classified into genetically (narrow range), intermediate (moderate range) and environmentally controlled characters (vast range) (Johal*et al.*, 1994).The characters belonging to the genetically controlled show minimum range of variation, characters belonging to intermediate show moderate range and the characters belonging to environmentally controlled shows maximum range of variation. In the Bariliusbendelisis and

Bariliusvagra, the majority of their morphometric characters showed narrow range and were genetically controlled (Negi and Nautiyal 2002). In Tor putitora 11 characters were genetically controlled, 5 characters were intermediate and 2 characters were environmentally controlled (Johal and Negi 2003). In Bariliusbendelisis all the characters show linear relationship and 13 characters were genetically controlled, 4 characters were of intermediate and 2 characters were environmentally controlled from hill streams of Himachal Pradesh (Johal and Kaur 2005).As the current investigation was undergone in order to observe the diversity between the populations of two composite species of Indian major carp which belong to different genus even though of the same family, the significant difference in their morphometric was evident.

CONCLUSION:

It is concluded that the species investigated being of the same family possess very close relationship with respect to the morphology and their polymorphic loci along with DNA based markers with large number of sample size for better understanding and sustainable utilization of the genetic diversity of this economically important contents.

REFERENCES

1. Munshi, J.S.D. and Srivastava, M.P. (1988). Natural history of fishes and systematics of freshwater fishes of India, Delhi, Narendra publishing house, 83-
2. Taylor, E.B. (1991). A review of local adaptation in salmonidae with particular references to Pacific and Atlantic salmon. Aquaculture 98: 185-207 [10].
3. Utter, F.M. (1981). Biological criteria for definition of species and distinct intraspecific anadromoussalmonids under the U.S. Endangered Species Act of 1973. Can. J. Fish. Aquat. Sci
4. Bonika Pant, Rajinder Kaur, VibhaLohani and RN Ram (2018): Morphometric characterstics of silver carp (*Hypophthalmichthysmolitrix*) under captive conditions,The Pharma Innovation Journal 2018; 7(2): 17-20
5. Bhatt Nakul A, Sharma B.K, Shwetanshumala, Shah Tarang (2016): Length-weight relationship and condition factor of *Catlacatla*in Lake Pichhola, Udaipur, Rajasthan International Journal of Fauna and Biological Studies 2016; 3(4): 19-23.
6. Anamika Barman1 and D. K.Sharma (2017):Morphometric study of *Labeonandina*, the fresh water endangered cyprinidfrom Brahmaputra River, Assam and a comparative analysis with four locallyavailable*Labeo*speciesAnamikaVIJRDO-Journal of Biological Science volume-3 | Issue-5
7. Muhammad Javed Iqbal and Muhammad Naeem (2018)**:**Study of External Morphometric Variants and Length-WeightRelationship of *Labeorohita*(Hamilton-1822) Fed with Varying Protein Levels,Sarhad Journal of Agriculture.
8. Johal M.S. Tandon K.K. and Sandhu G.S., Mahseer in Lacustrine Waters, Gobindsagar Reservoir (1994). Morphometry of Tor putitora. In P. Nautiyal (Eds.), Mahseer the Game Fish., Jagdamba, Prakashan Publisher, Srinagar, Garhwal, 67-85
9. Negi R.S. and Nautiyal P., (2002). Analysis of growth pattern and variation in some morphometric characters of sympatric hill stream Teleosts, Bariliusbendelisis and Bariliusvagra, Asian Fish. Sci., 15, 335-346

From Idea to Impact: The Start-up Journey Unveiled

Dr. P. Rama Krishna,
Professor & Head
Dept. of Management Science
Sasi Institute of Technology & Engineering, Tadepalligudem, Andhra Pradesh

Mr. Rama Swamy Palla
Assistant Professor
Dept. of Management Science
Sasi Institute of Technology & Engineering,Tadepalligudem, Andhra Pradesh

Abstract

The path from a simple idea to a successful startup is filled with challenges, learning curves, and transformative milestones. This chapter explores the essential stages of the entrepreneurial journey — from identifying a meaningful problem to scaling a solution that creates real-world impact. By weaving together foundational concepts, proven strategies, and real-world case studies, the chapter provides readers with a practical and insightful roadmap to navigate their own startup ventures. Topics such as ideation, validation, and funding, team-building, and measuring success are covered with a focus on both business sustainability and value creation. Whether you're an aspiring entrepreneur, a student innovator, or a startup enthusiast, this chapter aims to demystify the process and inspire action — guiding you from dreamer to doer.

Key words: Startup Development, Ideation and Validation, Value Creation

Introduction

In recent decades, entrepreneurship has emerged as a vital driver of economic growth, innovation, and social transformation across the globe. From Silicon Valley tech giants to grassroots social ventures, startups have reshaped industries, disrupted traditional business models, and addressed complex societal challenges. Yet, behind every successful venture lies a journey marked by uncertainty, iteration, and learning. The transformation of a raw idea into a sustainable startup is rarely linear; it involves navigating a complex set of decisions, trade-offs, and developmental stages that test both the entrepreneur's vision and adaptability.

This chapter aims to provide a comprehensive exploration of the startup journey, highlighting the key phases and strategic considerations that shape the trajectory from ideation to impact. It begins by examining the process of identifying and framing meaningful problems often the genesis of entrepreneurial activity and moves through the stages of market validation, business model development, resource acquisition, and early growth. Along the way, it underscores the importance of adopting iterative approaches, such as lean startup principles,

to efficiently test assumptions, minimize risk, and build ventures that are both market-ready and impact-driven.

Furthermore, the chapter integrates theoretical insights with real-world case studies to illustrate how entrepreneurs make decisions under conditions of ambiguity and resource constraints. It also explores the critical role of team dynamics, funding strategies, and performance measurement in shaping a start-up's capacity to scale and sustain its operations. In doing so, this work seeks to demystify the entrepreneurial process and offer a practical framework that is grounded in both academic scholarship and practitioner experience.

By the end of this chapter, readers will gain a clearer understanding of the entrepreneurial lifecycle and the tools necessary to transform an initial idea into a viable, scalable, and impactful venture. Whether approached from an academic, professional, or personal development perspective, this examination of the startup journey offers valuable insights for aspiring entrepreneurs, educators, and innovation practitioners alike.

Ideation: Identifying Problems Worth Solving

The ideation phase serves as the cornerstone of any entrepreneurial venture, marking the transition from abstract interest to focused intent. At its core, successful ideation is less about generating ideas at random and more about uncovering real-world problems that demand innovative solutions. A well-defined problem, grounded in user needs and contextual realities, lays the foundation for a viable and impactful startup. As such, effective ideation involves both creativity and rigor blending curiosity with systematic exploration to ensure the problem is worth solving.

Entrepreneurs can identify meaningful problems through a variety of human-centered and research-driven techniques. Observation allows for the detection of unmet needs and inefficiencies in daily life or specific industries. Interviews and empathy mapping help uncover latent pain points by engaging directly with potential users or stakeholders. Design thinking, a widely adopted innovation methodology, structures this process through iterative steps of empathizing, defining, ideating, prototyping, and testing. These approaches help entrepreneurs move beyond assumptions and toward insight-driven opportunities.

To support this exploration, tools like the Problem-Solution Fit framework and the Value Proposition Canvas are invaluable. Problem-Solution Fit requires founders to critically assess whether their solution effectively addresses a well-articulated and validated problem. The Value Proposition Canvas, on the other hand, helps align the product's features with customer jobs, pains, and gains ensuring that what is being created truly resonate with the target audience.

A compelling example of effective ideation is the story of Airbnb. The founders, facing difficulty paying rent, observed a lack of affordable accommodation during a local design conference. By hosting guests on air mattresses in their apartment and speaking with

attendees, they validated a broader problem: travellers seeking cost-effective, local stays and hosts looking to monetize spare space. This insight, though initially simple, uncovered a scalable global opportunity and became the bedrock of one of the world's most disruptive startups.

Ultimately, ideation is not just about coming up with ideas—it's about finding problems that matter. When done thoughtfully, this stage ensures that subsequent efforts in building, funding, and scaling are grounded in relevance and value, increasing the likelihood of startup success.

Validation: Testing Before Building

Validation is a critical phase in the entrepreneurial journey, as it ensures that a start-up's solution is grounded in real market demand. Before diving into product development, it is essential for founders to validate their ideas through market research and direct customer feedback. This helps minimize the risk of building a product or service that doesn't resonate with potential users.

Market research enables entrepreneurs to identify market gaps, understand customer pain points, and assess competitor offerings. Techniques such as surveys, focus groups, and in-depth customer interviews provide qualitative and quantitative data that shape product direction. Additionally, customer feedback loops where potential users provide input on early conceptsare vital for refining the idea and adjusting it to meet market expectations.

A key tool in the validation phase is the Minimum Viable Product (MVP), which allows entrepreneurs to launch a basic version of the product to test hypotheses with actual users. The MVP is deliberately stripped of non-essential features, focusing on delivering core value and learning from real-world use. Similarly, prototyping offers a tangible version of the product for early feedback before full-scale development.

The Lean Startup methodology, with its Build-Measure-Learn cycle, provides a systematic approach to validation. This loop encourages startups to iterate quickly, testing assumptions through small experiments, measuring results, and adapting based on data-driven insights. Tracking metrics like customer engagement, retention, and product usage early on helps entrepreneurs gauge traction and adjust strategies as needed.

Building the Venture: From Concept to Company

Building a venture is more than just crafting a business idea; it involves translating a concept into a structured, functioning organization. This phase includes crucial steps such as team formation, legal foundations, and continuous product development.

Team formation is one of the most critical early decisions, as the founding team's composition directly impacts the start-up's success. Entrepreneurs must identify the skills required to complement their own and create a culture of collaboration. The key roles

typically include product development, marketing, and operations. A diverse and balanced team brings varied perspectives, which is essential for innovation.

On the legal front, startups must handle company registration, intellectual property (IP) protection, and compliance issues. Ensuring that the startup complies with local and international laws, especially in terms of copyright and patent protections, is vital. Entrepreneurs should also consider structuring the business for tax efficiency and operational transparency.

Product development and iteration are ongoing processes. Startups must continually refine their offerings based on market feedback and technological advancements. The use of agile methodologies ensures that products evolve to meet changing customer needs and market trends. Furthermore, finding and nurturing early adoptersthe first customers who are willing to try new products is essential for gaining initial traction and refining the product-market fit.

Funding the Dream: Resources and Strategies

Securing the necessary resources to fund a startup is one of the most challenging aspects of the entrepreneurial journey. Entrepreneurs often have two primary paths to choose from: bootstrapping or seeking external funding.

Bootstrapping allows founders to maintain complete control over the venture by using personal savings or revenue generated by the business. This strategy avoids debt and equity dilution but can limit growth potential in the early stages. On the other hand, external fundingthrough angel investors, venture capitalists (VCs), or crowdfundingprovides the capital necessary for scaling. However, this route often involves giving up equity and control.

For angel investors and VCs, pitching the startup is a critical skill. Entrepreneurs must craft a compelling story; clearly communicate the problem, solution, market opportunity, and financial projections. Pitching tips include understanding the investor's interests, focusing on the potential return on investment (ROI), and anticipating common investor questions like "What differentiates your product?" and "How will you achieve scalability?" A sound startup financial plan is also critical to attract investors. This plan should include detailed projections, break-even analysis, and an understanding of unit economics. Managing cash flow and maintaining a lean budget during the early phases are essential to ensure longevity until profitability is achieved.

Scaling: Growth and Operational Strategy

Once a startup reaches product-market fit, the next challenge is scalingthe process of growing the business while maintaining efficiency and operational effectiveness. Scaling involves understanding when and how to expand resources, customer acquisition, and team size.

The decision of when to scale is nuanced. Premature scaling, where businesses expand too quickly without stabilizing their product or market base, is a common pitfall. A sustainable

growth strategy requires a firm foundation in operational systems, customer acquisition channels, and financial stability.

Building systems and teams for growth is vital. As a startup grows, the founder's role shifts from being a hands-on product creator to a leader managing broader operations. Efficient systems must be put in place to manage inventory, customer relationships, marketing efforts, and hiring.

Marketing and customer acquisition strategies must also evolve as the business scales. Startups should leverage both inbound marketing and targeted outbound strategies, using analytics to optimize marketing spend. Managing customer relationships through customer success teams and using CRM tools becomes increasingly important as the customer base expands.

Measuring Impact: Beyond Profit

For modern startups, impact measurement is becoming increasingly important, especially for those with social, economic, or environmental missions. Defining success should go beyond financial metrics to include qualitative aspects such as customer satisfaction, social value, and environmental sustainability.

Social, economic, and environmental impact can be measured using tools like the Triple Bottom Line (TBL), which assesses performance in three key areas: people, planet, and profit. Startups that prioritize impact often define clear key performance indicators (KPIs) to track their success across these dimensions.

Customer feedback plays a crucial role in measuring impact. Collecting and analyzing feedback helps entrepreneurs understand how their products are affecting users' lives. By measuring customer satisfaction, retention, and the perceived value of the product, startups can refine their offerings to maximize both profit and positive outcomes.

Furthermore, telling the impact story is vital for attracting customers, investors, and stakeholders who share similar values. Clear and transparent reporting on the social and environmental outcomes of the business helps build trust and credibility in the long term.

Lessons from the Journey

The startup journey is rarely a smooth ride. Entrepreneurs face various pitfallsrom product misalignment to market rejection and financial instability. However, each setback offers valuable lessons that contribute to growth and resilience. One of the key insights from successful founders is the importance of failure and resilience. Failures often act as stepping stones, providing critical feedback and opportunities for improvement.

Real-life case studies of successful entrepreneurs and startups offer valuable insights into overcoming challenges. These stories highlight the importance of persistence, adaptability,

and a willingness to learn from mistakes. Founders must be ready to pivot, iterate, and refine their approach based on real-world feedback.

Conclusion: From Dreamer to Doer

The entrepreneurial journey is a dynamic and evolving process that demands creativity, resilience, and a willingness to learn from both successes and failures. As this chapter has explored, the journey from ideation to impact is filled with critical milestones, each requiring its own set of skills and strategies.

For aspiring founders, the key takeaway is that entrepreneurship is not about waiting for the perfect moment but rather about starting with a vision and iterating based on feedback, data, and experience. The journey from dreamer to doer is one of action, learning, and growth ultimately transforming ideas into impactful ventures that shape industries and lives.

The challenge now lies in taking the first step: identifying a problem, validating it, and moving forward with the confidence that the entrepreneurial process is both an adventure and a learning experience.

A Review on Nanotechnology

G. G. Ramteke
Department of Physics
Dr. Ambedkar College, Chandrapur (M. S.) India, 442401

Abstract:
This review manuscript explores the current perspectives of Nanotechnology. It provides a concise description regarding nanotechnology along with its relevance in different domains like. Solar cells, food technology, medicine, computing and Robotics, etc. It deals as well with the upcoming perceptions of nanotechnology.

Introduction

Nanostructure science and technology is a broad and interdisciplinary area of research and development activity that has been globally rising explosively during the past few years. The prefix *nano* originates from the Greek word *nanos*, which means *dwarf*. This meticulous word has been assigned to signify the number 10^{-9}. Widely accepted threshold for a material to term as nano is < 100 nm in at least one dimension [1-3]. Nanoscale materials are defined as the set of substances where at least one dimension is less than about 100 nm. A nanometer is one millionth of millimeter or one billionth of meter- nearly 100,000 times smaller than the diameter of human hair. It engrosses transforming or growing materials indoors that dimension. It creates the substance lighter, powerful, quicker, slighter and long-lasting.

Nanotechnology necessitates the skill to structure mechanism of molecular dimension in addition to specific machine. Further, 'nanotechnology' offers to the unnatural capability to assemble objects from the bottom up, by means of utensils and methods that are being termed to formulate elevated performance yield. R. Feynman a physicist, in 1959, predicts this speculative potential. According to National Science Foundation, Nanotechnology is the proficiency to recognize, manipulate as well as organize matter at the altitude of individual atoms and molecules [4]. The most important operators of worldwide scientific contest are the science and engineering. Recent science stand lying on the amalgamate aspects of environment at the nano level adds a novel basis for improvement, awareness, and assimilation of expertise [5].
Sometimes nanotechnology is offered like common utility equipment due to its sophisticated edition, it determines considerable impact on majority regions of civilization along with all industries. In broad regions of engineering also in science there is a longitudinal method of merging and deviation. For illustration the merging of sciences at comprehensive range was proposed through the Renaissance, and it was currently pursued by narrow disciplinary specialization (NDS) in science and engineering in the 18th-19th decades. The merging at the nanosize attains its strength in about year 2000, and an evaluation of a deviation in the nano level designs in the subsequent decades. The figure.1 signifies how expertise merged to nano particles and how the nano globe achieved [6].

Wings of Nanotechnology

A concise outline as regards to the wings of nanotechnology is specified in this segment. A variety of nanotechnology yields are existing and still a terrifying quantity of investigations are continuing in scientific laboratories and institutions for higher learning. Wings of nanotechnology are being extended that could knock the comprehensive bazaar for mineral, non-fuel assets and farming. Nanotechnology is currently illustrated as innovatory discipline in relation to its supremacy on industrial relevance. Nanotechnology put forward credible resolution to numerous troubles by means of emanating nano skills. Depending on the powerful inter panel temperament of nanotechnology there are numerous investigation areas and a range of probable applications that includes nanotechnology. Here are some wings where nanotechnology has been implemented [6].

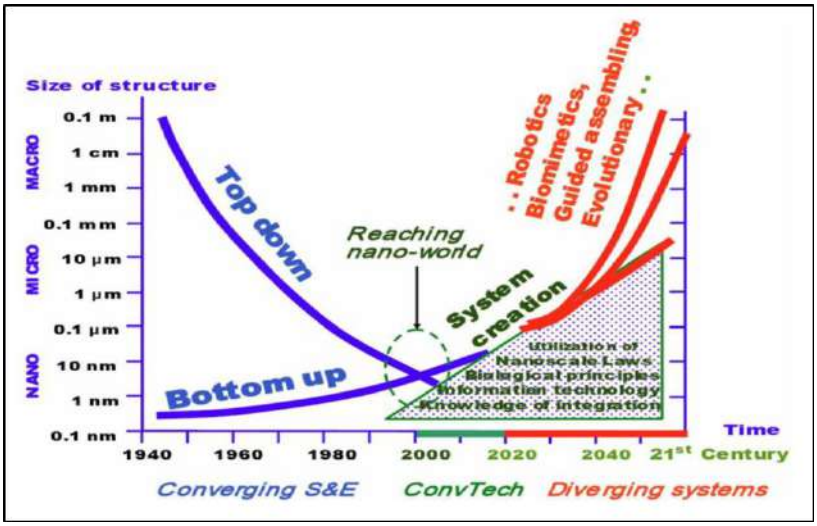


Fig.1. Reaching at the nanoworld (about 2000) and "converging technologies" approach for system creation from the nanoscale (2000-2020) towards new paradigms for nanosystem architectures in applications (after 2020).

1. Nano engineering

One of the wings of nanotechnology is Nano engineering that executes the drawing, manufacture and application of material and devices at the nano range. The name 'Nano-engineering' is resulting from the nanometer, a unit for the measurement equivalent to one billionth meters. This wing put emphasis on the engineering to a certain extent than the applied science feature of the field. It can be thought of as the practical application of nanoscience and focused on the study, development and refinement of materials at a very small scale. Nanoengineers direct the manufacturing of the nanomaterials via multiple techniques. Scanning tunneling microscope (STM) and molecular self- assembly are two systems of Nano engineering. STM is exploited to employ structures as tiny as a single atom while, an arbitrary sequence of DNA can synthesized with Molecular self-assembly and exercised to generate conventional proteins or normal designs of amino acids [7]. This wings has a broad variety of possible applications that includes new materials, electronics, medicine, energy and many more.

2. Green Nanotechnology

One of the the discipline of nanotechnology is the green nanotechnology that uses green chemistry and green engineering to create nanomaterials and products that are eco-friendly and sustainable. It improves the natural sustainability of development creating unenthusiastic aspect. It consists of producing green nano- inventions and then employing these Nano- inventions for maintaining sustainability [8]. The aim of green nanotechnology is to reduce upcoming natural and individuals strength hazards connected with the exercise of nanotechnology creations, and to enhance the substitute of accessible yields with nano- yields that are more eco friendly. It uses plant materials, microbes and biowastes like agricultural residues, eggshells and vegetable waste to create nanomaterials. It also uses less material and renewable inputs to reduce energy and fuel use. Solar cells [9], Nano remediation and water management all relevance are depend on green nanotechnology [10].

3. Wet Nanotechnology

Wet nano technology deals with operating up of bulky masses from tiny masses [9]. According to K. Eric Drexler Nano-assemblers functioning dry. The wet nanotechnology appears to be the first vicinity where a Nano-assembler accomplishes the trade outcomes. The core features of wet nanotechnology are pharmaceuticals and bioscience [11]. The fragments of green nanotechnology puts into a manufacture formation biokleptic nanotechnology by R. A. L. Jones. Trillions of nanotech robots are manufactured by the guiding ideology of biomimetic nanotechnology that looks like bacteria in structural features, entering a individual's blood stream to execute medical dealings such as cancer [12].

Applications of Nanotechnology

Nanotechnology has huge variety of use across diverse trades that include area such as electronics, material science, medicine and energy. Scientists and engineers have specialized the complexities of operating with nonmaterial from the earlier few centuries and investigation is still carrying on. Currently nearly all of the yields are prepared by using nanometric materials. Nanometric zinc oxide or titanium dioxide existing in sunscreens which replicates ultraviolet rays to prevent from sunburns. A nanosized dehydrated crush can be able to deactivate gas. Therefore, so as to convey additional power, the nanosized resources are being employed to fabricate the batteries for tools, more punctually and wasting a reduced amount of heat. Nanoscale silver being used for the covering of anti bacterial wound [13]. Nanotechnology further used in sports tools, automobile components, storage of power in batteries, moisturizing efficiency of cosmetics, drug delivery and other several methods and creations depend on nanoscale material are illustrated in brief.

1. Carbon Nano Tubes (CNT)

Carbon nanotubes (CNT) as depicted in figure 2 are the cylindrical tubes comprised of hexagonal nanostructure arrangements of carbon atoms, made from rolled – up grapheme. They have excellent tensile strength and thermal conductivity while also being incredibly lightweight. They are one of the allotropes of carbon. Nanotubes have been produced with

length-to-diameter proportion of up to 2, 80, 00, 000:1 that is much bigger as compared to any other material. These cylindrical carbon molecules hold amazing potency and exceptional electrical features. Due to these extraordinary features Carbon nanotubes are utilized to a large extent for variety of purposes in thin film electronics, energy storage, device modeling, sporting goods, optics, coating, and electromagnetic shield in addition to architectural fields. Hypothetical applications range from possible use in lithium ion batteries to improve their cyclability to use in water treatment systems for more efficient capture of certain contaminants. However, final usage of carbon nanotubes perhaps limited due to their probable toxicity [14].

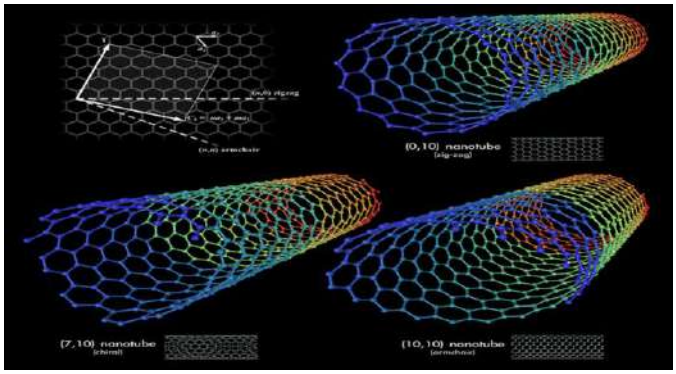


Fig. 2. Carbon Nano Tubes (CNT)

2. Thin Nano Films

Nanofilms are skinny coatings of material spanning from a portion of a nanometer to some micrometers in width that are deposited or grown on a substrate as represented in figure 3. Thin films are fabricated through a method called deposition. Deposition is a thin film coating technique which can be done by amending the four states of matter solid, liquid, vapor and plasma. A variety of nano sized materials can be employed in the fabrication of thin films so as to make them water repellent, UV or IR- resistant, anti reflective, anti-microbial, self-cleaning, anti-fog, scratch resistant or electrically conductive. The most common applications of thin film technologies are prevalent in virtually every industrial sector that includes thin film batteries, optics, magnetic, computer display, cameras, solar cells, eyeglasses and as a security feature on money, credit cards, driving licenses and many more [15].

Fig.3. Thin Nano film

3. Nano scale Transistors

A transistor is a semiconductor electronic device which has been employed to amplify or switch electronic signals and electrical power. In transistors, a little quantity of electricity is utilized as a gateway to manage the stream of larger quantity of electricity. More

the number of transistors are implanted in the computer; the superior will be the power. Computer has become extra influential as the sizes of transistors have been reducing gradually. Up till now, the industry's best trading technology created computer chips with transistors having 45-nanometer features. Latest broadcasts show that still tinier dimension of transistors is achievable by means of nanotechnology [16]. Nano scale transistors are shown in figure 4.

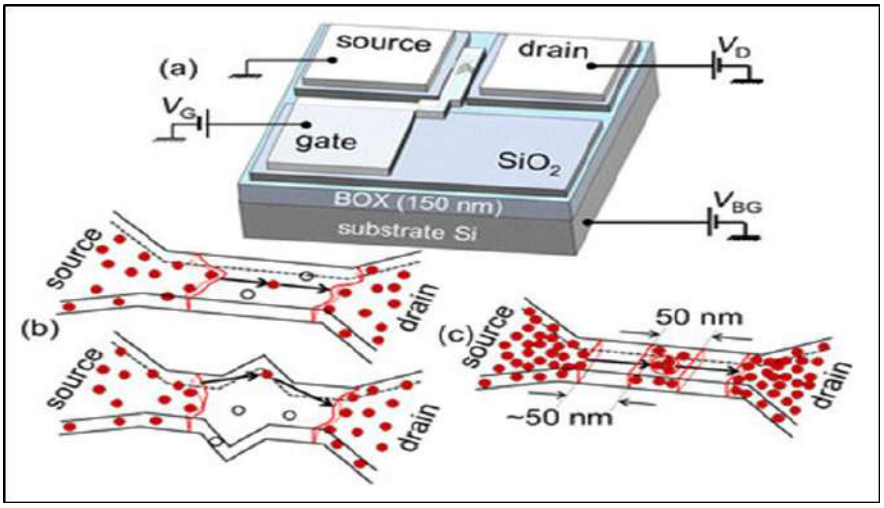


Fig. 4. Nano scale Transistors

4. Drug-Delivery Technique using Dendrimers

Dendrimers are highly ordered, class of polymeric molecules that are used in drug delivery technique to transport drugs to their target site. Dendrimers are typically symmetric about the core and adopt star-shaped three dimensional morphology with nanometer-scale dimension as depicted in figure 5. They are specifically fabricated and produced for a huge range of uses that includes the dealing of cancer, drug delivery, catalysis, gene transfixion, and energy harvesting and photo activity. Dendrimers carrying different materials and their branches can do several things at one time, such as perceiving diseased cells, diagnosing diseased states (including cell death), drug delivery, describing location and reporting events of therapy [14].

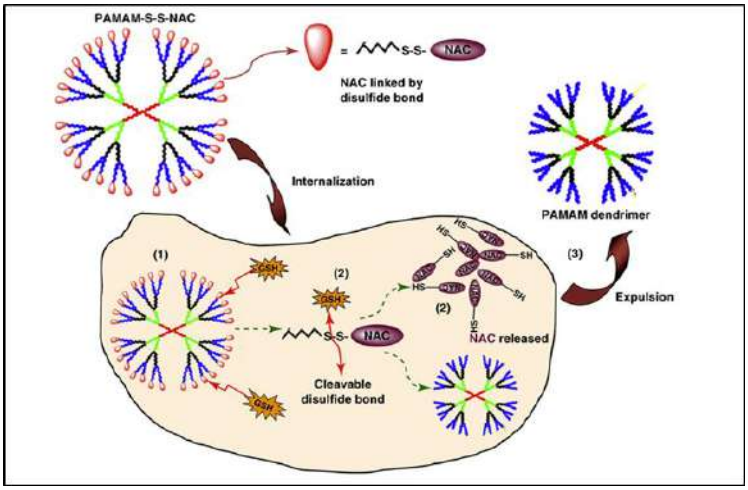


Fig.5. Drug delivery using dendrimers

5. Water Filtration technique

Filtration plays a significant task in the usual management of ground water since it seep through the earth. It is also a key ingredient of a large amount of water management. Groundwater that has been making softer, or treated by means of iron and manganese oxidation, needs filtration to get rid of floc produced by coagulation or oxidation course. Since surface water is subject to run-off and does not suffer normal filtration, it must be filtered to eliminate particles and contaminations. For water desalination, carbon nanotubes based membranes are utilized and nanoscale sensors to recognize contaminations in water system. The system of water filtration by means of carbon nanotubes is illustrated in figure 6. Nanoscale titanium dioxide is the other nanoscale substance that has immense prospective to clean and decontaminate water system and it is also exercised in sunscreen to deactivate bacteria [17].

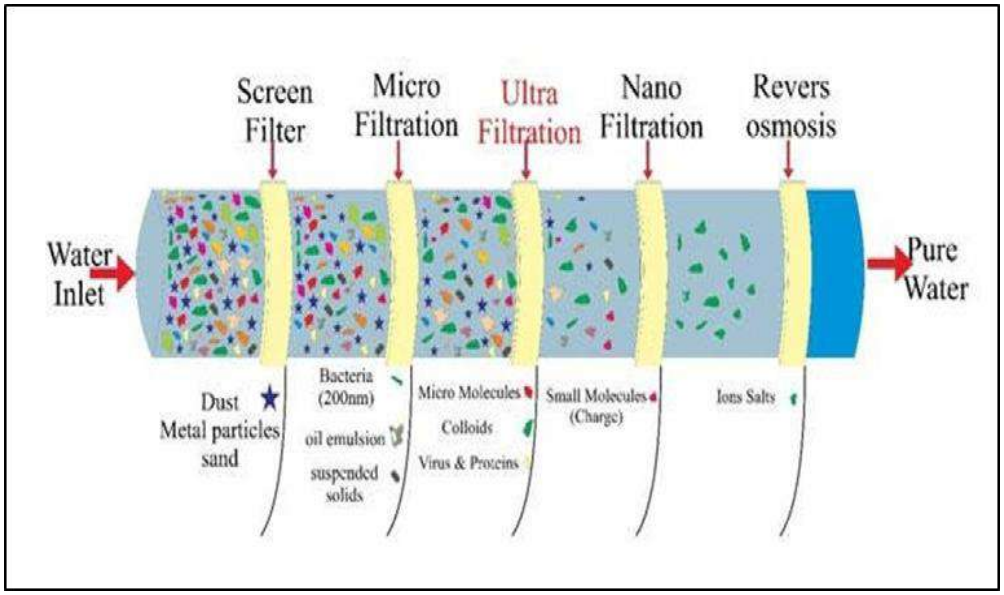


Fig.6. Water filtration technique

Conclusion

Nanotechnology is the science of minute particles. The nanotechnology predicts a world in which novel yields are produced at the atomic and molecular level; offers sensible, low cost techniques for powerful renewable energy resources and maintenance the atmosphere fresh. Various scientists and researchers are currently discovering latest traditions to utilize nanotechnology to develop the world. There are abundant uses of nanotechnology s electronics, biology, and chemical engineering and robotics electronics. Doctors detecting diseases at its primary phase by means of nanotechnology, and recovering sickness including heart disease, cancer and diabetes by means of highly effective and secure remedies. Researchers also picture new technologies for protecting both the civilians and military forces from conventional and chemical weapons. Even if there are lots of research challenges in front, nanotechnology already is generating a enormous choice of good materials and pointing to progress in several areas. It has released precise investigation to the stage of nanoparticles and offers a globe of latest opportunities.

References

1. C. Suryanarayana, "The Structure and Properties of Nanocrystalline Materials: Issues and Concerns", *J. Miner. Metals Mater. Soc.*, **54(9)**, 1-24, (2002)
2. K. Kulinowski, "Nanotechnology from "Wow" to "Yuck"?", *Bull. Sci. Technol. Soc.*, **24(1)**, 13-20, (2004)
3. A. S. Lanje, S. J. Sharma and R. B. Pode, "Functional Nanomaterials Synthesis and Characterization", **LAMBERT Acad. Pub**., Germany, (2014)
4. R. P. Feynman, "There's Plenty of Rooms at the Bottom", *Eng. Sci*., **23(5)**, 22-36, (1960)
5. Handbook on Nanoscience, Engineeering and Technology, *2nd Ed., Taylor and Francis*, 2007.
6. D.Bhattacharyya1 et.al., "Nanotechnology, Big things from a Tiny World: a Review", *International Journal of u- and e- Service, Science and Technology*, **2(3)**, (September, 2009).
7. Lusk, Mark T., and Lincoln D. Carr. "Nanoengineering defect structures on graphene." *Physical review letters* 100.17 (2008): 175503.
8. "Environment and Green Nano - Topics - Nanotechnology Project". Retrieved 11 (September 2011)
9. D. Garg, Literature Review of Nanotechnology, *JETIR*, **6(1)**, 69-73, (2019)
10. "Nanotechnology in water treatment". Retrieved 3 November 2013
11. K. E. Drexler, "Engines of Creation: the coming era of Nanotechnology", *Anchor Books, Doubleday, USA* (1986)
12. Madhu M. "Nanotechnology: dry versus wet engineering" *Anal Bioanal Chem*, 384, 4–6, (2006)
13. Jeremy J. Ramsden, Nanotechnology an Introduction a volume in Micro and Nanotechnologies, 2nd Edition, (2016)
14. Sakshi A. Unde, Pratik B. Bhanage and Megha T. Salve, "Nanotechnology: A Review", *Int. J. Res. Publication and Reviews*, 5(12), 1685-1688, (2024)
15. J. L. Plawskey et.al., "Nano and microstructures for Thin-Film Evaporation-A Review", *Nanoscale and Microscale Thermophysical Engineering*, Taylor and Francis group,18, 251-269, (2014)
16. Mark S. Lundstrom and Jing Guo, "Nanoscale Transistors Device Physics, Modeling and Simulation Book, Springer, (2006)

The Role of Artificial Intelligence in Enhancing Talent Acquisition and Recruitment Processes

Mr. M. Sameer Kumar
Assistant Professor, Dept. of Management Science
Sasi Institute of Technology & Engineering, Tadepalligudem, Andhra Pradesh

Mr. Rama Swamy Palla
Assistant Professor, Dept. of Management Science
Sasi Institute of Technology & Engineering,Tadepalligudem, Andhra Pradesh

Abstract

This research paper explores the transformative role of Artificial Intelligence (AI) in revolutionizing talent acquisition and recruitment processes. The use of AI technologies in recruitment has gained momentum across industries due to its ability to streamline hiring activities, minimize time-to-hire, and improve overall efficiency. From intelligent resume screening to automated scheduling and AI-powered chatbots, organizations are increasingly relying on advanced technologies to identify the best-fit candidates. The integration of machine learning algorithms and predictive analytics has further enabled data-driven decision-making in hiring, contributing to enhanced recruitment accuracy and reduced biases in candidate evaluation.

Moreover, AI in recruitment offers significant benefits in terms of candidate experience by providing real-time feedback, personalized job recommendations, and continuous engagement. However, its deployment also raises concerns regarding algorithmic transparency, ethical use, and data privacy. This study employs a mixed-method research approach to analyze the adoption and impact of AI in recruitment across various industries. The findings highlight both the opportunities and limitations of AI tools, offering insights into how HR professionals can effectively and ethically leverage AI in talent acquisition. Ultimately, this paper contributes to the understanding of AI's strategic role in shaping the future of human resource management.

Key words: Recruitment, AI tools, Talent Acquisition, Data Driven Hiring.

Introduction

The dynamic nature of the global labor market has made talent acquisition a crucial and competitive function in human resource management (HRM). With the advent of AI technologies, companies are rapidly transforming traditional recruitment methods. AI offers solutions for resume screening, candidate sourcing, interview scheduling, and even behavioural analysis. This paper aims to investigate the real-world impact of AI on recruitment and identify the potential benefits and drawbacks of integrating AI technologies in hiring processes.

The traditional recruitment process is often labor-intensive, time-consuming, and prone to human biases. With the increasing demand for efficiency and effectiveness in hiring, organizations are turning to AI as a strategic enabler. By automating repetitive tasks and leveraging data analytics, AI helps recruiters make faster and more informed decisions. This paper examines the key applications of AI in recruitment, explores the perceptions of HR professionals, and provides evidence-based recommendations for its ethical and efficient use.

Literature Review

AI has increasingly become a focal point in HRM research, particularly in recruitment and selection. According to LinkedIn's Global Talent Trends report (2023), 76% of recruiters believe AI will significantly impact hiring practices in the next few years. Scholars have discussed the role of AI in automating routine hiring tasks, such as sourcing candidates, shortlisting resumes, and conducting initial assessments. Technologies like natural language processing (NLP), machine learning, and robotic process automation (RPA) have been instrumental in enhancing these processes.

Moreover, studies have shown that AI contributes to a more engaging and personalized candidate experience. AI-powered chatbots and virtual assistants ensure real-time communication, keeping candidates informed and engaged throughout the recruitment process. However, research also raises concerns about data security, lack of transparency, and potential bias embedded in AI algorithms. Binns et al. (2018) caution against over-reliance on AI without proper checks and balances, emphasizing the need for ethical AI design and implementation.

Theoretical Framework

This research is grounded in the Technology Acceptance Model (TAM) and Resource-Based View (RBV) to explain the adoption and strategic use of AI in recruitment. TAM posits that the perceived usefulness and ease of use of a technology influence its acceptance among users. In the context of HRM, the adoption of AI tools depends on HR professionals' perception of the value these tools bring in terms of improving recruitment outcomes and reducing effort. On the other hand, the Resource-Based View (RBV) suggests that organizations achieve competitive advantage by developing and leveraging unique resources. AI-enabled recruitment capabilities can be considered strategic assets that enhance organizational performance. When integrated with HR practices, AI contributes to better talent acquisition, thereby reinforcing the firm’s ability to attract and retain top talent. Together, TAM and RBV provide a comprehensive framework to understand how and why organizations adopt AI in their recruitment processes.

Research Methodology

This study employs a mixed-method research design, combining both quantitative and qualitative approaches to ensure a holistic understanding of the topic. A descriptive and

exploratory approach was adopted to investigate the current state of AI adoption in recruitment. The sample consisted of 50 HR professionals from IT, banking, and manufacturing sectors who are actively involved in hiring decisions. Data were collected using structured questionnaires and semi-structured interviews to capture a range of perspectives.

In addition to primary data, secondary data sources such as academic journals, industry reports, and case studies were reviewed to validate and support the findings. Quantitative data from the surveys were analyzed using descriptive statistics, while qualitative responses from interviews were coded thematically to identify emerging patterns. This triangulation of data sources enhances the credibility and validity of the research findings.

Data Collection and Analysis

The survey results indicate a strong inclination towards AI usage in recruitment. Approximately 84% of respondents reported using AI tools for initial resume screening, highlighting the efficiency and time-saving aspects. Around 68% mentioned the use of AI-based chatbots to address candidate queries and provide instant support. Furthermore, 73% of participants agreed that AI had significantly reduced the time-to-hire and improved the quality of candidate shortlists. Interviews with HR managers revealed nuanced insights into the practical implementation of AI. While many acknowledged improved efficiency and consistency in hiring, some expressed concerns over the impersonality of AI interactions. They emphasized that AI should augment rather than replace human judgment. Candidates interviewed noted the convenience of AI tools but felt that AI-based interviews lacked the personal touch and emotional connection typically found in human-led interactions.

Observations and Suggestions

The study observed that AI is predominantly utilized in high-volume recruitment scenarios where speed and scalability are essential. While AI tools are efficient in screening and scheduling, there is still a need for human intervention to assess cultural fit and soft skills. Many HR professionals indicated that AI serves as a valuable support system rather than a complete replacement for human recruiters. Furthermore, organizations that have adopted AI reported better alignment between job requirements and candidate capabilities. To improve the effectiveness of AI in recruitment, several suggestions are proposed. First, regular audits of AI algorithms should be conducted to ensure fairness and eliminate biases. Second, HR professionals should be trained to understand how AI works and how to interpret its outputs. Third, a hybrid approach should be adopted, wherein AI handles initial tasks and human recruiters make the final decisions. Finally, companies should prioritize transparency and explainability in AI systems to build trust among candidates and stakeholders.

Conclusion

AI is undeniably transforming the recruitment landscape by improving efficiency, objectivity, and scalability. It allows organizations to process large volumes of applications quickly and

identify top talent using data-driven insights. Despite the many benefits, challenges such as ethical considerations, transparency issues, and candidate perceptions need to be carefully managed. With strategic implementation and continuous monitoring, AI can play a central role in modern talent acquisition. The success of AI in recruitment depends on its integration with human expertise and ethical guidelines. Organizations that effectively blend AI capabilities with human judgment are likely to gain a competitive edge in attracting and retaining talent. As technology continues to evolve, future research should explore how emerging AI tools influence other areas of HRM such as on boarding, learning, and retention. Ultimately, AI should be seen as a tool that complements and enhances human potential in recruitment.

8. References

- Binns, R., Veale, M., Van Kleek, M., &Shadbolt, N. (2018). "'It's reducing a human being to a percentage': Perceptions of justice in algorithmic decisions." CHI Conference on Human Factors in Computing Systems.
- LinkedIn. (2023). Global Talent Trends Report. LinkedIn.
- Chamorro-Premuzic, T., Akhtar, R., Winsborough, D., & Sherman, R. (2017). "The Talent Delusion: Why Data, Not Intuition, Is the Key to Unlocking Human Potential." Piatkus.
- Cappelli, P. (2019). "Artificial Intelligence in Human Resources Management: Challenges and a Path Forward." Journal of Business and Psychology.
- [1] Y. Acikgoz, “Employee recruitment and job search:
- Towards a multi-level integration,” Human Resource
- Management Review, vol. 29, pp. 1-13, 2019.
- [2] M. Ambrose, and C. Kulik, “Old friends, new faces:
- Motivation research in the 1990’s,” Journal of
- Management, vol. 25, no. 3, pp. 231-292, 1993.
- [3] G. Liddon, “Forecasting a competency model for in-
- novation leaders using a modi肆ed Delphi technique,”
- [Thesis], Pennsylvania State University, 2006.
- [4] R. Geetha, and B. S. Reddy, “Recruitment through ar-
- ti肆cial intelligence: A conceptual study,” International
- Journal of Mechanical Engineering and Technology
- (IJMET), vol. 9, no. 7, pp. 63-70, Jul. 2018.
- [5] A. Heene, and R. Sanchez, (Eds.), Competence Based
- Strategic Management. Chichester: John Wiley and
- Sons, 1997.
- [6] S. Jain, “Is arti肆cial intelligence - The next big thing in
- HR?,” International Conference on Innovative Research
- in Science, Technology and Management, 2017.
- [7] P. Kaur, “E-recruitment: A conceptual study,”
- International Journal of Applied Research, vol. 1, no.

- 8, pp. 78-82, 2015.
- [8] J. McCarthy, “What is arti肆cial intelligence?,” 1998.
- [9] R. Merlin, and Jayam, “Arti肆cial intelligence in human
- resource management,” International Journal of Pure
- and Applied Mathematics, vol. 119, no. 17, pp. 1891-
- 1895, 2018.
- [10] A. Murgai, “Role of arti肆cial intelligence in trans-
- forming human resource management,” International
- Journal of Trend in Scienti肆c Research and Development
- (IJTSRD), vol. 2, no. 3, 2018.
- [11] A. Raviprolu, “Role of arti肆cial intelligence in re-
- cruitment,” International Journal of Engineering
- Technology, Management and Applied Sciences, vol. 5,
- no. 4, 2012.
- [12] S. RinaMaiti, and L. Mishra, “GIS and sensor based rain
- water harvesting with arti肆cial intelligence system for free
- landsliding,” International Journal of Civil Engineering
- and Technology, vol. 9, no. 6, pp. 54-66, 2018
- [1] Y. Acikgoz, “Employee recruitment and job search:
- Towards a multi-level integration,” Human Resource
- Management Review, vol. 29, pp. 1-13, 2019.
- [2] M. Ambrose, and C. Kulik, “Old friends, new faces:
- Motivation research in the 1990’s,” Journal of
- Management, vol. 25, no. 3, pp. 231-292, 1993.
- [3] G. Liddon, “Forecasting a competency model for in-
- novation leaders using a modi肆ed Delphi technique,”
- [Thesis], Pennsylvania State University, 2006.
- [4] R. Geetha, and B. S. Reddy, “Recruitment through ar-
- ti肆cial intelligence: A conceptual study,” International
- Journal of Mechanical Engineering and Technology
- (IJMET), vol. 9, no. 7, pp. 63-70, Jul. 2018.
- [5] A. Heene, and R. Sanchez, (Eds.), Competence Based
- Strategic Management. Chichester: John Wiley and
- Sons, 1997.
- [6] S. Jain, “Is arti肆cial intelligence - The next big thing in
- HR?,” International Conference on Innovative Research
- in Science, Technology and Management, 2017.
- [7] P. Kaur, “E-recruitment: A conceptual study,”
- International Journal of Applied Research, vol. 1, no.
- 8, pp. 78-82, 2015.
- [8] J. McCarthy, “What is arti肆cial intelligence?,” 1998.
- [9] R. Merlin, and Jayam, “Arti肆cial intelligence in human

- resource management," International Journal of Pure
- and Applied Mathematics, vol. 119, no. 17, pp. 1891-
- 1895, 2018.
- [10] A. Murgai, "Role of arti隶cial intelligence in trans-
- forming human resource management," International
- Journal of Trend in Scienti隶c Research and Development
- (IJTSRD), vol. 2, no. 3, 2018.
- [11] A. Raviprolu, "Role of arti隶cial intelligence in re-
- cruitment," International Journal of Engineering
- Technology, Management and Applied Sciences, vol. 5,
- no. 4, 2012.
- [12] S. RinaMaiti, and L. Mishra, "GIS and sensor based rain
- water harvesting with arti隶cial intelligence system for free
- landsliding," International Journal of Civil Engineering
- and Technology, vol. 9, no. 6, pp. 54-66, 2018
- Chamorro-Premuzic, T., Akhtar, R., Winsborough, D., & Sherman, R. A. (2017). The talent delusion: Why data, not intuition, is the key to unlocking human potential. Piatkus.
- Cappelli, P. (2019). Artificial intelligence in human resources management: Challenges and a path forward. Journal of Business and Psychology, 34(3), 389–394. https://doi.org/10.1007/s10869-018-9601-5
- Upadhyay, A. K., &Khandelwal, K. (2018). Artificial intelligence-based recruitment and selection: A new way of hiring. International Journal of Advance Research and Innovative Ideas in Education, 4(4), 349–354.

A STUDY ON THE IMPACT OF SOCIAL MEDIA ON MARTHANDAM STUDENTS

Dr. C. Christal Pappa
Assistant Professor, Department of PG Commerce
Nesamony Memorial Christian College,
Marthandam, Kanyakumari District, Tamil Nadu

Abstract

Social media has become a significant influence on students' academic, social, and personal lives. This study investigates its multifaceted impacts, focusing on academic engagement, social relationships, time management, productivity, self-esteem, and overall well-being. Using convenient sampling, data was collected from 60 students in Marthandam through questionnaires, alongside insights from secondary sources such as published books, journals, websites, and reports. Statistical tools including the percentage method, Garret ranking method, and chi-square test were employed to analyse the data. The study aims to identify the most commonly used social media platforms among students, highlight both positive and negative consequences, and explore strategies to overcome challenges associated with social media use. The findings are intended to guide educators, parents, and policymakers in fostering balanced social media practices that promote academic success and personal well-being.

Key Words

Social Media, Academic Engagement, Self-Esteem, Procrastination, Cyberbullying, Social Relationships, Distraction.

Introduction

Social media has become an integral part of modern student life, influencing their academic, social, and personal development. Defined as digital platforms that enable users to create, share, and exchange content, social media offers students opportunities for communication, networking, and learning. However, its impact is complex. While social media enhances learning by providing access to educational content, peer support, and digital skills, excessive use can lead to distractions, cyberbullying, mental health issues, privacy concerns, misinformation, and reduced face-to-face interactions. Many students are increasingly addicted to social media, affecting their study habits, grammar, and focus. This research combines literature review, surveys, and interviews to explore the relationship between social media and students, highlighting its positive and negative consequences. The goal is to develop a deeper understanding of how social media influences students across various aspects of their lives.

Objectives of the Study

- To examine the positive effects of social media on students' academic and social lives.
- To identify how social media influences students' time management and productivity.
- To investigate the role of social media in shaping students' self-esteem and body image.
- To explore the negative consequences of social media on students' mental health.

- To determine the most commonly used social media platforms among students.

Scope of the Study

The study aims to analyse the impact of social media on students' lives. This research focuses on examining the effects of social media on students in Marthandam, identifying the problems faced by the respondents, and providing relevant suggestions.

Hypothesis

There is significant relationship between the respondent's age and the amount of time they spend on social media each day.

Research Methodology

The study employs a convenient sampling method to gather information from 60 students in Marthandam, using a questionnaire as the primary tool for collecting data. Primary data, collected directly from the respondents, provides firsthand insights relevant to the research objectives. Secondary data, obtained from existing records such as published books, journals, websites, and reports, supplements the primary findings to offer a comprehensive understanding of the topic.

Review of Literature.

1. Acheaw and Larson (2015): Social media usage negatively affects students' academic performance. The study suggests promoting the internet as a knowledge source while discouraging excessive use for socializing.
2. Alahmar (2016): Young people spend extensive time on social media, which leads to reduced productivity, academic achievement, and media addiction.
3. Azizi et al. (2019): University students are the most active users of social networking platforms, which have become integral to their daily lives.
4. Chang et al. (2019): Social networking sites distract students, leading to non-educational activities and reduced focus on academic responsibilities.
5. Mathewson (2020): Frequent use of social media is correlated with mental health issues in college students, such as anxiety, depression, and suicidality.
6. Mensah and Nizam (2016): Factors like usage nature and friend connections impact academic performance, while time duration and privacy concerns have little effect.
7. Raut and Patil (2016): social media has both positive and negative impacts on students' education. The study recommends strategies to minimize adverse effects, such as limiting access and usage time.
8. Iwamoto and Chun (2020): Social media fosters comparisons and unrealistic expectations, leading to emotional consequences for students.
9. Sivakumar (2020): Using social media for academic purposes has a positive impact on students' performance. The study suggests its inclusion as a learning tool by educators.

10. Vernon et al. (2017): Higher investment in social media predicts increased depression in adolescent students due to disrupted sleep patterns.

Data Analysis

Age-Wise Classification

Participants are categorized into distinct age groups to assess the impact of social media.

Age of the respondents

Age	No. of respondents	Percentage
Below 18	4	6.7
18 – 20	17	28.3
21 – 23	36	60
24 – 27	3	5
Total	**60**	**100**

Source: Primary Data

Theabove table shows that 4 respondents (6.7%) are below 18 years, 17 respondents (28.3%) are between 18 and 20 years, 36 respondents (60%) are between 21 and 23 years, and 3 respondents (5%) are between 24 and 27 years.

Gender wise classification

To examine the impact of social media, the participants are categorized based on gender.

Gender of the respondents

Gender	No. of respondents	Percentage (%)
Male	2	3.3
Female	58	96.7
Total	**60**	**100**

Source: Primary Data

The above table indicates the gender-wise classification of respondents. Of the total participants, 2 (3.3%) are male, while 58 (96.7%) are female.

Current Academic Level

Educational qualification influences social media usage. The classification of respondents based on their education is presented below:

Current academic level of respondents

Educational Qualification	No. of respondents	Percentage (%)
Secondary school	2	3.3
Under graduation	23	38.3
Post-graduation	34	56.7
Others	1	1.7
Total	**60**	**100**

Source: Primary Data

The table indicates that 2 respondents (3.3%) are secondary school students, 23 respondents (38.3%) are undergraduates, 34 respondents (56.7%) are postgraduates, and 1 respondent (1.7%) belongs to the "Others" category.

Most Used Social Media Platform for Academics

Social media platforms play a significant role in students' academic lives by facilitating learning, collaboration, and networking. The table below summarizes the most commonly used platforms:

Most Used Social Media Platform for Academics

Social media platform	No. of respondents	Percentage (%)
Chat GPT	25	41.7
Google	20	33.3
You tube	14	23.3
LinkedIn	1	1.7
Total	**60**	**100**

Source: Primary Data

The data reveals that ChatGPT (41.7%) is the most used platform, followed by Google (33.3%) and YouTube (23.3%). LinkedIn is the least used, with 1.7% of respondents.

Social Media Contributions for Academics

This study evaluates how social media supports the academic lives of respondents and identifies the most utilized categories of contribution.

Social Media Contributions for Academics

Contribution for academics	No. of respondents	Percentage (%)
Access to educational resources and materials	40	66.7
Communication with classmates and teachers	10	16.7
Collaboration with peers on assignments and projects	7	11.7
Content through online discussions	3	5
Total	**60**	**100**

The table reveals that 40 respondents (66.7%) use social media to access educational resources, making it the most common contribution. Other uses include communication with classmates and teachers (16.7%), collaboration on projects (11.7%), and online discussions (5%).

Effects of Social Media on Mental Health

Social media platforms have both positive and negative impacts. This study examines their effect on the respondents' mental health.

Effects of Social Media on Mental Health

Impact	No. of respondents	Percentage (%)
Positive	23	38.3
Negative	7	11.7

Not sure	30	50
Total	**60**	**100**

Sources: Primary Data

The table indicates that 23 respondents (38.3%) perceive a positive impact, 7 respondents (11.7%) report a negative impact, and 30 respondents (50%) are unsure about the effect of social media on their mental health.

Steps to Minimize the Negative Impact of Social Media

This study explores how social media usage affects respondents' productivity and examines the strategies they use to overcome its negative impact**.**

Steps to Minimize Negative Impact

Factor	**No. of respondents**	**Percentage (%)**
Setting specific times	22	36.7
Mindfulness/Meditation	12	20
Outdoor activities	15	25
Reduce platform use	11	18.3
Total	**60**	**100**

Source: Primary Data

The table above illustrates the strategies adopted by respondents to mitigate the negative effects of social media usage respondents. (36.7%) allocate specific times for using social media, promoting balanced and intentional usage. 12 respondents (20%) practice mindfulness or meditation to manage stress and maintain mental well-being. 15 respondents (25%) engage in outdoor or offline activities as a way to disconnect from social media and reconnect with the physical world.11 respondents (18.3%) limit the number of social media platforms they engage with, simplifying their digital presence.

Findings of the Study

- 60% of the respondents fall under the age group of 21–23.
- 96.7% of the respondents are female.
- 56.7% of the respondents are pursuing post-graduation.
- 41.7% of the respondents predominantly use ChatGPT for academic purposes.
- 45% of the respondents spend 2–3 hours daily on social media.

- 66.7% of the respondents stated that social media contributes to academics by providing access to educational resources and materials.
- 50% of the respondents indicated that they are unsure about the effects of social media on mental health.
- 36.7% of the respondents reported minimizing social media's negative impact by setting specific times for its use.
- 31.7% of the respondents said social media causes distractions and reduced focus.
- 36.7% of the respondents reported that social media contributes to feelings of anxiety and depression.
- 36% of the respondents said social media plays a role in shaping their self-esteem through role models and positive influencers.
- 45% of the respondents stated that depression and loneliness are the negative consequences of social media.
- 85% of the respondents expressed satisfaction with social media.

Suggestions

- Adults and adolescents should set time limits for social media usage.
- Awareness programs should be organized to address social media addiction.
- Users should avoid sharing personal information on social media platforms.
- Social media usage at night should be discouraged as it disrupts sleep patterns and affects health.
- Young individuals should be educated about both the benefits and drawbacks of social media.

Conclusion

The analysis highlights that social media has both positive and negative impacts on students' behaviour. On the positive side, social media facilitates access to information, supports social interactions in learning, enhances creativity, and enables communication with relatives in distant places. However, the research reveals that college students are particularly affected by social media. Its appeal lies in providing an alternative world to make friends and release pressure, yet it necessitates a balance between social media usage and academic responsibilities. Social media plays a pivotal role in shaping students' lives today, offering opportunities for communication, learning, and personal development while posing challenges related to mental health, privacy, and academic performance. The key to navigating these complexities lies in fostering a balanced and informed approach to social media use. Empowering students to leverage its benefits while mitigating drawbacks is essential. Cultivating digital literacy, promoting healthy usage habits, and creating supportive environments can enable educators, parents, and students to effectively navigate the digital landscape. This ensures that social media serves as a powerful tool for positive growth and development.

Bibliography

Books

1. Colak, M. (2014). *Master's thesis, Bilkent University Institutional Repository.*
2. Peter, O. (2015). *Faculty of Education, University of Lagos.*
3. Hamade, S. N. (2013). *Perception and use of social networking sites among undergraduate students in Kuwait.* Proceedings of the International Conference on Information Technology.
4. Vernon, L., &Modecki, K. (2017). *Tracking effects of problematic social networking on adolescent psychopathology: The mediating role of sleep disruption.*

Journals

1. Abbott, J. (2017). *Journal of Contemporary Asia,* 43(4), 576-590.
2. Acheaw, O., & Larson, A.G. (2015). *Journal of Education and Practices,* 6(6), 94-101.
3. Alahmar, A.T. (2019). *J. Med. Allied Sci.,* 6, 77-83.
4. Azizi, S. M., et al. (2019). *Education and Information Technologies,* 24, 2231-2239.
5. Chang, F. (2019). *Educational Computing Research,* 57(8), 2105-2126.
6. Chukwuere, J.E., &Chukwuere, P.C. (2017). *Gender Behave,* 15, 9966-9981.
7. Mathewson (2020). *Journal of Student Affairs,* 29, 146-160.
8. Mensah, S.O., & Nizam, I. (2016). *International Journal of Education, Learning and Training,* 1(1), 14-21.
9. Raut, V., & Patil, P. (2016). *International Journal on Recent and Innovation Trends in Computing and Communication,* 4(2), 281-285.
10. Sivakumar, R. (2020). *Samwaad-e-journal,* 9(2), 90-97.

Websites

- https://www.academia.edu/37599912
- https://doi.org/10.30596/arrasivid.v2i1
- https://www.ftms.edu.my/jouranals/index.php/journals/ijelt

Infographics in the Digital Classroom: Contemporary Pedagogy

Dr. S. Abdul Jabbar

Assistant Professor, Department of Education and Training, MANUU, Hyderabad,

MohdGufranBarkati,

Assistant Professor, Department of Education and Training, MANUU, Hyderabad,

Dr.JarrarAhamad

Assistant Professor, Department of Education and Training, MANUU, Hyderabad,

Abstract:

In this digitized age, infographics are educative tools that can be used to bridge gap between traditional and modern instructional deliveries in classrooms. It talks about the both theoretical knowledge as well as practical applications of infographics in enhancing student engagement, improving knowledge retention, and supporting concept recall in classroom settings. The paper also discusses how infographics can benefit teaching a variety of learners and change the scope of education. Infographics are not only tools for visual learning but also stimuli for developing creativity and critical thinking in students. It makes learners active analysers and synthesizers of knowledge as it represents information using a combination of visuals, text, and data. This approach resonates very well with the needs of education in the 21st century where problem solving and adaptability are primary skills. Besides, the flexibility of infographics makes it possible to adapt for any learning objective in which a teacher can make use to present the material to a variety of students' academic and cultural contexts.

Keywords: Infographics, Contemporary Pedagogy, Teacher Readiness

Introduction:

The integration of technology within education systems changes the form through which information is being conveyed and received. Over time, infographics have come to be known for the potential to make complex ideas easier to grasp and to reach a multitude of learning styles that exist for students in the 21st century (Mayer, 2021). This paper reveals how infographics bridge this gap between traditional pedagogical strategies that focus on text-based instruction and modern approaches on interactivity and visual communication. The information presented and consumed in educational systems has changed with technology. Infographics, one of the visual learning tools, is more often associated with the simplification of complicated concepts, engagement, and catering to the diverse range of learning styles of 21st-century students (Mayer, 2021). This paper explores how infographics fill the gap that lies between traditional pedagogical strategies that focus on text-based instruction and the more modern approaches on interactivity and visual communication.Over the past two years, infographics have been said to play a role in critical thinking as well as improved retention of information in students. In this regard, cognitive load theory reveals that combining text with visual aids can dramatically decrease the effort associated with the processing of complex information, where learners can easily acquire and retain information (Sweller et al., 2019). More research further established that infographics provide one of the visual aids required to

support the Universal Design for learning approach as it presents several representations necessary in serving different learners' needs (CAST, 2018). It gives much flexibility, thus a useful resource for inclusiveness and to get engaged learners in both digital and traditional classrooms (Sundar& Kim, 2020).

Defining infographics and literature review:

Infographics are very important in present learning environments because they illustrate complex information as a graphical representation (Lamb & Johnson, 2014). They can simplify hard concepts, data, and stories into short, graphical forms that can be told to various learners (Lamb & Johnson, 2014; Smiciklas, 2012). As Lankow et al. (2012) have noted, infographics exploit this tendency of the brain to work well with visual information in order to enhance memory and comprehension. This integration also supports the claim by Tufte (2001) that effective communication in education depends on conveying high-quality relevant information, which infographics do by combining images, charts, and text for an immersive and multidimensional experience.Further, infographics can easily fit digital media as this may enhance their value, particularly because it provides scope for interaction and personalized learning (Lankow et al., 2012). Based on theories of visual learning (Krum, 2013) and cognitive psychology principles, it enables the learners to organize and synthesize the information more appropriately; therefore, deep learning would be fostered. Thereby, infographics would surface not as add-ons, but as functional tools that would transform educational communication and foster learning.

Conceptual Frame work:

From all indications, infographics in education cannot be described as merely a modern trend but rather roots laid deep in established learning theories which provide a robust approach at understanding why visual tools have been effective in improving the outcomes of teaching and learning. Research has continuously made indications that the combination of visuals with information represented in text enhances the learners' abilities to absorb, process, and retain knowledge (Mayer, 2021) and, therefore, places the concept of infographics as science-backed in education.

Cognitive Load Theory

Sweller, 1988 suggests that visual information simplifies cognitive load because of the way it is arranged as easy-to-process forms. Infographics apply dual coding: the inclusion of text and images as a means of better processing and remembrance.

Constructivist Learning Theory

According to Vygotsky's theory, learning is most effective when students actively construct their knowledge. Infographics enable this through visual storytelling and interactive engagement.

Visual Learning Theory

According to Arnheim's research in 1974, visuals aid in better understanding by utilizing the brain's natural propensity to process images more rapidly than text. Infographics use this principle to make abstract or complex topics clearer.

This makes educators feel confident in their implementation of infographics, not having to worry about whether they are evidence-based. The intersection of cognitive load reduction, active knowledge construction, and visual preference ensures that infographics touch on multiple dimensions of effective learning. As empirical studies continue to grow, the potential of infographics to transform education continues to gain strong theoretical and practical support (Smith et al., 2020).

Advantages of Infographics in the Classroom:

Teachers have always sought new ways to respond to learner needs and sustain learner engagement in this age of digital transformation. Infographics are one of the relatively new tools for learning. Infographics can be presented in a form that can blend both visual information and conciseness for better understanding. As discussed by Mayer (2021), the multimedia learning principles facilitate how such tools improve learners' processing and memorization of information by taking advantage of both the visual and verbal channels of the cognitive system.

- Engagement: Infographics are more attractive to students as compared to plain text. According to a Nielsen (2022) survey, 90% of the students found content represented graphically instead of notes.
- Retention: According to Paivio's Dual Coding Theory, information presented both visually and verbally is better retained. For instance, a study found that students who used infographics to study science concepts scored 25% higher than those using only text materials (Smith et al., 2020).
- Accommodation of Diverse Learners: Infographics are helpful to those who are visual learners as well as students with disability such as dyslexic as they reduce dependence upon textual information (Johnson & Parker, 2021).

Advantages of infographics go well beyond the individual benefits as they encourage a collaborative and an inclusive learning environment in a classroom since they make the students to interpret and create visual content, this encourages a discussion on the very same topic thus aligning them with the constructivist theories of learning as postulated by Vygotsky in 1978; besides, their use during preparation of materials by a teacher creates a gap between techniques of olden times and the contemporary needs of education because adaptability is what the technique provides.

Infographics are amongst the most powerful teaching tools that can be used for making complex information visually interactive and available to students in easy, digestible form. They are very effective as a tool for meeting varied learning needs of students by integrating visuals, texts, and data. Infographics are thus an excellent tool in simplifying complex information so that engaging students with different learning orientations can be attained and at the same time bridge gaps between the traditional pedagogy and the modern digital education.Key benefits and examples of how infographics support different types of learners are given in the following table:

Table-1: **Benefits of Infographics in the Classroom with description and examples**

Benefit	**Description**	**Example**
Visual Appeal	Infographics simplify complex Information using pictures, and visual learners pick up concepts better.	A biology infographic illustrating the human digestive system with labelled diagrams.
Cognitive Accessibility	Combination of pictures, text, and data reduce cognitive load in students and assist students with other learning disabilities such as dyslexia.	Infographics using large fonts, high contrast, and simple layouts for dyslexic learners.
Cultural Inclusivity	Pictures do not have language barriers; content is accessible to students from multicultural and linguistically div erse backgrounds.	Infographics using universal symbols (e.g., weather icons for meteorology lessons).
Encourages Active Learning	This promotes engagement because it makes students a nalyze, compare, and synthesize information actively.	Students creating their own infographics summarizing historical events like World War II.
Supports Multiple Literacies	This engages digital, visual, and data literacy, which is of great importance in the contemporary educational landscape.	Infographics summarizing global trends in climate change with graphs and maps.
Customizabl e Content	Infographics are flexible, allowing teachers to adapt them accordi ng to the skill level and prior knowledge of their students.	Simplified infographics for elementary students and detailed ones for advanced learners.
Fosters Creativity and Collaboratio n	Encourages teamwork and creativity as students work on infog raphic designs for projects.	Group projects where students create infographics about local community issues.
Supports Memory Retention	Combines visual and textual information, according to researc h, which can facilitate long-term retention of information.	A periodic table infographic with mnemonic visuals to help memorize element groups.
Time Efficiency	Present large amounts of information in a concise manner; thus, students are able to grasp key ideas quickly without feeling overwhelmed.	Infographics summarizing the water cycle in one page instead of lengthy text-based lectures.
Universal Design for Learning (UDL)	Follows the principles of UDL, as it offers various means of representation and engagement to ensure equal opportunities for all learners.	Interactive infographics embedded in lessons accessible to students with and without disabilities

As shown in the table, infographics offer several advantages that enhance student engagement and understanding. They are suitable for various learning styles, making it easier for students to understand complex ideas and retain information. In addition, infographics help simplify content and make it visually appealing, which encourages creativity and active learning. Whether it is to improve memory retention, foster critical thinking, or support diverse student populations, infographics have proven to be a versatile and effective tool in modern education.

Challenges towards Implementation of Infographics

While infographics have great potential for improving learning, their implementation in the classroom requires several practical challenges to be addressed. According to Brown & Taylor (2021), educational tools are effective only if the infrastructure and skills of the educators are adequate. In this case, without proper support and training, the infusion of infographics into the classroom might not achieve its desired effects, and thus there is a need for targeted interventions and resources.

- **Accessibility Concerns:** Accessibility of infographics to learners with visual impairment is a daunting challenge. The inclusion of alternate text and screen reader amicable format is important but goes unnoticed (Williams, 2023).
- **Teacher Readiness;** Many teachers do not have the education on how to create effective infographics, so the quality and effectiveness of infographics will be variable (Jones et al., 2022).

Applications of Infographics:

The flexibility of infographics makes them a very useful tool in modern education, with uses going beyond mere presentation of information. According to Mayer (2021), research indicates that tools that integrate visual and textual elements do not only improve understanding but also stimulate active engagement. This flexibility allows educators to use infographics in different aspects of teaching and assessment, which will make learning more dynamic and interactive for students.

- **Concept Simplification Infographics:** Teachers can use infographics to describe complex ideas like Newton's Laws or timelines of history by taking a large amount of information and condensing it into concise, visual descriptions.
- **Collaborative Learning:** Infographics promote collaborative learning, as students can work in teams to create and analyse visual data, promoting communication and critical thinking.
- **Assessment Tool:** Infographics can serve as an innovative assessment tool for learners to represent their understanding in the form of a graphic representation, just like those using project-based learning techniques in the classroom (Brown & Taylor, 2021).

Modern pedagogy and infographics:

Centuries-old education practices form a foundation for traditional pedagogues where the text-based materials or lectures often are delivered based upon linear knowledge delivery. Indeed, though it may sound effective for its time, traditional pedagogy focuses majorly on rote memorization with minimal flexibility on adapting to the learner. The diversity and dynamics involved in today's classrooms emphasize the need to address its limitations through innovative tools of handling various learning styles.

Table -1: **Traditional vs Modern pedagogy and infographics**

Traditional Pedagogy:	**Modern Pedagogy and Infographics**
Text-dependent notes and lectures	Visual representation and interactive summary
Linear instructional process	Non-linear, learner-oriented
Dependence on rote memorization	Mastery of comprehension and critical thinking
Not adaptable to learners:	Suitable for all learners and learning

The emphasis in contemporary pedagogy and the inclusion of infographics in the classroom sets the learning environment leaning toward active student-centered processes. Infographics break hard, complicated information into these easily understood visual summaries through which information is made more tangible as well as challenging the mentalities to be more questioning and creative. This makes such a learning environment that incorporates different types of children in ability and preference into the class learning process and is in a big way a culmination in teaching methods between traditions and modernity.

Conclusion:

Infographics are a very powerful tool in bringing out the gap between conventional and modern pedagogy. They meet all requirements of 21st-century education because they can appeal to a variety of learning needs. However, there are issues of access and teacher preparedness that need to be addressed in order to get the best out of infographics. Once properly trained and resourced, infographics can revolutionize teaching and learning.Educators can make learning inclusive and interactive to meet the needs of diverse students by integrating infographics well. Their visual appeal makes them indispensable to academic success and lifelong learning, as they present complex information in a simplified manner. The future of education appears bright with innovation and support, as infographics will change the educational landscape to make learning accessible, engaging, and impactful.

References:

Adams, C. (2021). *Enhancing student engagement with infographics: A cross-pedagogical perspective.EdTech Magazine.* Retrieved December 6, 2024

Alston, B. (2019). *Visual learning tools: Infographics in the digital classroom.* Retrieved December 6, 2024

Anderson, T. (2020). *From analog to digital: The rise of infographics in modern pedagogy.* Retrieved December 6, 2024

Arnheim, R. (1974). Visual Thinking. University of California Press.

Brown, T., & Taylor, S. (2021). Visual assessments: A new paradigm. Innovations in Education, 29(1), 15-22.

CAST. (2018). Universal Design for Learning guidelines version 2.2. Retrieved from

J. Waddell. (2019). *Critical digital pedagogy: Infographics as tools for equity.College & Research Libraries News.* Retrieved December 6, 2024

Johnson, D. (2018). *The power of infographics in education: Connecting concepts visually.* Retrieved December 6, 2024

Jabbar, S. A. (2020). Teaching innovation, right now: technology delivers a new education and teaching imperative. advance and innovative research, 73.

Jones, R. (2021). *Digital storytelling and infographics: Modern tools for engaging students.College & Research Libraries News.* Retrieved December 6, 2024,

Jones, R. (2021). *Digital storytelling and infographics: Modern tools for engaging students.College & Research Libraries News.* Retrieved December 6, 2024,

Kelly, M. (2019). *Digital-age learning culture: Redefining the classroom.* Retrieved December 6, 2024,

King, L. (2020). *Infographics for 21st-century classrooms: A hybrid pedagogical approach.* Retrieved December 6, 2024

Kluwer, W. (2022). *Integrating infographics in healthcare education.* Retrieved December 6, 2024,

Mayer, R. E. (2021). *Multimedia Learning* (3rd ed.). Cambridge University Press.

Mayer, R. E. (2021). Multimedia Learning. Cambridge University Press.

Nielsen, J. (2022). Infographics as an engagement tool in the classroom. Educational Review, 34(4), 89-95.

Smith, A., Johnson, L., & Taylor, R. (2020). The impact of visuals on student learning. Journal of Educational Technology, 36(2), 45-60.

Sundar, S. S., & Kim, J. (2020). Interactivity and visual complexity in educational infographics: Impacts on engagement and comprehension. *Journal of Educational Technology Research*, *68*(4), 245–256.

Sweller, J. (1988). Cognitive Load Theory and its implications for educational design. Cognitive Science, 12(3), 257-285.

Sweller, J., Ayres, P., &Kalyuga, S. (2019). *Cognitive load theory.* Springer.

Williams, D. (2023). Accessibility in educational infographics. Inclusive Education Today, 11(1), 33-47.

Innovative Rural Marketing Solutions: Integrating Labor-Saving Technology and Human Resource Management

Koyel Mukherjee
Department of Rural Development and Management and Department of Social Work,
Seacom Skills University, Santiniketan, Bolpur, Birbhum-731236, West Bengal, India

Abstract
Multifarious challenges faced by rural agricultural sectors in developing countries should be minimized through application of innovative rural marketing strategies. This chapter concentrates on enhancement of marketing effectiveness and agricultural productivity in rural areas. Integration of Human Resource Management and labor-saving technologies is truly necessary at this moment. Tailored approaches must be adopted in rural markets as because they have been suffering from geographical isolation, lower literacy rates and limited infrastructural facilities. There is no doubt that both technological advancements along with skilled workforce development is urgently required. Overall business efficiency could be achieved through leveraging labor-saving modern technologies including mechanization and digital platforms. One thing should be kept in mind that HRM practices should be employed such as workforce training, change management and flexible work models. Proper empowerment of employees is required to help them in adoption of technological changes and improved job satisfaction. It is expected that such initiatives would increase market access of local communities. Besides they would benefit from improved income levels. So it can be said that such integrated approach would surely offer a sustainable solution for bridging the gap between technological innovation and optimization of human resources in rural marketing sectors.

Keywords: rural marketing, labor-saving technology, human resource management, agricultural productivity, workforce development

Introduction

This is the high time to think about the occupational transition scenario of developing countries. Nowadays, all state must depend on technological upgradation to maintain their worldwide status. Though the maximum man force tends to go for service sector, there is ample customized demand in primary sector. We can't deny the over growing population and their uprising demand. But the real fact is that minimum population wants to be directly engaged in primary agricultural production sector. But its marketing and other allied scopes have been increasing day by day. So prime focus should be given on optimal human resource management along with installation of labor-saving technologies for appropriate utilization of time, money and service.

The Role of Human Resource Management in Agricultural Labor-Saving Technologies

Adoption and successful implementation of labor saving technologies are crucial for smooth running of agricultural system. Human resource management (HRM) has a pivotal role here. There are multiple challenges likewise shortages of agricultural labor, adequate productivity and enhanced sustainability in the agricultural sector. These technologies are truly required to combat the critical challenges. The integration of those agricultural technologies is not

always a core technical process but there are other aspects including proper management of people, processes and organizational changes etc. That's why HRM is considered so vital.

1. Workforce training and skill development: An efficient workforce along with particular technical skills is urgently required for initiation of labor-saving technologies (e.g. mechanized equipment, automated irrigation systems and multiple tools for precision agriculture). HRM has big responsibility for training and development and upskilling.

- **Training and Development:** Identification of skill gaps in the existing workforce is necessarily required to organize successful training programs to make employees well-equipped with the vital lessons of operating new machinery and technologies. We may have an example i.e. agricultural workers should know the correct process of handling drones for crop monitoring. They must understand the proper use of GPS based tools especially for smooth management of precision farming. HRM plays a great role for this.
- **Upskilling:** HR departments emphasize upskilling employees by which they can easily operate and manage the digital technologies effectively. The increasing use of multiple tools likewise data analytics, artificial intelligence and machine learning demands necessary upskilling of man force for proper execution and farm management in agriculture sector. The interesting fact is that it leads to improve agricultural productivity along with boosting morale and career development intention of employees.

3. **Change Management:** Adoption of labor-saving technologies is deeply related with significant changes in agricultural operation management. Such transition is influenced by HRM as because it plays a very crucial role in communicating change, leadership and support.

- **Communicating change:** It is necessary to ensure the benefits and implications of adoption of modern technologies are properly communicated to the workforce or not. HR professionals take this important responsibility. Because application of new technologies faces typical challenge of resistance to change. HRM helps a lot to minimize this common challenge in agriculture field.
- **Leadership and Support:** We know that any type of technological adoption and innovation must be driven by specific leaders those who are experts in particular segment. Such leadership development is effectively facilitated by HR initiatives. A culture should be created in support of technological advancements. Because the cultural environment ensures the easier transitions along with allover acceptance of new methods.
- **Employee Engagement:** Technologically transitional period needs maintenance of maximum level of employee engagement. HR teams play key role here. They focus on addressing concerns about job security as because most of us assume that labor-saving technologies might be potential threats to employment. Now it is the duty of HR team to assure employees about the growing opportunity through emergence of modern technological advancements. Employees should be reassured about higher value job roles in agricultural fields by expert guidance of HR team.

3. Labor force optimization

There is an interesting point is that though the labor-saving technologies are specifically designed for minimizing manual work, but human supervision is primly needed to apply such technologies in practical field along with their maintenance and timely decision making. There is the key role of HRM in ensuring optimal work force management by work force planning and framing effective work models as follows -

- **Work force planning:** HR managers focus on balancing between human work force and machine labor. So they seriously analyze and predict the requirement of labor in the organization after practical implementation of modern agricultural technology. It ensures the system about importance of human resource or manual labors for creativity, decision making and complex problem solving along with repetitive tasks handled by technology at a time.
- **Flexible work model:** Work schedules should be more flexible to encourage work force engagement. HR emphasizes more flexible work schedules such as exploring part-time work models or seasonal employment for some specific tasks. Because less manual intervention is prioritized with the introduction of new technologies. But expert and wise farm workers are needed to be employed. They may not engage themselves for day to day operations but they must have proper technical knowledge and decision-making power.

4. Health, safety and compliance

Workers must know well about safety risks to handle new agricultural technologies as because they have to remember maintaining health safety in dealing with complex machineries and chemicals. HRM has special responsibility in ensuring compliance with safety regulations along with promotion of safe working environment through -

- **Health and Safety Training:** HR departments may implement different safety training programs for workers in agricultural field to make them confident of safe operation of new equipment. The most beneficial fact is that workplace accidents could be reduced through this. It may ensure compliance with existing labor laws.
- **Monitoring compliance:** Maintenance of safety regulations and standards is mandatory for any type of organization or company. HR plays vital role of regular monitoring of compliance. The positive outcome is specific risk associated with machinery use and new technology could be mitigated in multiple farming operations.

5. Employee retention and recruitment

There is no doubt that modern agriculture becomes more technology driven for which HRM has to face different challenges to attract and retain talents with required technical skills. HR team may address such critical challenges through creating effective career guidelines-

- **Creating attractive career paths:** New age specific career specific plans should be designed by HRM especially for the employees working with new technologies. Because it is expected that it would enhance job satisfaction along with reduced turn over.
- **Recruitment of tech-savvy workers:** If we look at the recruitment strategy of HR, we may find that they mainly focus on engaging individuals having strong

backgrounds in data analytics, agricultural engineering and technology. This is truly necessary to fill in the gaps in required knowledge of managing advanced complex agricultural tools and machineries.

So it is to be said in conclusion that modern agricultural labor-saving technologies can't be successfully utilized without intervention of Human Resource Management strategies. The required skilled manpower to deal with particular tools and machineries must be groomed in such a way that they would be able enough to tackle the whole system. HRM plays guiding role in engagement of such well trained employees to facilitate smart work culture in agricultural sector.

Measures to improve the agricultural marketing system

It is essential to improve agricultural marketing system if we want to ensure that fare prices would be received by farmers along with accessibility of consumers to quality food. The real fact is that there are multifarious challenges the way of India's agricultural marketing system. Such constraints include poor infrastructure, middleman exploitation, market inefficiency etc. But some measures could be taken for enhancing the agricultural marketing system in India-

1. Improvement of infrastructure

Storage and cold chains: Both post harvest loss prevention and quality maintenance of perishable goods are very crucial tasks. Those can't be achieved without building strong storage facilities. Warehouses, cold storage may be good solutions. They may reduce spoilage. Besides farmers would be satisfied through the assurance of selling their produce at better prices.

Transportation and market yards: If we think about cost reduction and cost friendly supply of produce to markets, we must emphasize improved road connectivity along with efficient system for cost reduction and time friendly supply of produce to markets. Upgradation of market yards (mandis) may help farmers to access market more effectively. The mandis must be upgraded with better grading and storage facilities should be improved too.

2. Digitalization of market

e-NAM (National Agriculture Market): This is an online platform connecting different mandis. The public reach of e-NAM should be expanded to facilitate better price discovery for farmers. The interesting fact is that the farmers would be enabled to sell their produce across regions. So it is to be said that the geographical limitations would be reduced along with business transparency.

Mobile Apps for price information: Farmers need real-time price information for making informed decisions about places and time for selling their produce to get best return. So mobile app or sms services may help the process through proper initiation and full course practical application.

3. Reducing the role of middleman

Direct Marketing: This is an emergent need for reduction of dependency on middleman. Establishment of direct farmer to consumer market (e.g. Kisan Hatts) may be a good solution. The Farmer's Producer Organizations (FPOs) could be encouraged too. Farmers could be able to earn higher profits through this as they can sell their produce directly to consumers or retailers.

Contract Farming: Assurance of price security is a key factor behind farmers' satisfaction. So promotion of contract farming should be encouraged where agreements are signed with companies before plantation of specific crops. Production planning according to market demand with guaranteed buyers would make farmers more willing and confident as there is pre-agreed price in the contract.

4. Regulatory Reforms

APNC Act reform: It is found that the product selling by farmers is restricted in many states i.e. they've to sell within regulated markets under the Agricultural Produce Market Committees (APMCs). Reformation of APMC act may allow farmers to sell their farm products outside these markets or across whole state. The positive impact is that it'll create more competition along with better price realization.

Model Contract Farming Act: Private sector engagement may be promoted through contract farming through implementation of a transparent regulatory framework for contract farming. At a time it would protect farmers from unfair price.

5. Promoting farmers' cooperatives

Farmer Producer Organizations (FPOs): FPOs have true potential to help farmers to pool their resources along with improved bargaining power. So they can access better markets. Besides it would help farmers to obtain important inputs at lower costs. They would get the fruit of collective action through marketing their produce more effectively with reduced risks.

6. Access to credit and financial support

Credit facilities: Farmers need access to affordable credit flows for future investment in storage, transportation and technologies. Kisan credit card scheme is such an initiative that provides working capital to farmers for supporting them to meet their marketing expenses along with minimization of risky dependence on high interest loans.

Improved infrastructure and necessary market competition could be achieved through effective agricultural marketing system. It would empower farmers with modern digital tools leading to direct market access. The most interesting fact is that it has immense potential to reduce market inefficiencies i.e. truly important for significant increment in farmers' income. It is expected that agricultural productivity in India would a giant leap through these initiatives.

Top Rural Marketing Challenges and Strategies for Success

Indian rural marketing system faces multiple challenges for some specific factors such as vast geography, huge population and several infrastructural limitations. But there are significant market opportunities in rural areas if the scopes are nourished in proper way. Successful rural marketing system may be developed through required interventions of companies for overcoming specific challenges. Adoption of tailored strategies may lead this initiative. Significant challenges and necessary strategies for true success in rural marketing are as follows:

Challenges in rural marketing:

1. Geographical dispersion: Normally it is tough to imagine that rural population is spread over about 6 lacs Indian villages that make adequate distribution of logistics a critical challenge. Besides maximum of those areas are not easily accessible as because there substandard roadway infrastructure along with poor transportation facilities.

2. Low literacy and awareness level: If we compare we'll find poor literacy rate and lower awareness of products and services in rural areas compared to urban areas. The unfortunate fact is that the effectiveness of traditional advertising and unique marketing techniques face very tough challenges due to this factor.

3. Cultural diversity: India is famous for its cultural diversity. Diversity in languages, traditions and consumer behaviors make rural India most attractive place to visit for foreigners too. But the problem is that one-size-fits-all marketing approach becomes really becomes ineffective in this particular segment.

4. Low purchasing power: Low average income of rural India makes the village population underprivileged compared to urban areas. So a cautious approach for spending is always there to limit holistic and inclusive rural development. Poor villagers hesitate to demand for premium products as because they've to emphasize more on value for money due to lower affordability.

5. Seasonal demand: Agriculture is the backbone of rural economy. So seasonal uncertainty makes their income patterns most irregular. It is noticed that the maximum purchasing power is concentrated only throughout the harvesting season. Because farmers get their income or receive money during this particular time. So seasonal fluctuations lead to seasonal demand.

6. Limited infrastructure: Unstable power supply and poor internet connectivity are the most problematic parts of poor infrastructure. Penetration of E-commerce and digital marketing in rural areas are truly hampered for this.

Strategies for success in rural marketing:

1. Tailored distribution networks: Development of efficient, low cost distribution models is required by companies present in the market. So partnership with local distributors is necessary. It may be said that rural retail networking including cooperative societies have immense potential to improve the whole marketing chain system.

2. Localized marketing: Marketing campaigns could be adopted as per local culture, languages and preferences. Vernacular languages along with culturally relevant symbols must be exhibited in advertisements for building a strong connection with rural consumers.

3. Affordability and small packaging: It is to be kept in mind that most of the rural population faces challenge of low purchasing power. So the products should be offered in smaller, affordable packages (sachets). Such strategy may enable rural consumers to afford goods within their purchasing capacity.

4. Rural specific branding: There is an interesting fact that rural consumers give high value on trust and brand reputation. So companies should give best efforts to build strong relationships with rural consumers. Multiple strategies including credible branding, local partnership development and rural community engagement programs may be adopted for this.

5. Leveraging digital platform: Though there's limited infrastructure in rural areas, mobile or internet availability is rising by day. So mobile marketing, rural apps can be availed by companies to initiate serious marketing system development. It is to be said that SMS based campaigns are highly necessary to communicate with rural consumers residing in remote areas.

Achieving success in rural marketing sector is not so easy. It requires multiple factors including adaptability, innovations and a deep or proper understanding of rural consumers' mind and behavior. Some localized strategies should be adapted along with building of efficient distribution network. The actual affordability of rural consumers should be prioritized because it'll help the companies to take grant entry into India's vast rural marketing system.

Conclusion

So we may say that integration of labor-saving technologies with effective, strategic human resource management in rural marketing sector may create significant opportunities for enhancement of significant operational efficiencies and productive outcomes. We must concentrate on streamlining business processes along with reducing over reliance on manual labor. Timely adoption of modern technologies should be emphasized. Besides simultaneous empowerment of local communities through job creation and skill development initiatives should be prioritized. A well-structured human resource management framework may ensure us regarding the adoption of these new technologies by existing workforce. Effective training and support have to be initiated to boost up employees' motivation and competency. It is expected that such synergy would not only accelerate business achievement but also a competitive edge in rural markets fostering sustainable growth and resilience in rural economies. Overall, this holistic approach would hopefully balance technological advancements with the necessary human element, advancing both productivity and community engagement for prolonged benefits.

Reference

1. Alston, J. M., Pardey, P. G., & Ruttan, V. W. (2001). **Research Lags Revisited: Concepts and Evidence from U.S. Agriculture**. *American Journal of Agricultural Economics*, 83(3), 619-632. https://doi.org/10.1111/0002-9092.00183
2. Dauda, M., & Mohammed, S. A. (2012). **Impact of Mechanization on Agricultural Productivity in Nigeria**. *Journal of Agriculture and Social Sciences*, 8(4), 156-159.
3. Deressa, T. T., Hassan, R. M., & Ringler, C. (2011). **Perception of and Adaptation to Climate Change by Farmers in the Nile Basin of Ethiopia.** *Journal of Agricultural Economics*, 69(2), 338-345. https://doi.org/10.1016/j.jdeveco.2010.06.002
4. Choudhary, A., & Kumar, A. (2020). Agricultural Marketing: Issues and Challenges. Indian Journal of Agricultural Economics, 75(2), 112-125. https://doi.org/10.22004/ag.econ.305206
5. Dauda, A., & Nwankwo, A. (2021). The role of cooperatives in agricultural marketing: A case study of Nigeria. Journal of Agricultural Science, 13(2), 45-58. https://doi.org/10.5539/jas.v13n2p45
6. Jha, A., & Singh, R. (2019). Market information systems for farmers: A review. Journal of Rural Studies, 65, 91-101. https://doi.org/10.1016/j.jrurstud.2019.01.011
7. Ascent Group India. (2024). *Top rural marketing strategies in India: Insights for 2025*. Retrieved from https://www.ascentgroupindia.com

8. Dey, S. (2022). *Rural marketing: Exploring new opportunities. Marketing91*. Retrieved from https://www.marketing91.com/rural-marketing
9. Mystery of Marketing. (2023). *Overcoming challenges of rural marketing: Key insights.* Retrieved from https://www.mysteryofmarketing.com
10. Tractor Junction. (2023). *9 rural marketing strategies to succeed in rural India.* Retrieved from https://www.tractorjunction.com/rural-marketing
11. The Strategy Story. (2022). *Rural marketing in India: Strategies, challenges, and success factors.* Retrieved from https://www.thestrategystory.com/rural-marketing-india

Intellectual Property Rights, Innovation, and Entrepreneurship Development in Hospitality Education

Prof. Prashant Adsule
Magarpatta College of Hospitality
Affiliated to Savitribai Phule Pune University, Pune.

Mrs. Sneha Prashant Adsule
Vibgyor High School, Yerwada, Pune.

Abstract

Innovation and entrepreneurship have become key drivers of sustainable growth and competitiveness in the rapidly evolving hospitality industry. Hospitality education, therefore, must integrate intellectual property rights (IPRs) to empower students and faculty with the knowledge to protect and commercialize their creative and innovative outputs. This paper explores the intersection of IPR, innovation, and entrepreneurship development within the realm of hospitality education. It analyzes how including IPR education fosters a culture of innovation, enhances entrepreneurial mindset, and contributes to industry-relevant research and product development. The study also offers a strategic framework for hospitality institutions to incorporate IPR-driven innovation as a core pillar of their academic and entrepreneurial ecosystems.

Keywords: Intellectual Property Rights, Hospitality Education, Innovation, Entrepreneurship, Knowledge Economy, Start-ups

1. Introduction

The hospitality industry is undergoing a dynamic transformation driven by globalization, digitalization, and changing consumer behavior. As competition intensifies, innovation is no longer optional but a strategic necessity. Hospitality education must equip students not only with operational skills but also with a mindset for innovation and entrepreneurship. At the heart of this lies Intellectual Property Rights (IPRs), which serve as the legal backbone for protecting and monetizing innovation. Traditionally, hospitality education has focused on service delivery, culinary skills, and hotel operations. However, in the 21st century, the focus is shifting toward experiential learning, technological integration, and entrepreneurial competencies. This transformation requires academic institutions to create conducive environments where students and faculty can innovate, start ventures, and protect their creations through IPRs.

2. Conceptual Framework

2.1 Intellectual Property Rights (IPRs)

IPRs refer to the legal rights granted to individuals or organizations over the creations of their minds. These include:

- Copyrights (for original works like cookbooks, culinary guides, training manuals),
- Trademarks (for logos, brand names of hospitality ventures),
- Patents (for novel equipment, food preservation techniques),
- Design Rights (for restaurant interior designs, packaging),
- Trade Secrets (for recipes, business processes).

Understanding these rights allows hospitality professionals to protect and monetize their ideas, giving them a competitive edge.

2.2 Innovation in Hospitality

Innovation in hospitality can be:

- Product Innovation (new dishes, beverages, or food experiences),
- Process Innovation (automated check-ins, AI-based guest service),
- Marketing Innovation (interactive menus, influencer-driven promotions),
- Organizational Innovation (green hotels, wellness-integrated resorts).

2.3 Entrepreneurship in Hospitality Education

Entrepreneurship education focuses on:

- Opportunity identification,
- Business planning,
- Venture creation,
- Risk assessment,
- Innovation management,
- IPR strategy.

Incorporating IPR education enables aspiring entrepreneurs in hospitality to protect their brand identity, unique services, and business models.

3. The Interplay of IPR, Innovation, and Entrepreneurship

3.1 Why IPR Awareness is Crucial

In hospitality, where experiences are central, many innovations remain unprotected due to a lack of IPR awareness. For instance, a student-developed food festival concept or a signature dish might be replicated without credit or compensation. Educating students about IPR ensures that their work can be recognized, protected, and possibly commercialized.

3.2 Innovation-to-Commercialization Pipeline

IPR serves as a bridge between innovation and commercialization. A well-protected innovation can lead to:

- Licensing opportunities (e.g., unique hospitality tech solutions),
- Start-up ventures (e.g., eco-tourism brands, food delivery apps),
- Industry-academia collaborations (e.g., AI-driven housekeeping tools).

Academic institutions can establish Incubation Centers and Technology Transfer Offices (TTOs) to guide students through this pipeline.

4. Case Studies and Best Practices

4.1 Cornell University's Center for Hospitality Research (CHR)

Cornell CHR actively encourages research with commercial potential, provides IP guidance, and partners with industry leaders. Students and faculty regularly publish and patent innovations in hotel operations and guest management systems.

4.2 Indian Institute of Hotel Management (IIHM)

IIHM encourages food start-ups and culinary innovation projects, some of which have been patented and commercialized. Their collaboration with start-up incubators has resulted in student-led ventures in healthy dining and food waste management.

4.3 Ecole Hôtelière de Lausanne (EHL), Switzerland

EHL has integrated innovation labs and start-up challenges into its curriculum. Students learn the fundamentals of IPRs and develop scalable ventures using hospitality technology.

5. Challenges in Integrating IPR and Entrepreneurship in Hospitality Education

Despite its benefits, integrating IPR education faces several challenges:

- Lack of IPR Experts: Many hospitality institutions lack faculty trained in IPR, making it difficult to teach or mentor students.
- Limited Funding: Innovation requires investment in labs, software, and prototypes, which may be scarce.
- Curriculum Rigidities: Hospitality programs often prioritize practical skills over conceptual innovation or business planning.
- Low Industry-Academia Synergy: Weak linkages between institutions and the hospitality industry hamper real-world innovation exposure.

6. Strategic Recommendations

To foster a culture of innovation and entrepreneurship in hospitality education, institutions should:

6.1 Introduce IPR and Innovation Courses

Curricula should include dedicated modules on IPR laws, IP management, case studies, and entrepreneurship development tailored to hospitality.

6.2 Establish IPR Cells and Incubators

IPR cells can assist students in filing copyrights or trademarks. Incubators provide mentoring, seed funding, and workspace to help translate ideas into ventures.

6.3 Promote Industry Collaboration

Partnerships with hotels, resorts, culinary businesses, and tech companies can bring real-time innovation challenges to classrooms.

6.4 Encourage Research and Competitions

Intra-college and inter-college innovation competitions can stimulate creativity. Publishing student innovations in indexed journals builds credibility.

6.5 Faculty Development Programs

Regular workshops for faculty on IPR, innovation pedagogy, and start-up mentoring can equip them to nurture entrepreneurial talent.

7. Future Prospects and Emerging Trends

7.1 Digital Innovation and IPR

Digital menus, VR-based tourism, and AI-driven guest service models are reshaping hospitality. These innovations are rich in IP and need robust protection frameworks.

7.2 Green Hospitality Start-ups

Sustainable hospitality businesses focusing on zero-waste kitchens, energy-efficient hotels, and local sourcing are gaining traction. These ventures can benefit from IPR in branding and process innovation.

7.3 Global Mobility and IP Compliance

As hospitality entrepreneurs target international markets, understanding global IP laws (WIPO, TRIPS) becomes vital.

Conclusion

The integration of Intellectual Property Rights into hospitality education is not just timely—it is imperative. As the industry seeks novel ways to delight customers and improve operations, hospitality institutions must evolve into hubs of innovation and entrepreneurship. Empowering students with IPR knowledge enhances their capacity to transform ideas into ventures, create proprietary brands, and contribute meaningfully to the knowledge economy.

By fostering an ecosystem where innovation is nurtured, protected, and commercialized, hospitality education can play a transformative role in shaping future-ready professionals.

References

1. World Intellectual Property Organization (WIPO). (2022). IP and Innovation in the Service Sector.
2. Schumpeter, J.A. (1934). The Theory of Economic Development. Harvard University Press.
3. Cornell University Center for Hospitality Research. (2023). Annual Innovation and Entrepreneurship Report.
4. EHL Group. (2022). Integrating Innovation in Hospitality Education.
5. Indian Ministry of Education. (2020). National Innovation and Start-up Policy (NISP).
6. Ducker, P.F. (1985). Innovation and Entrepreneurship: Practice and Principles. Harper & Row.
7. Gans, J.S., Stern, S., & Wu, J. (2019). Foundations of Entrepreneurial Strategy. MIT Press.
8. OECD (2021). Entrepreneurship in Education: What, Why, When, How.

Implementation of Advance cyber security surveillance framework with E Governance & Smart city

Mr. Jigul Nimavat
PhD Scholar – Computer Engineering Department Swaminarayan University, India,

Dr.Vijaykumar B. Gadhavi
Associate Professor & Dean – Faculty of Engineering (I/C), Computer Engineering Department Swaminarayan University, India, vijaybgadhavi@gmail.com

Abstract

Smart cities are need on an hour for the holistic development and growth of nation. Government is committed to provide basic services to the people living in urban areas with Intelligent Governance. Such governance in smart cities could be provided to its citizen through the use of Digital Gadgets and creating a network of Digital services. Digital network is a combination of interconnected digital devices creating Internet of Things, while communicating and exchanging services to each other producing voluminous data. This data produced is converted into knowledge and self-operated services using Big Data mechanism. IoT and Big Data techniques are Digital services creating new cyber world. This Cyber world of Smart Cities will have all related information for Intelligent Governance. As Data is becoming more powerful than any other source of energy security mechanisms has to be adopted to keep them safe and secure for providing better governance to citizens of Smart City. This paper provides key components and pillars of smart city and mechanism that have to be kept in mind for securing Data and protecting it from Cyber criminals. This paper also proposes a Digital Security Task Force establishment for controlling and protection of Cyber network and digital data. It also suggests components for Governance and Management solutions for Cyber challenges.

Keywords: Smart Cities, Security, Digital Forensics, Cyber Security, Challenges of Smart City, Cryptography, Digital Network.

INTRODUCTION

The Smart Cities initiative is a striking innovative activity by the Indian Government to provide momentum for financial development and enhance the personal satisfaction of individuals by empowering neighborhood improvement and outfitting innovation as a way to make keen results for natives. A brilliant city is a urbanized zone where various divisions collaborate to accomplish practical results through examination of logical continuous data shared among part explicit data and operational innovation frameworks. Keen Cities will use most recent computerized gadgets for the smooth working of the different administrations made accessible to the natives. Various activities will be taken by the Government too to give opportune and rapid administrations to its national in this manner making E-Governance to walking ahead towards Intelligent Governance. With the expansion of Digital system and gadgets Cyber security will end up

one of the key difficulties as a large portion of the information will be on the web. Today Cyberspace contacts pretty much all aspects of our day by day life. Be it through broadband systems, remote signs, neighborhood systems or the monstrous frameworks that control our country.

The risk from digital assaults and malware isn't just obvious yet in addition extremely troubling. There can't be a solitary answer for counter such dangers. A decent mix of Law, People, Process and Technology must be set up and after that an exertion be made to fit the laws of different nations remembering normal security measures.

1.1 Key Parameters of a Smart City

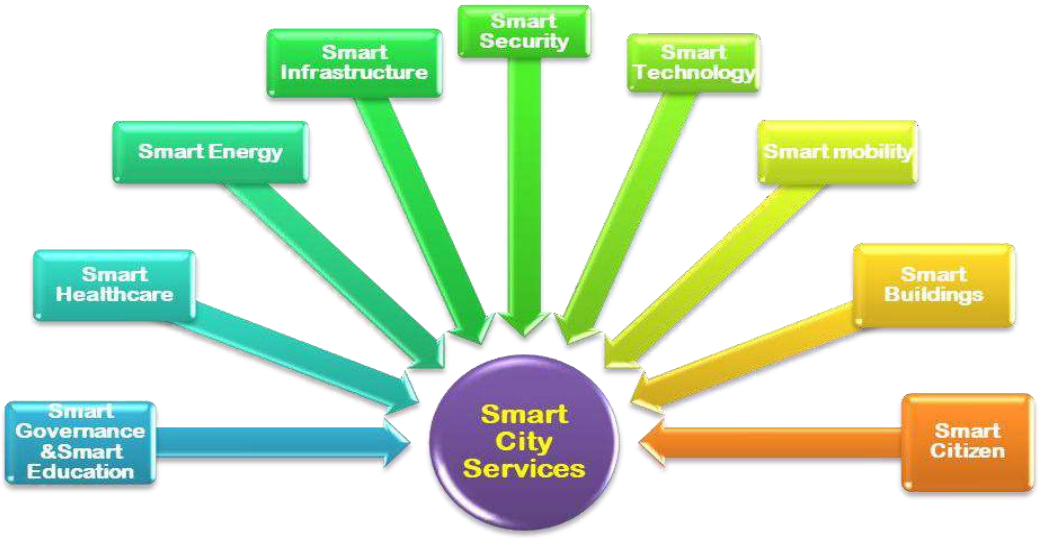


Fig: Key Issues / Parameters of Smart City

- **Smart Governance and Smart Education:** Digital Government services; e-Government, e-Education, Digital school / education arrangements
- **Smart Healthcare:** Digital Healthcare; Distance Doctor Technology, Use of e-Health and m-Health frameworks Smart and associated medicinal gadgets
- **Smart Energy:** Smart Management of Energy; Digital frameworks, Digital meters, Intelligent vitality stockpiling
- **Smart Infrastructure:** Smart Administration of Infrastructure; Sensor systems, Smart control of clean and potable water and waste administration
- **Smart Security:** Threat Detection using Smart Bot; Digital Surveillance, Biometrics, Simulation displaying and wrongdoing insurance, Advanced proactive antivirus assurance
- **Smart Technology:** 5g & 4G availability, Uninterrupted Connectivity; Super optical fiber, Free Wi-Fi
- **Smart versatility:** Intelligent portability; Advanced traffic the board framework (ATBF), Parking the executives, ITS-empowered transportation evaluating framework
- **Smart Buildings:** Renewable Energy creation, Sustainable Buildings; Advanced

Heating Ventilation and Air molding frameworks, Lighting Equipment

- **Smart Citizen:** Citizens of Smart City shall be trained to use the services and facilities available in the surroundings for better utilization and economic development.

Till 2020 worldwide Smart city marketplace is estimated to go beyond USD $1.5 trillion, with one- portion of smart urban communities from North America and Europe. E-Services to residents, for example, m- Payments, m-Exchange, m-Sharing, and so forth, will engage natives with continuous access to individual information and related administrations.

Essential to the formation of keen urban areas is the producing, investigating and sharing of expansive amounts of information. For sure the primary point of brilliant urban communities' advancements is to make urban areas information driven; permitting city frameworks and administrations to be responsive and follow up on information progressively.

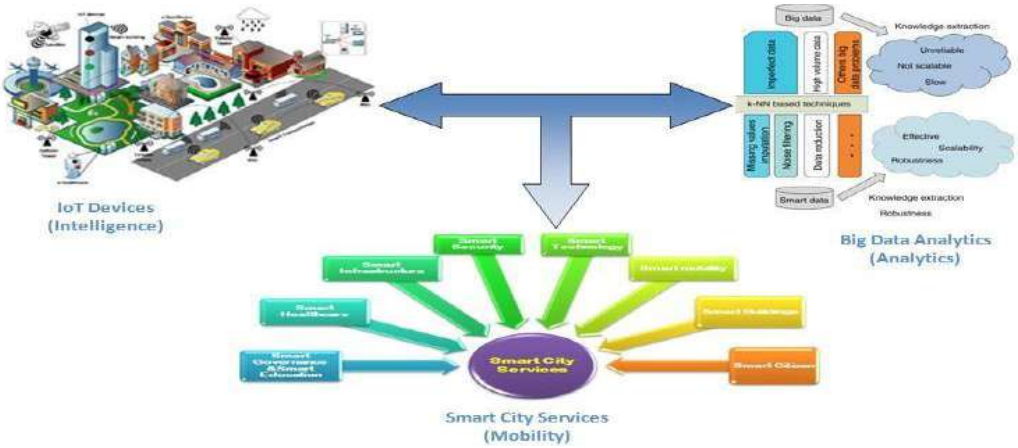


Fig: Utilization of Internet of Things (IoT) Devices & Big Data for Smart City Services

- **Intelligence:** Initial and most significant phase of security is deep observation and insight data congegation. This calls for gear, for example, CCTVs and Biometrics equipment and programming to gather the basics in its crude, natural shape. Anchored organize for transmission of information is vital to guarantee non- treating of information.
- **Analyzing Data gathered:** Analytics enable process, to translate and understand the terabytes of data and information gathered, by giving anchored stockpiling, investigation and measurable apparatuses. Transformation from bite-sized to chomp measured for powerful aversion against dangers or response to a disaster and give situational mindfulness.
- **Channelizing the Resources:** There is human mediation in any security establishment with physical security contraption from edge insurance to specialized gadgets for work force progressing. The powerful assembly of individuals and gear is

significant to the whole foundation of an immovable and anchored area. The interconnectivity of individuals, gadgets and associations in the present computerized world, opens up new susceptibilities — passages where the digital crooks can get in.

1.2 Key Challenges

The duplicating impact of the present cyber security challenges displays a dark universe of dangers that frequently originate from surprising or unexpected spaces which have a heightening impact.

- The pace of progress – can the Smart City's cyber security keep updated?
- New item dispatches, mergers, acquisitions, advertise extension, new innovation
- A system of systems has made information open all over the place, whenever
- One defenseless gadget can prompt other powerless gadgets
- Traditionally shut working frameworks can be gotten to remotely
- Cloud liabilities and Big information – capacity and server security challenges
- Bandwidth utilization from billions of gadgets will put a strain on the range of different remote interchanges.

1.3 Pillars of a Smart City

- **Institutional Infrastructure:** alludes to exercises identifying with administration, arranging and the executives of a city. ICT has given another feature to this framework making it national driven, proficient, responsible and straightforward.
- **Physical Infrastructure:** alludes to its load of cost-effective and savvy physical foundation, for example, the urban versatility framework, rapid broadband foundation, the lodging stock, the vitality framework, the water supply framework, sewerage framework, sanitation offices, strong waste administration framework, seepage framework, and so forth which are coordinated through utilization of innovation.

- **Social Infrastructure**: identifies with parts that empower advancement of human and social capital, for example, the training, medicinal services, stimulation, and so on. It additionally incorporates execution and innovative expressions, sports, the open spaces, youngsters' parks and gardens.
- **Economic Infrastructure**: relates to creating legitimate framework that produces business openings and pull in ventures.

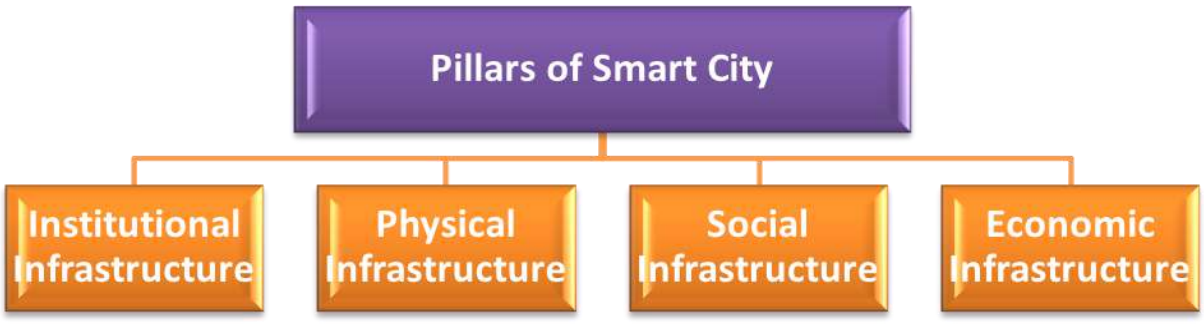


Fig: Pillars of Smart City

The development of smart urban areas and the expanding requirement for availability and interchanges will imply that more data is being accumulated and translated. This examination at that point gives knowledge on acceptable behavior and respond to basic circumstances. The transmission, examination and capacity of huge information will trigger the requirement for data security at all stages.

SECURITY IN SMART CITIES

Brilliant (astute) physical, social, institutional and monetary framework of Smart Cities guaranteeing quality life of residents in a maintainable domain. It is normal that such a Smart City will create alternatives for all occupants to seek after their occupations and interests definitively and with euphoria. (As indicated by the Indian Government Draft note on Smart City arrangements). Keen reconnaissance innovation or investigation to deal with the group, traffic, digital safety, information protection, construction law to oversee characteristic/man-made fiascos and so on, are key aspects that could make a urban area safe and anchored for a national to flourish.

The ascent of digital danger

Viable cyber security is progressively mind boggling to convey. Digital crooks are taking a shot at new systems for traversing the security of built up associations, getting to everything from IP to singular client data

— They are doing this with the goal that they can cause harm, upset touchy information and take protected innovation.

Consistently, their assaults turn out to be increasingly advanced and harder to overcome. In light of this continuous improvement, we can't tell precisely what sort of dangers will rise one year from now, or in coming few years' time; we can just guess upcoming dangers that will be considerably more unsafe. We can likewise be sure that as old wellsprings of this danger blur, latest techniques will develop for their rectification. In spite of this vulnerability — truth be told, as a result of it — we should be clear about the kind of security controls required

Cyber-assaults have changed the hazard scene

City-wide issue of cyber security is not only an innovation hazard. Since numerous open doors for IoT will emerge through mechanical joining and joint effort, which will keep on expanding in multifaceted nature — this unpredictability breeds chance. A standard way to deal with hazard the executives accept that the trust limit is as of now characterized. What is absent in the hazard centered and techno-driven methodology is everything identified with the administration of trust, i.e., the new capacities and forms, and the new arrangements and structures required to extend the hazard limit.

Hazard Landscape

To successfully deal with the dangers in a Smart City, it is vital to obviously characterize the cutoff points of that biological community. We likewise needs to choose

what we will oversee inside those points of confinement: is it simply the dangers looked by gatherings of individuals that are in the city itself, or should we additionally attempt to impact the moderation of dangers looked by individuals/information outside the breaking points characterized.

SMART CITIES SAFETY ISSUES

Information Confidentiality and security threats: confidentiality and protection is considered as a fundamental human right and is ensured by Indian Constitution in various ways. Protection worries incorporate the worthy practices with respect to getting to and uncovering individual and touchy data about an individual.

Touchy data can identify with a number of individual aspects, for example, any data that can be utilized without anyone else or with other data to recognize, contact, or find a solitary individual, or to distinguish a person in setting.

Smart city advancements catch information identifying with all types of protection and definitely grow the volume, range and granularity of the information being created about individuals and spots. Security can be compromised and ruptured by various practices which are typically treated as unsatisfactory, anyway are a piece of tasks in a keen city eco framework.

- **Surveillance:** Viewing, following, tuning in to or recording an individual's exercises
- **Accumulation:** Blending of different parts of information about an individual to recognize a pattern or example of exercises.
- **Data spillage:** absence of information assurance arrangements can prompt spillage or inappropriate access of touchy data
- **Extended utilization:** utilization of information collected for duration longer than expressed or for purposes other than the expressed reason without the subject's assent

Unreliable Hardware: Other than known, significant worries about savvy urban communities sensors in the gear; structures and so on are uncertain and not tried altogether. Attributable to absence of institutionalization of IoT gadgets, the sensors are inclined to hacking. Infamous people can trap the sensors and feed counterfeit information, causing signal disappointments, framework shutdowns and so on.

Bigger Attack surface: Smart city tasks use complex, arranged get together of ICT framework to oversee different administrations. Any gadget that is associated with the system is helpless against being hacked; the quantity of potential passage focuses is increased in Smart Cities. By trading off a solitary gadget, it is conceivable to assault the whole framework or system. The powerlessness of frameworks is exacerbated by various issues including frail security and encryption; the utilization of shaky inheritance frameworks and poor support; course impacts; and human mistake.

Transmission capacity utilization: Large portion of the sensors utilize a decoded connection to convey, and subsequently, there are conceivable outcomes of security slips.

The transfer speed utilization from lakhs of gadgets will put a challenge on the range of different remote interchanges, which additionally work on other frequencies like radio, TV, crisis administrations, and so forth.

Application hazard: Apps have quickened the reconciliation of cell phones inside our day by day lives. From mapping applications, to long range informal communication, to profitability devices, to diversions, applications have to a great extent driven the cell phone upset and have made it as critical and as sweeping as it is today. While applications exhibit utility that is apparently bound just by engineer creative energy, it likewise expands the danger of supporting stakeholder own gadgets in a professional workplace.

As the association empowers representatives to use their very own gadgets, the requirement for utilizing similar gadgets to get to business related information definitely introduces itself. This presents for the most part two security dangers:

- **Malicious applications (malware):** the expansion in the quantity of applications on the gadget improves the probability that some may contain malevolent code or security gaps
- **App Susceptibilities:** applications created or conveyed by the association to empower access to corporate information may contain safety shortcomings

GETTING IN FRONT OF DIGITAL WRONGDOING

Early cautioning and identification of ruptures are conclusive to being in a condition of availability, implying that the accentuation of cyber security has changed to danger insight. A condition of preparation to manage digital assaults requires practices that are insightful, considered and communitarian. No association or government can ever anticipate or keep all (or even most) assaults; yet they can decrease their engaging quality as an objective, increment their flexibility and limit harm from some random assault.

A condition of preparation incorporates:

- Designing and actualizing a digital risk insight technique to help key choices and use the estimation of security
- Defining and enveloping the associations broadened cyber security biological community, including accomplices, providers, administrations and business systems
- Taking a digital monetary methodology — understanding your crucial resources and their esteem, and putting explicitly in their assurance
- Using legal information examination and digital risk knowledge to dissect and envision where the probable dangers are originating from and while, expanding availability
- Ensuring that every one of the partners comprehend the requirement for solid administration, client controls and responsibility

Governments will be unable to control when data security episodes happen, however they can control how they react to them — extending location capacities is a decent place to begin. A well-working Cyber security Task Force (CSTF) can frame the core of

compelling location. Overseeing digital dangers as per key needs should be the focal point of the CSTF. By relating important data against a safe pattern, the CSTF can deliver significant announcing, empowering better basic leadership, chance administration and business coherence. A CSTF can empower data security capacities to react quicker, work all the more cooperatively and offer learning all the more viably.

4.1 Cyber Security Components of a Safe Smart City

- **Surveillance framework and hardware:** The point of keen city is to give shared security nearness and ongoing reconnaissance with the utilization of camcorders. The cameras gather information in picture or video organize which might be checked from a focal area, and enable specialists on call for act immediately in a crisis circumstance.
- **Video investigation:** Video examination is the capacity of consequently dissecting recordings to identify certain items, conduct, spatial and worldly occasions. This is utilized in a wide scope of spaces, including excitement, Health care, observation, home computerization and so forth. These Video examination apparatuses can be utilized with a wide scope of modules for different purposes and can function as a proactive observing device, activating cautions to flag prompt consideration of concerned groups.
- **Data focus:** The server farm is the unified storage room for every one of the information gathered from the numerous sensors in the system. The server farm gives constant information to checking habitats for powerful activities. The server farm has applications for the activity of video the board, examination and traffic control and so on. The structure of server farm relies upon the sort of uses that are kept running in the brilliant city.
- **Command Center:** The war room gives a framework that can evaluate the coordinated data given by the server farm, for example, live video for occurrence reaction. It helps in faster examination of information for better basic leadership.
- **Knowledge Transfer:** It is critical to scatter the required learning and abilities for the smooth task and execution of the smart city activities. The concerned staff should be prepared in working the new and overhauled administrations and productively convey the yields.

4.2 Possible Solutions to Challenges

As referenced already, keen city advances have expansive assault surfaces that have various vulnerabilities, particularly in frameworks that contain inheritance segments utilizing old programming which has not been routinely fixed. Innovation arrangements expect to utilize best practices to relieve these dangers

This incorporates:

► End-to-end encryption
► Strong secret key arrangement
► Up-to date firewalls, hostile to infection
► Audit logs
► Isolation of confided in assets from open assets (DMZ)

► Implement manual supersedes on all frameworks

The point is to diminish the assault surface however much as could be expected and to make the surface that is unmistakable as strong and flexible as would be prudent.

Security as an Expense, to security as an Income

Security is typically situated as a compulsory expense — an expense to pay to be agreeable, or an expense to pay to lessen chance. In any case, moving to a model of security as hazard and trust the executives infers viewing security as an empowering influence; for instance, overseeing open information get to use the money related estimation of the information as opposed to concentrating on the insurance of the information itself. Actually, this change implies empowering the advancement of significantly increasingly expanded systems of systems, of more and new types of joint effort and portability, and of new plans of action. "Security as an Income" ought to be a backbone of the business.

Ceaselessly Learn and Develop

Nothing is static — not the lawbreakers, not the eco framework or any piece of its working condition along these lines the cycle of consistent enhancement remains. Turn into a learning association: consider information (counting crime scene investigation), keep up and investigate new community oriented connections, invigorate the technique consistently and develop cyber security abilities.

Fiasco recuperation and back-up administrations

Server farms, either on location or off site, are at the core of savvy urban areas. Fiasco recuperation is a basic piece of the server farm's design. On the off chance that servers go down, is it vital that frameworks are brought back online as quickly as time permits and, when those frameworks are back going, need all their past outstanding tasks at hand operational. It is critical to distinguish the correct dimension of back-up required for different administrations.

Information back-ups ought to be done frequently, and as indicated by the accepted procedures, ought to be done off site. This aides in information insurance if there should be an occurrence of physical security rupture at the server farm.

4.3 Prominent Norms at Global Level

- **Data Protection Directives**: Recently the European Parliament embraced The EU General Data Protection Regulation (GDPR) which intends to reinforce and bind together information insurance inside the European Union. At the point when GDPR becomes effective in May 2018, the EU inhabitants will acquire control of their own information, all associations will have similar guidelines and will answer to one regulating expert. There are stringent limitations on profiling, and meaning of "assent" to gather/process information.

- **Digital get to Control Frameworks**: DACs must be worked to guarantee just the

approved authorities approach smart city information and the systems. DACs are essential to shield the city's administrations from digital dangers, hacking or modifications to information. In these DACS, diverse dimensions of section can be allotted to various gatherings so as to guarantee that the opportune individuals see precisely the required measure of data. Isolation of obligations and refreshed database of who approaches the information and systems will help recognize causes when a rupture happens.

- **Privacy Enhancing Technologies**: PETs give people instruments, applications and components to secure their by and by recognizable data (PII) and direct how PII ought to be dealt with by various administrations. PETs have been characterized by the European Commission as 'a cognizant arrangement of data and correspondence innovation estimates that ensure security by disposing of or diminishing individual information or by avoiding superfluous and additionally undesired handling of individual information without losing the usefulness of the data framework. PETs incorporate moderately basic apparatuses, for example, advertisement blockers, treat blockers and removers, malware identification and capture attempt, site blocking, encryption devices, and administrations to quit databases held by information merchants. When all is said in done, these sorts of PETs are gone for ensuring PII on sites and cell phones and overseeing how information are taken care of by information agents.

4.4 Management and Recommended Solutions

A basic part of well-run smart city is its administration and the board structure and procedures. Administration gives the structure through which vital bearing is thought and set, and control and oversight managed. Then again the board comprises of driving and driving forward activities and managing the day-today running of administrations. Setting up solid rule drove administration and the board is accordingly an essential for making a savvy city that tries to amplify benefits while limiting damages. Anyway to date, there are not very many reported instances of such administration and the board structures being established. Rather, savvy city activities have been acquired and created with minimal composed thought of protection and security hurts and opened into existing city the executives in an impromptu mold with insignificant vital oversight. Given the potential damages and the related costs that can emerge, this piecemeal methodology should be stopped to be supplanted with a progressively key, facilitated approach that comprises of mediations at three dimensions: vision and technique (savvy city warning board); oversight of conveyance and consistence (keen city administration, morals and security oversight council); and everyday conveyance (center protection/security group and PC crisis reaction group). This methodology perceives that there is a requirement for coordinated effort between specialists in various areas to guarantee sharing of information and shared learning.

- **Smart City Corporation**: in light of the security ramifications of smart city advancements and various reactions of the city's information rehearses,

Government should establish up a Smart City Corporation Advisory Committee (SCCAC) to survey the manners by which the city specialists create, store and use information, and to consider issues, for example, classification, secrecy, recorded methods, cancellation, sharing and distributing as open information, and the capacity to direct legal inside reviews. The SCCAC shall distribute a lot of essential protection standards. Generally, these standards basically affirm that the city is following FIPPs (reasonable data practice standards) and its effectively existing legitimate commitments. They are supplemented by a significantly more Nitti gritty security articulation that sets out the city strategy on protection issues.

- **Transparent Information Arrangement:** A neighborhood government body in charge of open transport in Europe and organizing travel for many travelers day by day creates and deals with a huge measure of information from a various arrangement of sources. The association has received a straightforward way to deal with information security and information assurance arrangements, which are distributed on their site.

  For each sort of information detail: what individual data they hold, why they gather that data, how they utilize the data; the period of time they keep it before erasing differs from 24 hours to 7 years, contingent upon sort and reason, how they secure it, how they share it, if any of the information are prepared abroad, how somebody can get to the information held about them, any pertinent protection takes note.

- **City Computer Emergency Response Teams (CERTs)**: CERTs comprise of a group of key work force, drawn from the center protection/security group, IT administrations, smart city activities and crisis benefits, that spring vigorously when a brilliant city innovation encounters a cyber-security occurrence and is hacked and records stolen or the framework disturbed or terminated.* CERT is like other crisis reaction groups that handle other city occasions. CERTs get ready Nitti gritty plans of activity and responsibility/obligation on account of various sorts of episodes.

CONCLUSION

Smart Cities construction and establishment are an enormous market chance of 2.0$ trillion, with in huge number of urban communities projected to be set up by 2025. Smart Cities intend to give global scope of advantages, for example, better transportation, squander the board, vitality the executives, which will extensively enhance the expectations for everyday comforts for the residents. The test is to recognize that there are a lot of issues and worries that should be tended to, and to discover and receive answers for these that likewise empower the advantages of brilliant city advances to be picked up.

Keen city models should support improvement while not trading off on information protection and security. Brilliant city arrangements include multi-faceted improvements, completed by a differing biological community of suppliers including front line innovation including basic and complex ICT executions.Notwithstanding, expanding ICT

unpredictability infers expanding powerlessness, both to malignant assaults and accidental occurrences. By having hearty security and data insurance system and strategies set up, wellbeing for the two nationals and endeavors can be guaranteed. It is presently imperative to build up the great practices distinguished up until this point, to expand on and thoughtfully improve the recommended arrangements. When the arrangements are sent by and by, these should be assessed thusly and continuous learning mechanism should be connected.Public Private Partnership associations should be established for succesfull implementation of Smart City utilities, technologies and administration, to utilize the skill of the private segment so as to convey the advantages of brilliant urban areas proficiently.

REFERENCES

[1]. Internet-of-Things Based Smart Cities: Recent Advances and Challenges, Yasir Mehmood, Farhan Ahmad, Ibrar Yaqoob, Asma Adnane, Muhammad Imran, and Sghaier Guizani, IEEE Communication Magazine 55(9) · September 2017

[2]. A. Zanella, N. Bui, A. Castellani, L. Vangelista, and M. Zorzi, ―Internet of Things for Smart Cities,‖ *Internet of Things Journal, IEEE*, vol. 1, no. 1, pp. 22–32, 2014.

[3]. J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, ―In- ternet of Things (IoT): A Vision, Architectural Elements, and Future Directions,‖ *Future Generation Computer Sys- tems*, vol. 29, no. 7, pp. 1645–1660, 2013.

[4]. A. Gluhak, S. Krco, M. Nati, D. Pfisterer, N. Mitton, and T. Razafindralambo, ―A Survey on Facilities for Ex- perimental Internet of Things Research,‖ *Communications Magazine, IEEE*, vol. 49, no. 11, pp. 58–67, 2011.

[5]. J. Jin, J. Gubbi, S. Marusic, and M. Palaniswami, ―An Information Framework for Creating a Smart City through Internet of Things,‖ *Internet of Things Journal, IEEE*, vol. 1, no. 2, pp. 112–121, 2014.

[6]. Source: Cerrudo, C. (2015) An Emerging US (and World) Threat: Cities Wide Open to Cyber Attacks.

[7]. https://www.ey.com/Publication/vwLUAssets/ey-cyber-security-a-necessary-pillar-of-smartcities/%

[8]. 24FILE/ey-cyber-security-a-necessary-pillar-of-smart-cities.pdf

[9]. http://www.sersc.org/journals/IJSH/vol10_no11_2016/18.pdf

AN ANALYTICAL STUDY ON JOB STRESS AMONG WOMEN TEACHERS OF SELF-FINANCED COLLEGES IN KANNIYAKUMARI DISTRICT

Dr.S.A.DEEPA AZHAKESWARI,
Assistant Professor, Department of Business Administration,
Muslim Arts College, Thiruvithancode.

Mrs.G.J.BINI,
Assistant Professor, Department of Business Administration,
Muslim Arts College, Thiruvithancode.

Abstract

Job stress is a growing concern in the education sector, particularly among college teachers who often face a unique set of professional and personal challenges. Teaching at the college level is no longer limited to just delivering lectures; it encompasses research, student mentoring, administrative duties, and sometimes even community engagement. Teaching at the college level is no longer limited to just delivering lectures; it encompasses research, student mentoring, administrative duties, and sometimes even community engagement. With rising expectations and limited resources, many educators find themselves overwhelmed, leading to significant stress in their daily work lives.One of the main causes of job stress in college teachers is the increasing workload. Many institutions expect faculty members to juggle multiple roles: teaching several courses, publishing research, attending conferences, and fulfilling administrative tasks. These expectations, often without adequate support or compensation, can lead to burnout. Additionally, the pressure to secure research funding and meet publication requirements adds another layer of stress, especially in highly competitive academic environments.The important objective of the study is to evaluate Job Stress among women teachers of self-financed colleges in Kanniyakumari District. The study is confined with primary and secondary data. There are six taluks in Kanniyakumari District and for the purpose of the study 10 women teachers from each taluk confined of total 60 teachers are randomly selected as samples by using convenient sampling method. To analyze the collected data the statistical tools such as Percentages, Garrett ranking and Chi-square test are adopted.

Key Words: Teachers, Stress, Stressors and Causes

Introduction

Job stress is a growing concern in the education sector, particularly among college teachers who often face a unique set of professional and personal challenges. Teaching at the college level is no longer limited to just delivering lectures; it encompasses research, student mentoring, administrative duties, and sometimes even community engagement. With rising expectations and limited resources, many educators find themselves overwhelmed, leading to significant stress in their daily work lives.

One of the main causes of job stress in college teachers is the increasing workload. Many institutions expect faculty members to juggle multiple roles: teaching several courses, publishing research, attending conferences, and fulfilling administrative tasks. These expectations, often without adequate support or compensation, can lead to burnout.

Additionally, the pressure to secure research funding and meet publication requirements adds another layer of stress, especially in highly competitive academic environments.

Another key factor contributing to stress is a lack of job security and career advancement opportunities. Adjunct and contract teachers, in particular, often face uncertainty regarding contract renewals, limited access to benefits, and little room for professional growth. The ever-changing education policies and curriculum revisions also demand constant adaptation, further increasing pressure on faculty to stay updated and relevant.

The effects of job stress on college teachers are far-reaching. It can lead to physical and mental health issues such as fatigue, anxiety, and depression. High stress levels may also result in decreased job satisfaction, reduced teaching effectiveness, and ultimately, lower academic outcomes for students. In the long run, persistent stress can drive experienced educators away from the profession, leading to a shortage of qualified faculty.Addressing job stress among college teachers requires systemic changes. Institutions need to recognize the pressures their faculty face and offer better support in terms of workload management, professional development, and mental health resources. By fostering a more balanced and supportive work environment, colleges can not only improve the well-being of their educators but also enhance the overall quality of education. Coping with job stress is essential for college teachers to maintain their health, motivation, and effectiveness in the classroom. One of the most effective ways to manage stress is through proper time management and setting realistic goals. Prioritizing tasks, breaking large projects into smaller steps, and avoiding procrastination can help reduce the feeling of being overwhelmed. Using planners or digital tools to organize schedules can also make workloads feel more manageable. Creating a healthy work-life balance is another key to reducing stress. College teachers should make time for regular physical activity, hobbies, family, and relaxation. Taking short breaks during the day, practicing mindfulness or meditation, and getting enough rest can significantly improve mental well-being. Seeking social support from colleagues, friends, or counsellors also helps in sharing burdens and gaining perspective.Institutions can also play a big role in helping teachers cope with stress. Providing access to professional development, counselling services, and fair workloads can create a more positive work environment. Encouraging open communication, recognizing teachers' efforts, and involving them in decision-making can improve morale. By combining personal stress-management strategies with institutional support, college teachers can better handle job-related challenges and thrive in their roles.

Objective of the study

The important objective of the study is:

To evaluate Job Stress among women teachers of self-financed colleges in Kanniyakumari District

Methodology

The present study is mainly based on both primary and secondary data. The primary data needed for the study have been collected by personal interview method. The secondary data have been mainly collected from the books, journals, magazines and also from internet.

Sampling design

There are six taluks in Kanniyakumari District namely Kalkulam, Vilavancode, Killiyur, Thiruvattar, Thovalai and Agasteeswaram. For the purpose of the study 10 women teachers from each taluk confined of total 60 teachers are randomly selected as samples by using convenient sampling method.

Frame work of analysis

To study about the job stress among self-financed college teachers in the study area the statistical tools such as Percentages, Garrett ranking and Chi-square test are adopted.

Analysis and Interpretation

Age of the sample teachers

Job stress is experienced by the employees across all age groups and hence the age of the sample teachers is also considered for the study. The classification of the sample self-financed college teachers is presented in the following table.

Table:1 Age of the sample teachers

S. No	Age	No. of. respondents	Percentage
1.	Up to30years	12	20
2.	30 years to 50 years	32	53.3
3.	Above 50 years	16	26.7
	Total	**60**	**100**

Source: Primary data

The above table shows that 12(20 percent) of the respondents belongs to the age group of up to 30 years, 32(53.3 percent) of them comes under the age group of 30 – 50 yearsand the remaining 16(26.7 percent) of them belongs to the age group of Above 50 years.

Marital Status of the sample teachers

The marital status is an important factor which decides the family nature and responsibilities of a person. Hence the martial status of the teachers is also analyzed and presented in the following table.

Table: 2 Marital Status of the sample teachers

S. No	Marital status	No. of respondents	Percentage
1.	Married	43	71.7
2.	Unmarried	17	28.3
	Total	**60**	**100**

Source: Primary data

The above table reveals that 43(71.7 percent) of the sample teachers are married and the remaining 17(28.3 percent) of them are unmarried.

Nature of family of the sample teachers

The family nature of the sample women teachers is also analyzed since it is both a source of support and a potential source of stress. Hence the nature of family of the teachers is also analyzed and presented in the following table.

Table: 3

Nature of family of the sample teachers

S. No	Nature of family	No. of respondents	Percentage
1.	Nuclear	29	48.3

2.	Joint	31	51.7
	Total	**60**	**100**

Source: Primary data

It is clear from the above table that 29(48.3 percent) of them belongs to nuclear family and the remaining 31(51.7 percent) of them belongs to joint family.

Educational qualification of the teachers

Educational qualification plays a significant role in shaping an individual's stress levels and hence the qualification of the sample teachers is also considered for the study. The classification of the respondents on the basis of their educational qualification is presented in the following table.

Table:4

Educational qualification of the teachers

S. No	Educational qualification	No. of. respondents	Percentage
1.	PG with M.Phil	16	26.7
2.	Ph.D	35	58.3
3.	Others	09	15
	Total	**60**	**100**

Source: Primary data

It is inferred from the above table that out of 60 respondents 16(26.7 percent) of them are having the qualification of PG with M.Phil, 35(58.3 percent) of them are Doctorates and the remaining 9(15 percent) of the respondents are having other qualifications such as Post Graduate degree, NET/SET.

Designation of the sample teachers

The designation of the sample teachers is also considered for the study to know the Job stress among the women teachers in self-financed colleges and presented in the following table.

Table:5

Designation of the consumers

S. No	Designation	No. of. respondents	Percentage
1.	Assistant Professors	54	90
2.	Associate Professors	06	10
	Total	**60**	**100**

Source: Primary data

It is clear from the above table 54(90 percent) of the sample teachers are Assistant Professors and the remaining 6(10 percent) of them are Associate Professors.

Experience of the sample teachers

Teaching is a demanding profession where stress levels can vary based on experience. The teachers often face many problems and it is assumed that the experienced teachers may deal the stress experienced by them effectively. Hence the experience is also analyzed and presented in the following table.

Table:6 Experience of the sample teachers

S. No	Experience	No. of. respondents	Percentage
1.	Up to 5 years	18	30
2.	5 – 10 years	29	48.3
3.	Above 10 years	13	21.7
	Total	**60**	**100**

Source: Primary data

The above table depicts that 18 (30 percent) of the sample teachers are having up to 5 years of experience, 29(48.3 percent) of them are having 5 – 10 years of experience and the remaining 13(21.7 percent) of the teachers are having above 10 years of experience.

Monthly Salary of the teachers

Monthly salary is a key factor influencing an individual's financial security and standard of living. The low or inconsistent income can lead to anxiety, while higher earnings may reduce stress but increase job pressure. The following table illustrates the monthly salary of the sample respondents.

Table:7 Monthly Salary of the teachers

S. No	Monthly Income	No. of. respondents	Percentage
1.	Up to Rs.25000	38	63.3
2.	Rs.25,000 – Rs. 50,000	19	31.7
3.	Above Rs.50,000	03	05
	Total	**60**	**100**

Source: Primary data

The above table infers that 38(63.3 percent) of the sample teachers said that their monthly salary is up to Rs.25000, 19(31.7 percent) of them opined that their monthly salary is from Rs.25,000 – Rs. 50,000 and the remaining 3(5 percent) of them said that their monthly salary is above Rs.50,000.

Causes of Stress among the sample teachers

There are many stressors which cause stress among the college teachers. The ranks assigned by the college teachers are converted into scores and presented in the following table.

Table: 8 Factors influencing the consumers to purchase fast-food

S. No	Factors	Mean Score	Rank
1.	Students' behaviour	57.73	III
2.	Job insecurity	56.09	V
3.	Heavy workload and time pressure	57.97	II
4.	Low Salary	58.11	I
5.	Interpersonal Relations	55.95	VI
6.	Low infrastructure and facilities	56.18	IV
7.	Rare Promotions	55.83	VII
8.	Others	55.56	VIII

Source: Primary data

It is revealed from the above table that Low salary scores high (58.11) and holds the rank first, Heavy workload and time pressure and the students' behaviour holds second and

third rank respectively in the causes of stress among self-financed college teachers in the study area.

Level of stress experienced by the sample teachers

The level of stress experienced by the sample self-financed college women teachers are also analyzed and presented in the following table.

Table:9 Level of stress experienced by the sample teachers

S. No	Level of stress	No. of. respondents	Percentage
1.	High	11	18.3
2.	Medium	42	70
3.	Low	7	11.7
	Total	**60**	**100**

Source: Primary data

It is inferred from the above table that 11(18.3 percent) of the sample teachers are experiencing high level of stress, 42(70 percent) of them stated that they are experiencing medium level stress and the remaining 7(11.7 percent) of them are experiencing low level of stress.

Association between personal factors and Level of stress experienced by the teachers

The researcher made an analysis to know about the association between the personal factors and the level of stress experienced by them by adopting chi – square test. The following null hypothesis was framed for the above purpose.

Null Hypothesis

H_o There is no significant association between the personal factors and stress experienced by the teachers

Age and Level of Stress

The association between the age of the respondents and the level of stress experienced by them is analyzed using chi-square test and presented in the below table.

Table: 10 Age and Level of Stress

Chi-square value	Degrees of freedom	Table value	Inference
13.33	4	9.488	**Significant**

Source: Computed Value

From the above analysis it is seen that the calculated value (13.33) of Chi-square is greaterthan the table value (9.488), and hence the null hypothesis is rejected. Hence it is inferred that there is a significant association between the Age and the level of stress experienced by the sample teachers.

Marital status and Level of Stress

The association between the marital status of the respondents and the level of stress is analyzed using chi-square test and presented in the below table.

Table11 Marital status and Level of stress

Chi-square value	Degrees of freedom	Table value	Inference
5.01	**2**	**5.99**	**Insignificant**

Source: Computed Value

It is clear from the above analysis the calculated value (5.01) of Chi-square is less than the table value (5.99), and hence the null hypothesis is accepted. Hence it is revealed that

there is no significant association between the Marital status and theLevel of stress experienced by the sample teachers.

Monthly Salary and Level of Stress

The researcher further made an attempt to know the association between the Monthly salary of the teachers and the level of stress experienced by them by using chi-square test and the results are presented in the below table.

Table: 12 Monthly Salary and Level of Stress

Chi-square value	Degrees of freedom	Table value	Inference
13.62	4	9.488	**Significant**

Source: Computed Value

From the above analysis it is seen that the calculated value (13.62) of Chi-square is greater than the table value (9.488), and hence the null hypothesis is rejected. It is found that there is a significant association between the monthly salary and the level of stress experienced by the sample teachers.

Findings of the Study

The important findings of the study are:

- The researcher found that out of 60 respondents 32(53.3 percent) of them comes under the age group of 30 – 50 years.
- Majority 43(71.7 percent) of the sample teachers are married.
- Regarding the nature of family 31(51.7 percent) of the sample teachers belongs to joint family.
- It is also found that out of 60 sample women teachers 35(58.3 percent) of them are Doctorates.
- Most 54(90 percent) of the sample teachers are Assistant Professors.
- It is also revealed that 29(48.3 percent) of them are having 5 – 10 years of experience.
- The researcher found that 38(63.3 percent) of the sample teachers said that their monthly salary is up to Rs.25000.
- Low salary scores high the rank first, Heavy workload and time pressure and the students' behaviour holds second and third rank respectively in the causes of stress among self-financed college teachers in the study area.
- Majority 42(70 percent) of the sample teachers stated that they are experiencing medium level stress in their work place.
- The personal factors such as age and monthly salary is dependent and the factor marital status is independent to the level of stress experienced by the sample teachers of self-financed college teachers in Kanniyakumari District.

Conclusion

Job stress among college teachers is a growing concern that affects not only the educators themselves but also the quality of education. The pressure of heavy workloads, limited job security, and high expectations can lead to serious physical and emotional consequences. However, with effective coping strategies and strong support from educational institutions, this stress can be managed. Promoting a healthy work environment, encouraging open communication, and prioritizing teacher well-being are essential steps toward reducing

stress and ensuring that educators can perform their roles effectively and with satisfaction.Job stress among college teachers is a significant issue that impacts their performance, health, and overall job satisfaction. If left unaddressed, this stress can lead to burnout and a decline in teaching quality. Therefore, it is essential to take proactive steps to manage and reduce stress in the academic environment.

REFERENCES

Aminabhavi, and Triveni. (2000). Variables causing occupational stress on thenationalized and non- nationalized bank employees. *J. Com. Gui. Res*., 17(1): 20-29.

Anil Gore, Amar Bondre. (2012). Impact of Job Stress on Performance of Indian Managers. *Golden research thoughts*, Vol.1, Issue.X: pp.1 – 4.

Aujla, Harshpinder, Sandhu, and Gill. (2004). Stress management techniques used by Working women and Non-Working Women of Ludhiana city. *Indian J. Soc.Res.*, 45(1): pp. k47-58.

GhodsyAhghar. (2008). The role of school organizational climate in occupational stress among secondary school teachers in Tehran. International Journal of Occupational Medicine and Environmental Health, 21(4):319 -329.

Jyoti Budhraja.(2008). Causes of stress among Insurance employees: An empirical study. *The ICFAIAN Journal of Management Research*, Vol.VII, No. 10, pp.7-17.

Potter, Smith, Strobelb and Zutra. (2002). Interpersonal workplace stressors and well being: A multiwave study of employees with and without Arthritis. *J. App. Psy*., 87(4): pp.789-796.

The Bluest Eye as a Tool for Critical Pedagogy in the 21st Century Classroom: Challenging Colorism, Racism, and Inequality through Literature

Alkin Saji
Postgraduate student
Department of English
kristu Jayanti(Autonomous)College Bangalore

Introduction

The Bluest Eye by Toni Morrison which published in 1970 continues to represent powerfully how racial prejudice and racial favoritism inflict profound destruction inside cultural communities. Throughout 1940s Ohio the story traces Pecola Breedlove as she desperately wants blue eyes thinking this would lead to social acceptance and love. The social commentary in Morrison's work about damaging beauty standards has established itself as a fundamental discussion point regarding racial inequality and discrimination in the present. The book persists as an essential educational resource because it appears often in scholarly programs and sparks both praise and criticism which demonstrates its vital commentary on social matters. **(Madhavi. and Rao, 2023), (Shasha, 2009)**

Transformative education depends on critical pedagogy as its basic principle promotes students to critique established power dynamics and social norms. Paulo Freire's book Pedagogy of the Oppressed launched critical pedagogy which focuses on helping people become conscious of oppression therefore they can take action against such social injustices. Through this learning approach students become active learners who analyze content material to both understand their realities and develop ways to transform them. **(Freire, 2020), (Freire, 1996)**

Within this document authors propose that The Bluest Eye functions effectively as an educational instrument for critical pedagogy during the current 21st-century learning environment. The themes of race colorism and inequality in the novel serve as learning opportunities for educators to create critical consciousness in their student body. The narrative from Morrison leads students into an analysis of fundamental societal frameworks that establish ideas about beauty standards which creates opportunities for understanding industrial prejudices. When schools include The Bluest Eye on their curriculum it provides students with an enhanced literary connection while teaching them to recognize and dispute conventions which create social disparities.

Theoretical Foundations

Assessing success in using The Bluest Eye by Toni Morrison for modern-day classes requires applying strong theoretical approaches promoting educational change and inclusivity. Three vital theoretical frameworks including Critical Pedagogy and Critical Race Theory (CRT) together with Black Feminist Pedagogy establish how literary education helps students fight organized discrimination and develop analytical abilities.

Critical Pedagogy (Paulo Freire)

The critical framework developed by Paulo Freire enables education to function as a freedom space which helps students challenge and restructure societal oppression. Freire opposes the common "banking model" in teaching since he promotes learning through active dialogue which develops student critical thinking and active participation. Through this teaching approach readers can analyze the cultural impositions of beauty and racial identity from dominant social groups as seen in The Bluest Eye. Going through Morrison's text helps students grasp how social beliefs become internalized through cultural perpetuation which matches Freire's concept of liberating education. **(Díaz, 2020)**

Critical Race Theory in Education (Gloria Ladson-Billings & William F. Tate)

The educational theories developed by Gloria Ladson-Billings and William F. Tate about critical race theory state that racism persists within institutional frameworks of the educational system. Through CRT students receive access to marginalized perspectives of people of color which fight against dominant narratives that reduce their experiences to insignificance. As a major work in this context The Bluest Eye recreates the real African American struggles against internal racism and social marginalization of its characters. The use of the right literature in classroom settings enables students to identify and analyze racial discrimination by the system thus promoting educational spaces that reflect diverse perspectives. **(Ladson-Billings and Tate, 1995), (Ladson-Billings, 1998), (Ladson-Billings, Tate and Donnor, 2021)**

Black Feminist Pedagogy (bell hooks)

Bell hooks employs Black Feminist Pedagogy to spotlight the essential role which positions Black women as the core focus in educational discussions. The approach shows understanding of intersectionality since different identities merge to create distinct patterns of oppression and survival. Through its exploration of Black girlhood the book demonstrates how social expectations about self-perception affect Black females. Morrison's work provides teachers with educational tools to organize discussions which respect the complete stories of minority groups and help students explore different forms of prejudice as well as grow their capacity for understanding diverse groups. **(Biana, 2020), (Specia and Osman, 2015)**

The inclusion of these theoretical frameworks in The Bluest Eye analysis makes classrooms into spaces where students explore literary(higher level) thinking and develop social(community) consciousness. By employing this multi-faceted instructional method students gain capabilities to identify and combat the system-generated powers which determine social group recognition and collective identity development.

Literary Analysis: Morrison’s Critique of Systemic Oppression

Through The Bluest Eye Toni Morrison presents a penetrating examination of systematic discrimination that stresses internal racism and colorism on people and societies. The novel

shows how both racial structures and societal beauty standards create destructive social effects by using its characters and plot elements.

Internalized Racism and Colorism

Through its narrative The novel shows how people adopt unjust social standards that make them disrespect themselves along with their neighbors. Pecola Breedlove shows her inner loathing by believing blue eyes would make her appealing enough to gain love because she desperately wants others to accept her. Through membership in a white household her mother Pauline adopts white standards of beauty thus neglecting herself and the family she could have had. Claudia MacTeer presents a conscious understanding of social norms when she rejects white dolls and questions why white beauty standards receive such adoration. **(Nunez, 2023), (Bryan-o, 2020), (Ms. Khamsa Qasim and Dr. Farhan Ebadat Yar Khan, 2023), (Mamun and Siddika, 2020)**

Character Analysis

Pecola Breedlove: Pecola expresses destructive racism effects because she believes having blue eyes would bring acceptance from others. **(Bryan-o, 2020)**

Pauline Breedlove: Bone exhibits an identity based on serving a white family where she completely ignores her own Black culture. **(Bryan-o, 2020)**

Claudia Mac-Teer: This character demonstrates social resistance through her refusal to accept dominant white beauty conventions together with her evaluation of white superiority's societal values.**(Bryan-o, 2020)**

Narrative Style and Critical Engagement

The story presents itself through multiple disjointed voices for characters Claudia and Pauline and Pecola who each have their own perspective. Because of its polyphonic narrative structure this text obligates readers to confront different perspectives thus enabling them to better grasp how characters experience the world and what social pressures affect them. The novel presents various stories which helps readers develop critical thinking about the complex nature of identities as well as beauty standards and social oppression. **(Jsour dillon, 2018)**

The novel demonstrates its significance by analyzing racial self-hatred while examining character relationships along with its experimental storytelling methods to dissect educational institutional racism.

Pedagogical Strategies for the Classroom

Study of The Bluest Eye by Toni Morrison creates valuable chances for students to discuss racial matters and identity challenges together with structural discrimination systems.

Teaching The Bluest Eye requires educators to use multiple pedagogical methods which facilitate strong comprehension and emotional strength.

Dialogic Discussions: Student-led discussions which do not restrict students to predetermined answers create opportunities for novel theme investigation among learners. Educators who create classrooms without fear enable their students to exchange meaningful thoughts which stimulate critical thinking and overcome prior beliefs. A productive conversation environment requires both definite procedures and welcome listeners who show respectful conduct. **(Dakamsih and Hammouri, 2022)**

Reflective Journaling: Students achieve personal understandings of the text when educational programs add reflective journaling components to classwork. Students who document their character and event responses in writing gain better comprehension of novel themes and better process their complex emotional reactions. The writing process helps students develop both empathy and self-perception abilities.

Creative Responses: By permitting students to communicate their readings through artistic media or speech they can gain better understanding of literary content. The choice of creative assignments enables students to discover different methods for understanding novel themes which creates an environment where all learners feel included. The methods enable understanding of complex material while making it simpler to relate to. (**Mankhia and Alhusseini, 2020)**

Role of the Teacher: The educational role of facilitator should substitute the function of moral authority when teachers lead discussions about sensitive content. The teacher's task includes supporting student analysis of the text together with promoting varied interpretations that lead to sophisticated knowledge acquisition. The teaching method follows critical pedagogy principles because it requires both communication among students and self-examination of ideas. **(Moore and Deshaies, 2012)**

Handling Discomfort: Because the novel treats traumatic content students also need appropriate guidance dealing with emotional outcomes. Teacher should use trauma-sensitive practices by alerting students about sensitive material through warnings and allowing voluntary participation in distressing discussions to build secure educational spaces. Teachers need to be ready to run sensitive classroom discussions while displaying emotional intelligence and compassionate behavior. **(Lopez, 2023)**

These educational strategies enable teachers to develop educational environments which boost literary content evaluation in addition to encouraging critical mental development and emotional maturation in their students.

Challenges and Ethical Considerations

Teaching Toni Morrison’s The Bluest Eye provides both deep academic prospects along with substantial moral dilemmas for teachers to handle. The sensitive content in The Bluest Eye

demands careful understanding of trauma so educators may create supportive conditions for their students.

Navigating Difficult Themes: Through its plot The Bluest Eye explores multiple horrifying experiences where Pecola Breedlove experiences sexual assault which results in her psychological collapse. The critical stories which demonstrate systemic oppression may cause students distress even though they serve a fundamental role in comprehension. Both the teachers and the educators need to take caution in presenting these delicate topics through appropriate warnings and ensuring their students experience a secure environment.

Implementing Content Warnings and Age-Appropriate Engagement: The school should integrate content warning systems alongside appropriate engagement practices for different age groups. Students require a careful suitability assessment for the book due to its explicit content. At the start of classes students need to know about sensitive information so they can mentally prepare themselves for harsh material. Teaching professionals must evaluate student development together with readiness to determine how they should structure discussions so students learn without suffering any mental challenges.

Adopting Trauma-Informed Pedagogy: The trauma-informed instructional model understands both its wide reach and its educational effects through the student experience. The effort of educators should focus on building a classroom environment where students feel protected with trust and possess empowerment. Teaching staff needs to remain alert to student emotional reactions and give help and steer clear of educational practices that harm students.

Avoiding Performative Teaching: Educators need to progress from basic discussions about race and oppression to truly develop student understanding of these topics. Deep examination of the text combined with active analysis and recognition of novel themes in present-day social issues makes up this method. Teacher guidance enables students to acquire deep knowledge about how systematic inequalities express themselves.

The implementation of The Bluest Eye into school programs needs careful management to protect students' mental health and educational benefits from the text. Educators who plan carefully alongside their sensitivity toward students and prioritize critical consciousness development will be able to handle The Bluest Eye complexities to create effective educational experiences.

Conclusion

The Bluest Eye by Toni Morrison serves as a critical educational tool which helps instructors develop classroom activities for promoting social engagement and critical thinking. The novel reveals internal racism together with color prejudice and institutional oppression which makes students explore how cultural systems construct and define personal and communal identities. Morrison promotes reader understanding about harmful effects from dominant beauty paradigms and racial organizational systems through their focus on characters like

Pecola Breedlove. The story follows critical pedagogical principles by showing how students need to challenge oppressive social norms through questioning. Through their study of such literature students become more empathetic while they better understand the complex nature of racial and identity matters. Educational programs should include The Bluest Eye because it demonstrates the value of multicultural literature which represents multiple life experiences. Academic findings demonstrate that inclusion practices within classrooms result in improved social emotional outcomes which produce better classroom equality. The process of developing inclusive curricula enables schools to fulfill the learning requirements of students while improving social outcomes.The Bluest Eye provides both an enhanced book analysis experience and mentor students to become aware of systematic inequalities. Through educational adoption of inclusive social literature educators establish instructional practices that create just and reflective education.

References

1. Biana, H.T. (2020) 'Extending bell hooks' feminist theory', *Journal of International Women's Studies* [Preprint].
2. Bryan-o (2020) 'Toni Morrison's "The Bluest Eye": A Look at How Racism Is Internalized'. Available at: https://ablacklitblog.wordpress.com/2020/06/16/toni-morrison-bluest-eye/?utm.
3. Dakamsih, N.J. and Hammouri, R.N. Al (2022) 'Analyzing Toni Morrison's The Bluest Eye in Terms of Bakhtin's Notion of "Heteroglossia"', *Theory and Practice in Language Studies*, 12(9), pp. 1945–1951. Available at: https://doi.org/10.17507/tpls.1209.29.
4. Díaz, K. (2020) 'Paulo Freire (1921—1997)'. Available at: https://iep.utm.edu/freire/#:~:text=Instead of tacitly promoting oppressive,equals rather than oppressive imposition.
5. Freire, P. (1996) 'Pedagogy of the oppressed (Rev. ed.)', *Chapter 1* [Preprint]. Available at: https://doi.org/10.1017/CBO9781107415324.004.
6. Freire, P. (2020) 'Pedagogy of the oppressed', in *The Community Performance Reader*. Available at: https://doi.org/10.4324/9781003060635-5.
7. Jsour dillon (2018) 'The Bluest Eyes and narrative shifts'. Available at: https://voices.uchicago.edu/201801engl25640/2018/02/14/the-bluest-eyes-and-narrative-shifts/.
8. Ladson-Billings, G. (1998) 'Just what is critical race theory and what's it doing in a nice field like education?', *International Journal of Qualitative Studies in Education*, 11(1), pp. 7–24. Available at: https://doi.org/10.1080/095183998236863.
9. Ladson-Billings, G. and Tate, W.F. (1995) 'Toward a Critical Race Theory of Education', *Teachers College Record: The Voice of Scholarship in Education*, 97(1), pp. 47–68. Available at: https://doi.org/10.1177/016146819509700104.
10. Ladson-Billings, G., Tate, W.F. and Donnor, J.K. (2021) 'Critical Race Theory in Education: A Scholar's Journey. Multicultural Education Series.', *Teachers College Press* [Preprint].
11. Lopez, H. (2023) 'Finding the Why: T Finding the Why: Trauma's Origins and E s Origins and Effects in Morrison ects in Morrison's The Bluest Eye'.

Bianchi Type-VI Cosmological Model with Dark Energy: Transition to an Accelerating Phase

Sudipta Karmakar
MSc Student
Department of Mathematical Sciences, Bodoland University

Mukunda Dewri
Assistant Professor
Department of Mathematical Sciences, Bodoland University

Abstract

A cosmological model with $a(t) = e^{(\alpha t + \beta)^n}$ is analyzed using specific parameters. The model exhibits continuous expansion, characterized by increasing volume, decreasing Hubble and expansion scalars, and isotropization. The deceleration parameter (q) transitions to acceleration, and the equation of state parameter (w) evolves dynamically. Energy density (ρ) and density parameter (Ω) decrease, indicating a universe transitioning to a state of dark energy dominance and exponential expansion.

Keywords: Bianchi Type-VI, Cosmological Models, Dark Energy, Accelerating Phase

1.Introduction

Bianchi type VI cosmological models have garnered significant attention in theoretical cosmology because they can describe worlds that are both inhomogeneous and homogeneous. These models provide a framework to explore various aspects of the universe's evolution under different physical conditions and theoretical constructs. Abdel-Megied and Hegazy (2016) investigated Bianchi type VI models incorporating electromagnetic fields within Lyra geometry. Further studies by Reddy et al. (2016) and Tiwari et al. (2016) expanded on anisotropic models in scalar-tensor theories and models with variable deceleration parameters, respectively. Recent works have explored diverse themes, such as bulk viscous effects in self-creation theories (Hegazy, 2019), time-varying gravitational constants (Satish and Venkateswarly, 2019), and dynamical cosmological parameters (Samdurkar and Bawnerker, 2019). Studies by Srivastava (2019) and Hegazy and Rahaman (2019) explored barotropic and electromagnetic field parameters within the Lyra geometry and general relativity frameworks. Research has also examined perfect fluid distributions (Groeniger, 2020) and magnetized barotropic fluid models (Tyagi et al., 2020).

In recent years, studies have incorporated inflationary scenarios (Sharma et al., 2021), dark energy parametrization (Dixit and Pradhan, 2020), and the presence of massive strings and cloud strings (Mete and Dudhe, 2023; Kandarkar and Thakare, 2023). Other contributions include exploring geodesic deviations (Osetrin et al., 2023) and applications in modified gravity theories like $f(R,T)$ and Saez-Ballester gravitation (Kumawat et al., 2024; Nimkar and Ugale, 2024).

These extensive investigations underscore the importance of Bianchi type VI models in understanding anisotropic cosmologies under varying physical assumptions, including bulk viscosity, dark energy, electromagnetic fields, and string sources, enriching our comprehension of the universe's anisotropic dynamics.

2.Metric and Field Equations

We consider the Bianchi type VImetric in the form

$$ds^2 = -dt^2 + A^2dx^2 + B^2e^{-2mx}dy^2 + C^2e^{2mx}dz^2 \qquad (2.1)$$

where A, B, and C are scale factors that are functions of cosmic time t, and m is a non-zero constant.
The Einstein field equations, in natural limits ($8\pi G = c = 1$) are

$$R_{\mu\nu} - \frac{1}{2}R\,g_{\mu\nu} = -T_{\mu\nu} \qquad (2.2)$$

where $R_{\mu\nu}$ is the Ricci tensor, R the scalar curvature, and $T_{\mu\nu}$ the energy-momentum tensor of the matter. If the gravitational field is generated by a perfect fluid, the associated energy-momentum tensor has the form

$$T_{\mu\nu} = (\rho + p)v_\mu v_\nu + pg_{\mu\nu} \qquad (2.3)$$

where ρ is the energy density of the cosmic fluid, p is the pressure and v^μ is a four-velocity vector.

In comoving coordinates $v^\mu = (0,0,0,1)$, the field equations (2.2), together with (2.1), yield the following independent equations independent equations

$$\frac{\ddot{B}}{B} + \frac{\ddot{C}}{C} + \frac{\dot{B}\dot{C}}{BC} + \frac{m^2}{A^2} = -\omega\rho \qquad (2.4)$$

$$\frac{\ddot{C}}{C} + \frac{\ddot{A}}{A} + \frac{\dot{C}\dot{A}}{CA} - \frac{m^2}{A^2} = -\omega\rho \qquad (2.5)$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{m^2}{A^2} = -\omega\rho \qquad (2.6)$$

$$\frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}\dot{C}}{BC} + \frac{\dot{C}\dot{A}}{CA} - \frac{m^2}{A^2} = \rho \qquad (2.7)$$

$$\frac{\dot{B}}{B} - \frac{\dot{C}}{C} = 0 \qquad (2.8)$$

where a dot denotes differential with respect to t. The matter, in general, will represent an anisotropic fluid with timelines as the flow lines of the fluid. The kinematical parameters of the expansion scalar (θ) and shear scalar (σ) of the fluid flow are given by

$$\theta = \frac{\dot{A}}{A} + \frac{\dot{B}}{B} + \frac{\dot{C}}{c}, \quad (2.9)$$

$$\sigma^2 = \frac{1}{2}\left[\frac{\dot{A}^2}{A^2} + \frac{\dot{B}^2}{B^2} + \frac{\dot{C}^2}{C}\right] - \frac{\theta^2}{6}. \quad (2.10)$$

For the metric (2.1), the spatial volume V is given by

$$V = ABC \quad (2.11)$$

The physical parameters, such as directional Hubble's parameters (H_1, H_2, H_3) , average Hubble parameter H and the density parameter Ω are defined by

$$H_1 = \frac{\dot{A}}{A}, \qquad H_2 = \frac{\dot{B}}{B}, \qquad H_3 = \frac{\dot{C}}{C},$$

$$H = \frac{1}{3}(H_1 + H_2 + H_3),$$

$$\Omega = \frac{\rho}{3H^2} \quad (2.12)$$

A crucial observational quantity in cosmology is the deceleration parameter q, defined by

$$q = -\frac{a\ddot{a}^2}{\dot{a}^2} \quad (2.13)$$

The sign of q indicates whether the model inflates or not. A positive sign of q corresponds to the deceleration model, whereas the negative sign of q indicates inflation.

3.Solution of The Equations

Solving equation (2.8), we get

$$B = C \quad (3.1)$$

Where the constant of integration can be absorbed in B or C. Using equation (3.1), the field equations (2.4) -(2.7) reduce to

$$\frac{2\ddot{B}}{B} + \frac{\dot{B}^2}{B^2} + \frac{m^2}{A^2} = -\omega\rho \quad (3.2)$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} - \frac{m^2}{A^2} = -\omega\rho \quad (3.3)$$

$$\frac{2\dot{A}\dot{B}}{AB} + \frac{\dot{B}^2}{B^2} - \frac{m^2}{A^2} = -\rho \quad (3.4)$$

Thus, Equations (3.2) and (3.3) are three equations in four unknowns: A, B, ω, and ρ. To solve the above equations in closed form, we utilize a physical condition that the expansion scalar is proportional to a shear scalar. We use a physical condition that the expansion scalar. We use the condition either $B = A^n$ or $A = B^n$. where n is a constant.

When $B = A^n$, we obtain from (2.11) that

$$A = V^{\frac{1}{2n+1}}, B = V^{\frac{n}{2n+1}}$$
(3.5)

where $n \neq 1$ is an arbitrary constant.
Let us assume the scale factor

$$a(t) = e^{(\alpha t+\beta)^n}$$
(3.6)

By using Equation (3.6), we obtain Equation (2.11) and Equation (3.5) of the form

$$A = e^{\frac{3(\alpha t+\beta)^n}{2n+1}} \quad (3.7)$$

$$B = C = e^{\frac{3n(\alpha t+\beta)^n}{2n+1}} \quad (3.8)$$

As a result, spatially homogeneous and anisotropic space-time in equation (2.1) becomes

$$ds^2 = -dt^2 + \left(e^{\frac{6(\alpha t+\beta)^n}{2n+1}}\right)dx^2 + \left(e^{\frac{6n(\alpha t+\beta)^n}{2n+1}}\right)dx^2 e^{-2mx}\,dy^2 + \left(e^{\frac{6n(\alpha t+\beta)^n}{2n+1}}\right)e^{2mx}\,dz^2 \quad (3.9)$$

By using Equation (3.7) and Equation (3.8) in Equation (2.9), we obtain expansion scalar (θ)

$$\theta = 3n\alpha(\alpha t+\beta)^{n-1}$$
(3.10)

Using Equation (3.7), Equation (3.8) and Equation (3.10), we obtain shear scalar

$$\sigma^2 = 3\left(\frac{n-1}{2n+1}\right)^2 n^2\alpha^2(\alpha t+\beta)^{2(n-1)}$$
(3.11)

By using equation (3.6), we obtain the volume

$$V = e^{3(\alpha t+\beta)^n}$$
(3.12)

Using Equation (3.7),(3.8) in Equation (2.12), we obtain the Hubble parameter H_1 , H_2 and H_3

$$H_1 = \frac{3n\alpha(\alpha t+\beta)^{n-1}}{2n+1}, H_2 = \frac{3n^2\alpha(\alpha t+\beta)^{n-1}}{2n+1}, H_3 = \frac{3n^2\alpha(\alpha t+\beta)^{n-1}}{2n+1} \quad (3.13)$$

Using Equation (3.13), we obtain the Hubble Parameter

$$H = n\alpha(\alpha t + \beta)^{n-1}$$
(3.14)

From Equation (3.4), we obtain Energy Density

$$\rho = \frac{m^2}{e^{\frac{6(\alpha t+\beta)^n}{2n+1}}} - \frac{9n^2\alpha^2(2n+n^2)(\alpha t+\beta)^{2n-2}}{(2n+1)^2}$$
(3.15)

Using Equation (3.14) and Equation (3.15), we obtain the density parameter

$$\Omega = \frac{m^2}{3n^2\alpha^2(\alpha t+\beta)^{2n-2}e^{\frac{6(\alpha t+\beta)^n}{2n+1}}} - \frac{3n(2+n)}{(2n+1)^2}$$
(3.16)

The deceleration parameter is given by

$$q = \frac{1-n-n(\alpha t+\beta)^n}{n(\alpha t+\beta)^n}$$
(3.17)

Adding Equation (3.2) and Equation (3.3), we obtain state parameter

$$\omega = -\frac{\left[\frac{9n^2(4n^2+n+1)\alpha^2(\alpha t+\beta)^{2n-2}}{(2n+1)^2} + \frac{3n(n-1)(3n+1)\alpha^2(\alpha t+\beta)^{n-2}}{(2n+1)}\right]}{2\left[\frac{m^2}{e^{\frac{6(\alpha t+\beta)^n}{2n+1}}} - \frac{9n^2(2n+n^2)\alpha^2(\alpha t+\beta)^{2n-2}}{(2n+1)^2}\right]}$$
(3.18)

4.Graphical Representation

The graphical behavior is represented by considering the values of $\alpha = 0.1, \beta = -0.001, n = 0.9$

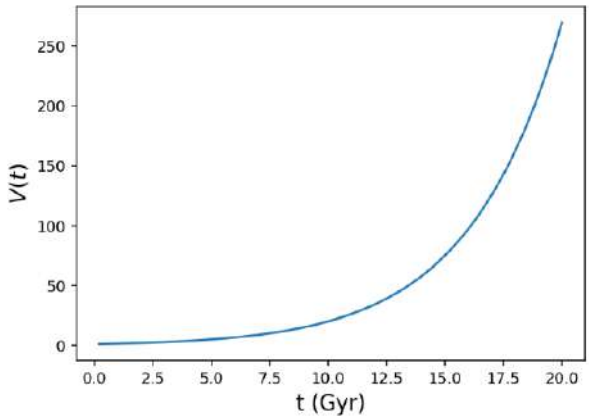


Figure 4.1: Evolution of V vs. t

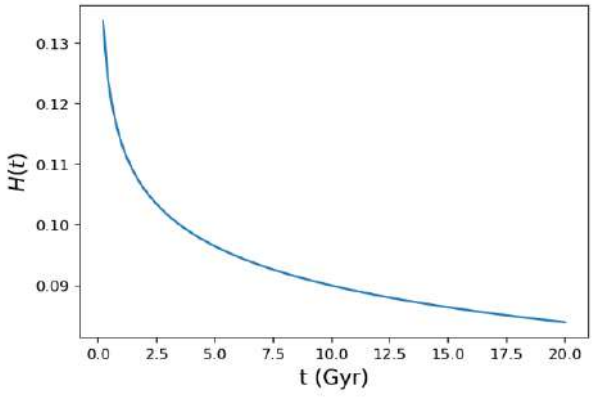
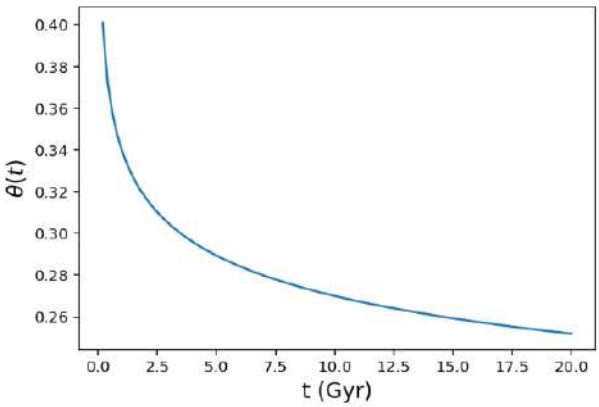


Figure 4.2: Evolution of *H* vs. t



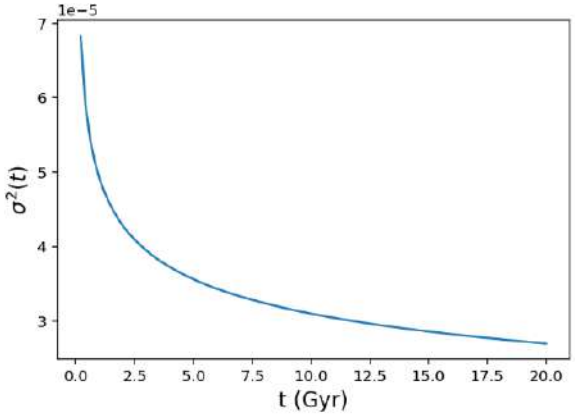
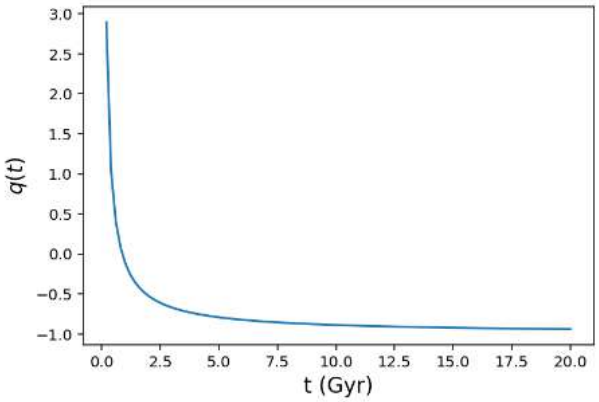


Figure 4.3: Evolution of θ vs.



tFigure4.4: Evolution of σ^2 vs. t

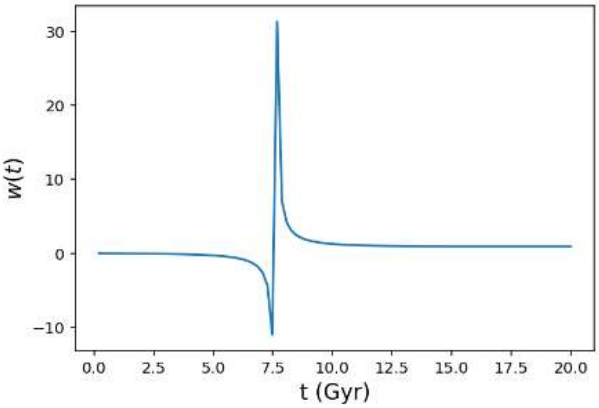
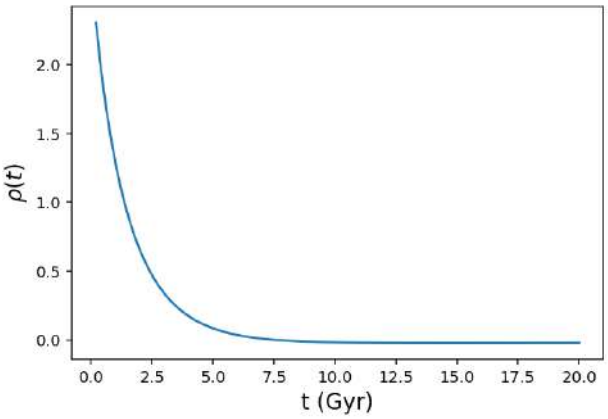


Figure 4.5: Evolution of q vs. t

Figure 4.6: Evolution of ω vs. t



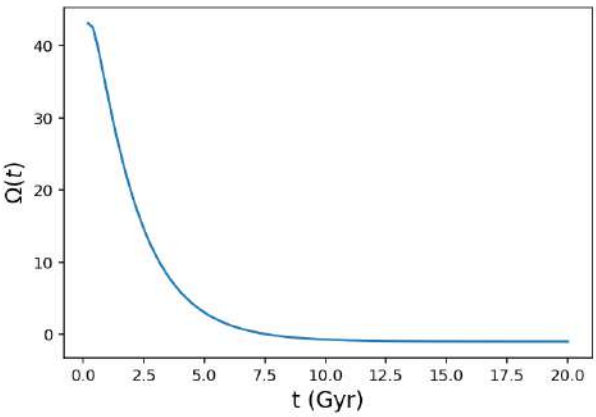


Figure 4.7: Evolution of ρvs. t

Figure 4.8: Evolution of Ω vs. t

Conclusion

In this chapter,Bianchi Type-VI Cosmological Modelfield equations have been solved using appropriate physical assumptions, and the scale factor $a(t) = e^{(\alpha t+\beta)^n}$ has been assumed to

find the solution for the field equations. Taking the values of $m = 1, \alpha = 0.1, \beta = -0.001$ and $n = 0.9$The graphical images are identified and analyzed.

The assumed cosmological model, defined by the scale factor $a(t) = e^{(\alpha t+\beta)^n}$, describes a universe that initially expands with deceleration due to the dominance of matter or radiation.Transitions to an accelerating phase as dark energy begins to dominate.Gradually smooths out anisotropies and inhomogeneities, resulting in a nearly isotropic and homogeneous universe.As $t \to \infty$, approaches a de Sitter-like exponential expansion dominated by dark energy. The transient behavior of the equation of state parameter w highlights the model's sensitivity to initial conditions and parameter choices. Such features might be explored further to refine the model's alignment with observational data.

References

Abdel-MegiedM, Hegazy E A, (**2016**), Bianchi type VI cosmological model with electromagnetic field in Lyra geometry.*Canadian Journal of Physics 94*,**10,** 992- 1000.

Reddy, D. R. K., Anitha, S., & Umadevi, S. (2016). Anisotropic holographic dark energy model in a scalar-tensor theory of gravitation.*Astrophysics and Space Science*, **361**, 1-7.

Tiwari R. K, Agarwal R. K., Shukla B. K, (**2016**), Bianchi type-VI_0Cosmological model with variable declaration parameter,*Prespacetime Journal 7*,**5.**

Hegazy E. A., (**2019**), Bulk Viscous Type VI_0 Cosmological in the Self-Creation Theory of Gravitation and in the General Theory of Relativity, *Iranian Journal of Astronomy and Astrophysics 6*,**1** 33-44.

Satish J.,VenkateswarlyJ., (**2019**), Anisotropic Bianchi Type-VI_0 Two Fluid Cosmological Model Coupled with Massless Scalar Field and Time-Varying G and Λ,*Bulg. J. Phys.*,**46** 67-79.

Samdurkar, S., &Bawnerkar, S. (2019). Bianchi Type VI Cosmological Model with Dynamical Cosmological Parameters G and Λ in the presence of Bulk Viscous Stress. IJSRSET, 246-254.

Srivastava S. K., (**2019**), Shishir Cosmological model Bianchi type VI with use Barotropic in modified theory of general relativity. AIJRFANS 19-215 pp60-62

Hegazy E. A., Rahaman F., (**2019**), Bianchi type VI_0 cosmological model in self - creation theory in general relativity and Lyra geometry,*Indian Journal of Physics 93* ,**12,** 1643-1650.

Hegazy E. A., RahamanF., (**2020**), Bianchi type VI_0 cosmological model with electromagnetic field parameter in general theory of relativity,*Indian Journal of Physics 94*, **11** ,1847-1852.

Groeniger, H. O., (2020), On Bianchi Type VI_0 Spacetime with Orthogonal Perfect Fluid Matter. arxiv:1908.02677v2, https://doi.org/10.48550/arxiv.1908.02677

Singh J., Tyagi A., Singh G. P., (**2020**), Bianchi Type-VI_0 Cosmological Model with Bulk Viscosity and Dust Distribution in C-field Theory,*Prespacetime Journal 11, 7, 617-625*.

Dixit A., Pradhan A. ,(**2020**), Stability , Dark energy parametrization and swampland aspect of Bianchi Type-VI_0 cosmological models with f(R,T)-gravity , *International Journal of Geometric Methods in Modern Physics* , **Vol.17** , **No.14** , 2050213 .

Maternal Health Care Services in North East India: (A comparative study among the north-eastern states)

Dr. Jonali Nath
Assistant Professor, Dept. of Economics.
D.K. College mirza.

Abstract

Motherhood is one of the most cherished and important stages in a woman's life. It is a stage where woman require special care, attention, support and nutrition. But the road to the safe motherhood is not a smooth one for every woman across the globe. Many factors including socio – economic ones, are responsible worldwide disparity in receiving the necessary support and care by the expecting mothers. Despite best of intension of the concerned Govt. and non-Govt. agencies such attention and care are as far cry for the majority of the expecting/lactating mothers worldwide. Pregnancy outcomes are directly affected by the social and economic status of the girls and women, their education, nutrition as well as the health and family planning services of the concerned. Maternal mortality reflects one of the shameful failures of human development (Freedman et al 2003). Every two minutes, a woman dies in pregnancy related complications. The foremost common causes being severe bleeding after childbirth, infections, high blood pressure during pregnancy and unsafe abortion (WHO, UNICEF, UNFPA & WORLD BANK 2005). Utilization of maternal health care services in turn related to their availability and socio- economic, demographic and cultural factors such as women's age, education, employment, caste and autonomy (obermeyer,1991; Becker et al.,1993;Elo 1992, Bhatia and clenlend 1995, Pebley et.al., 1996; Raghupathy,1996; Dharmalingam et.al.1999; Addai 2000; Acharya and clelend 2000.). *In this paper I try to make a comparative study for utilization of various maternal health care services among the north eastern states and status of maternal health services among the north eastern region.*

Keywords: women, pregnancy, maternal health, healthcare services, northeast

1) Introduction:

Maternal mortality reflects one of the shameful failures of human development (Freedman et al 2003). Every two minutes, a woman dies in pregnancy related complications. The foremost common causes being severe bleeding after childbirth, infections, high blood pressure during pregnancy and unsafe abortion (WHO, UNICEF, UNFPA & WORLD BANK 2005). Maternal death due to these causes are unjust and can be avoided with key health interventions, like provision of antenatal care and medically assisted delivery (Adam et al.2005, MCcaw-Binns et al 2007.

Promotion of maternal health and child care has been one of the most important objectives of the family welfare programme in India. The National population Policy 2000 had strongly stressed on reducing maternal mortality rate to 100 per 100,000 live births. To achieve this objective Government launched the current Reproductive and Child Health programme (RCH) in October, 1997. The RCH programme incorporates the components covered under child survival and safe motherhood programme. In recent times on 12th April 2005, the government of India has launched the National Rural Health Mission

(NRHM) with the goal of improving the availability and access to quality health care by people, particularly in rural areas. The NRHM seek to provide effective health care to rural population over the country with specific focus on 18 states. There are mainly 3 sub programmes under national rural health mission such as ASHA (Accredited social Health Activist), IPSH (Indian public health Slandered) and JSY (Janani Surakha Yojana). Under the Janani suraksha Yojna the National Rural Health Mission attempt to strengthen the institutional delivery through the provision of escort reference services by ASHA and free hospital services for below poverty line (BPL women). The mains goals of NRHM are: Reduction of Infant mortality Rate (IMR) and Maternal Mortality Rate (MMR), Access to integrated comprehensive primary healthcare, Population Stabilization, gender and demographic balance, Revitalize local health traditions and mainstream of AYUSH, promotion of healthy life styles.

Utilization of maternal health care services in turn related to their availability and socio- economic, demographic and cultural factors such as women's age, education, employment, caste and autonomy (obermeyer,1991; Becker et al.,1993;Elo 1992, Bhatia and clenlend 1995, Pebley et.al., 1996; Raghupathy,1996; Dharmalingam et.al.1999; Addai 2000; Acharya and clelend 2000.). ***This paper tries to make a comparative study for utilization of various maternal health services among the north eastern states.***

Globally, 210 maternal deaths per 100,000 live births occur due to pregnancy related complication (WHO 2014). Though the MMR is sharply fall in developed countries, but it is remain very high in developing country like India. In India Maternal Mortality Rate (MMR) declined 301 in 2001-03 to 212 in 100000 live births in 2007-09; it is still quite high in Assam (390 in 2009) and NE region. During 2004-06 MMR in Assam was 480 which fall to 381 in 2010-11 as per annual health survey report Assam, total 99 point drop of MMR during NRHM period which is the highest drop in the country during NRHM period. But ever after 99 point drop of MMR during NRHM period Assam recorded the highest MMR state in the country. North Eastern states are very poor in case of utilization of maternal health services. Socio economic, demographic and health indicators are showing a very poor of the general population. It has been observed that women of lower social status often do not avail the existing reproductive health care services. Most victims are poor people in remote rural areas who have little or no access to health care. Maternal Mortality Rate is high in char areas, tea garden areas and remote areas because in these areas health care services are very poor. Therefore it is not so surprisingly observation and so common in NE where the utilization of maternal health services are very low and people are not much conscious about pregnancy and its related problems.

1.2 Objectives of the paper:

1 Status of maternal health services in north eastern states. And

2 Make a comparative study for utilization of maternal health services among the north eastern states.

1.3 Methodology: This paper is completely based on secondary data taken from the reputed published sources like various books, conference proceedings and Economic survey and web based resources. Data used for this paper were collected from sources i) population census 2011 published by Register General, GOI, ii) National Family Health Survey NFHS-3, iii) District level Household survey (DLHS-3) 2007-08 conducted by International Institution for

population Science (IIPS), Mumbai. The analysis of the paper is solely qualitative and descriptive

1.4 Maternal health status in the NER:

Most maternal deaths are preventable if mothers receive essential healthcare before, and after childbirth (save the children, 2013). India, being a signatory to many regional and international agreements including the Alma-Ata Declaration (1978), International Conference on population and Development, Cairo (1978l), the Millennium Declaration (2000), bears an obligation to make sure that women do not die or suffer complications from preventable pregnancy –related causes (United Nations, 1994; United Nation 2000). Over past decades, the government of India has implemented several policies and programs such that Child Survival and Safe Motherhood Programme,1992; Reproductive and Child Health (RCH) programme,1997; National Population policy,2000; and National Urban Health Mission, 2013-2017 to reduce the burden of maternal mortality and improve maternal health. As a result, the overall utilization of maternal health care services in India has improved over time, however, the level of uptake is still considered to be low among the north eastern mother. The utilization of maternal health care is a complex phenomenon influenced by several factors. Several studies from developing countries have recognized socioeconomic factors and service delivery environment as important determinants of maternal healthcare utilization. Distance of health facility, lack of transport, religion, quality of care, women low social status, women age, economic status, lack of autonomy, decision making power are some important factors which affecting the utilization of maternal health services in different countries of the world.

1.5 Demographic profile of north Eastern state: The North Eastern region comprises eight states viz. Arunachal-Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, and Sikkim. It is the land of hills and valleys and the mighty river Brahmaputra and Goddess Kamakhya lies in the North East corner of India. The location of the region is strategically important as it has international borders with Bangladesh, Bhutan, china, Myanmar and Tibet. The area is characterized by rich bio diversity, heavy precipitation, endowed with forest wealth and suited to produce a whole range of plantation crops, fruits and vegetables. The basic demographic characteristics of the eight North Eastern states are given in the table **1**

	A.P.	**Assam**	**Manipur**	**Meghalaya**	**Mizoram**	**Nagaland**	**Sikkim**	**Tripura**	**Total**
Area(000 km)	**83.74**	**78.44**	**22.33**	**22.43**	**21.03**	**16.30**	**7.1**	**10.49**	**262**
% Forest area	**61.55**	**34.45**	**78.0**	**42.34**	**79.3**	**52.05**	**82.3**	**60.01**	**_**
Population (in millions)	**1.098**	**26.656**	**2.389**	**2.319**	**0.889**	**1.989**	**0.541**	**3.199**	**39.1**
Density	**13**	**340**	**107**	**103**	**40**	**120**	**76**	**304**	

Sex ratio	**901**	**932**	**972**	**975**	**938**	**909**	**875**	**950**
Literacy	**44.71**	**53.79**	**59.85**	**50.75**	**74.44**	**57.65**	**69.68**	**63.01**
%Population BPL	**33.47**	**36.09**	**28.54**	**33.87**	**19.41**	**32.67**	**36.55**	**34.44**
%SC population	**0.6**	**6.9**	**2.8**	**0.5**	**00**	**00**	**5.0**	**17.4**
% ST population	**64.2**	**12.4**	**34.2**	**85.4**	**94.5**	**89.1**	**20.6**	**31.1**

Table 1: Source: North East Vision 2020 and IBEF

The eight states cover an area of 2,62,179 sq. km. constituting 7.9% of the country's total geographical area, but have only 39 million people or about 3.8 % of total population of the country (2001 census). Over 68% of the population of the region lives in the state of Assam alone. The density of population varies from 13 per sq. km. in Arunachal Pradesh to 340 per sq.km. in Assam. The forest cover in the region constitutes 52% of its total geographical area. Again the sex ratio varies from 850 to 975. Sex ratio is highest in Meghalaya (975) and lowest in Sikkim (875). The literacy rate is highest in Mizoram (74.44) among the NE states and lowest in Arunachal Pradesh (33.47%). The percentage people living below the Poverty line (BPL) are highest in Sikkim 36.55%, followed by Assam 36.09% and lowest in Mizoram (19.41%). Again among the North Eastern states Tripura has the highest number of SC population (17.4%). In case of ST population, Mizoram has the highest number of highest number of ST (94.5%) and Assam has the lowest number of ST (12.4%) population among the north eastern states.

Table 2: Table

	2009-10			**2010-11**		
NE states	**Total no. of ANC registration**	**Nos. of women receive ANC**	**Nos. of given TT2/boosters**	**Total no. of ANC registration**	**Nos. of women receive ANC**	**Nos. of given TT2/boosters**
Arunachal Pradesh	**22414**	**8144**	**9971**	**24151**	**8225**	**10474**
Assam	**746492**	**419680**	**592204**	**740545**	**469620**	**572982**
Manipur	**111670**	**43008**	**35147**	**98692**	**46069**	**34884**
Meghalaya	**102540**	**42142**	**54033**	**110804**	**46879**	**58103**
Mizoram	**32096**	**22763**	**22626**	**29126**	**22364**	**22358**

Nagaland	**33754**	**9848**	**12798**	**34544**	**11251**	**13362**
Sikkim	**15212**	**8,163**	**7260**	**9925**	**7813**	**8173**
Tripura	**72676**	**36,685**	**44141**	**67653**	**35423**	**45130**

Source: Family welfare statistics in India 2011.

Table 2 shows that in Arunachal Pradesh total number of women receive ANC is lowest (8144) in 2009-10, which increase to 8225 in 2010-11. Again the number women receive ANC is highest in Assam (419680) in 2009-10 which increase to 469620 in 2010-11. The table2 also shows that the increase number of women receives ANC are highest in Assam among the all other states of North East India. In case of number of given TT2/ boosters is highest in Assam in 2009 -10 (592204) and in 2010-11 the number of TT2/ booster in Assam is 572982. And this number is lowest in Sikkim which was 7260 in 2009-10 increased to 8173 in 2010-11..

Table 3 Antenatal care by NER states:

Percentage distribution of women who had a live birth in the five years preceding the survey by Ante natal care (ANC) provider during pregnancy for the most recent live birth, according to state, India 2005-06

State	Doctor	ANM	Other health person	Dai/ TBA	ANW	Other	No one	Missing	Total
India	50.2	23.0	1.0	1.2	1.6	0.1	22.8	0.1	100
Arunachal Pradesh	50.3	3.2	00	2.1	00	1.3	42.6	0.5	100
Assam	52.9.	13.2	0.7	2.7	0.4	2.4	27.8	00	100
Manipur	83.1	2.6	0.2	0.7	00	00	13.4	00	100
Meghalaya	55.7	7.9	0.2	4.0	0.2	00	31.7	0.2	100
Mizoram	54.8	11.1	3.8	3.0	2.1	00	25.1	00	100
Nagaland	51.2	3.5	2.6	0.4	00	0.7	42.2	00	100
Sikkim	63.7	24.7	1.0	00	0.2	00	10.4	00	100

Tripura	74.2	1.8	0.6	1.7	0.4	00	21.1	0.2	100

The table3 shows the wide variation in the use of Antenatal care services among the North Eastern states.

Table4 Antenatal care indicators by NER states: percentage of women who received different types of ANC during pregnancy for most recent live birth, India 2005-06

State	**% who had at least one ANC visit**	**% who had three or more ANC visit**	**% who receive two or more TT injection**	**% given IFA**	**% Who took IFA for at least 90 days**
India	**76.4**	**52.0**	**76.3**	**65.1**	**23.1**
Arunachal Pradesh	**52.6**	**35.5**	**40.1**	**47.7**	**11.2**
Assam	**70.7**	**39.3**	**65.4**	**62.1**	**16.2**
Manipur	**86.3**	**68.6**	**79.2**	**65.2**	**13.1**
Meghalaya	**67.6**	**54.0**	**51.8**	**54.7**	**16.7**
Mizoram	**74.3**	**59.3**	**51.4**	**61.9**	**24.7**
Nagaland	**57.8**	**32.7**	**50.7**	**25.6**	**3.5**
Sikkim	**89.3**	**70.1**	**81.1**	**86.4**	**38.7**
Tripura	**78.3**	**60.0**	**74.4**	**68.8**	**18.0**

NFHS -3

IFA iron and folic acid tablet, TT tetanus Toxoid

Table 4 shows: in India 76.4% women receive at least one ANC and 52.0% women received three or more ANC visit. Among the NE states Sikkim (70.1%) highest number of women receives three or more ANC followed by Manipur (68.6%). this rate is lowest in Arunachal Pradesh (35.5%). And in Assam only (39.3) women receive three or more Ante Natal care services. In India 23.1 % women took IFA for at least 90 days. This rate is lower than all India average in case of many NE states except Sikkim (38.7%) and Mizoram (24.7%). In Assam only 16.2% women took IFA for at least 90 days which lies below the all India average. Again 76.3% women in India received at least two or more TT injections. This rate is highest in Sikkim

(81.1%) among the NE states followed by Manipur (79.2%) and lowest in Arunachal Pradesh (40.1%). In Assam (65.4%) women received at least two or more TT injection which is lower than the all India average.

Table: 5 Maternal care indicators by NER states: Maternal care indicators for birth during the five years preceding the survey by states, 2005-06

States	% who received all recommended types of ANC	% of birth delivered in health facilities	% of delivered assisted by health personnel	% of delivered with post natal check -up
India	**15.0**	**38.7**	**46.6**	**41.2**
A. P	**6.5**	**28.5**	**30.2**	**23.7**
Assam	**9.6**	**22.4**	**31.0**	**15.9**
Manipur	**10.5**	**45.1**	**59.0**	**50.1**
Meghalaya	**8.1**	**29.0**	**31.1**	**33.2**
Mizoram	**8.7**	**59.8**	**65.4**	**53.5**
Nagaland	**1.9**	**11.6**	**24.7**	**11.8**
Sikkim	**27.2**	**47.2**	**53.7**	**52.4**
Tripura	**10.6**	**48.8**	**48.8**	**33.7**

Source: NFHS-3 A.P. = Arunachal Pradesh

1.6 Discussion and conclusion: In general, utilization of maternal health services (antenatal check-up, TT vaccine, institutional delivery, assistance of health personal during delivery) is lower in the NE states than in the other parts of the country. However, there is a difference among the NE states in order to utilization of maternal care health services. Sikkim is the leader in the use of all reproductive health services followed by Manipur and Tripura. Table 4 shows that 89.3 % women who had at least one ante-natal care (ANC) visit which is 13.5% more than the all India average and 19% more than Assam. Similarly percentage of women who had three or more ANC visit is 70.1% in Sikkim which is 18% more than the all India average and 19% more than the Assam. In case of utilization of 2 or more TT vaccine women in Sikkim likely to use 14% higher than the all India average and 26% more than utilization of Assam. Similarly percentage of women took IFA for at least 90 days is 38.7% in Sikkim which is 15 % higher than all India average and 22% higher than Assam. The difference in the utilization of health care services among the North Eastern states basically depends on the accessibility, availability and acceptability of these services and also social customs of this region..

The table 5: **s**hows that in India 15% women who received all recommended types of ANC. But this rate is lower than all India average in case of all the NE states except Sikkim (27.20). This service is very low in Nagaland (1.9) followed by Arunachal Pradesh (6.5) and highest in Sikkim. In Assam only 9.6 % women received all types of ANC. In India 38.7% of delivered in health facilities. In NE states this rate is highest in Mizoram (59.8) followed by Tripura (48.8), Sikkim (47.2) and Manipur (45.1) and lowest in Nagaland (11.6) followed by Assam (22.4) which is much lower than all India average. The post natal services receive women in India is 41.2 % which is 53.5% in Mizoram, 52.4% in Sikkim and 50.1% in

Manipur which are higher than the all India average. And the post natal services are lowest in Nagaland (11.8) and Assam (15.9)

It is also found that the magnitude of regional difference is not the same in case of all the maternal health care indicators among the NE states. For instance women in Sikkim (47.2) and Tripura (48.8) were 2 times more likely to deliver babies at health care institution than in Assam and 4 times more than the Nagaland. Again, the percentage of delivered assisted by health personnel is highest in Mizoram (65.4%) followed by Manipur (59.0%) and Sikkim (53.7%). In Assam this rate is only 31.0%. The percentage delivered by health personnel is lowest in Nagaland ic 24.7% and followed by Arunachal Pradesh (30.2%).

Maternal mortality is serious problem facing million of women in worldwide. In the conclusion it is found that the use of Maternal Health Services among the north eastern region is very poor. It may be concluding that the utilization of maternal health care services is not same across the NE states. There is a variation in utilization of MNC among these states due to differences in availability, accessibility and acceptability of these services. To overcome this drawback the facilities should be improved in order to making better use of MNC services in this region. Education and empowerment lead women to be more proactive about their health and the health of their children. It should be a main priority of the government to get women to be more proactive and feel comfort to use the govt. measures. In addition further studies are needed to explore ways through which the negative attitude of health care providers could be alleviated.

References:

- Addai,I(2000) " Determinants of use of maternal- child health services in rural Ghana. J biosoc sci. (2000), 32, 1-15.
- Annual Report to the people on Health, Govt. of India Ministry of Health and Family Welfare , December 2011
- Adam et al. 2005 " cost effectiveness analysis of strategies for maternal and neonatal health in developing countries, British Medical journal,331:1107
- Bhatia J.C. and John Cleland, "Determinant of Maternal care in region of south India".
- Elo, IT, 1992 "utilization of Maternal Health Care Services in peru: The role of women education, *Health Transition Review*:
- Family welfare Statistics in India
- Freedman LP, Graham WJ, Brazier E, Smith JM , Ensore T et al. 2007, Practical lesson from global safe motherhood, Initiative
- MC caw- Binns A, Lagrenade J, Ashely D 2007. Under user of antenatal care- A comparison of non attenders and late attenders for ante natal care with early attenders. Social science medicine 40: 1003-1012
- National Rural Health Mission. Meeting people's health need in rural areas, framework for implementation 2005-2012 New Delhi. Ministry of Health and Family Welfare, Govt. of India 2005, http//www.mohfwnic.in/NRHM/Documents/NRHM Framework latest pdf cited on 28 august 2011.
- National Family Health Survey -3 in India

- Family Welfare Statistics in India 2011
- Navaneetham K, Dharmalingam A 2002, utilization of maternal health care services in southern India, social science and medicine 43:459-471
- Oberemeyer C.M. & Potter J.E 1991, "Maternal Health Care Utilization in Jordan, A study of pattern and Determinants studies in Family planning, Vol 22No.3
- Raghupathy, S (1996) "Education and the use of maternal healthcare in Thailand, social science and medicine 1996, 43 (4) : 459-471.
- World Health Organization 2005, *World Health Report. Make every mother and child count* Geneva: WHO/UNICEF/UNFPA/WORLD BANK 2012, trend in maternal mortality 1990-2010. Estimates developed by WHO, UNICEF, UNFPA AND THE WORLD BANK. Geneva, World Health Organization.

EDUCATIONAL TOOLS FOR ICT LEARNING IN THE DIGITAL ERA

Jonali Nath
Assistant Professor
Dept. of Economics. D.K. College mirza

Ms. V.REKHA
Assistant Professor, Department of BCA,
Agurchand Manmull Jain College, Chennai – 600061, Tamilnadu, India.

Abstract
The rapid advancement of digital technology has revolutionized education, particularly in the domain of Information and Communication Technology (ICT). This chapter explores various educational tools that have enhanced ICT learning, focusing on interactive platforms, coding environments, virtual labs, and learning management systems. It also highlights how these tools are integrated into modern pedagogy to foster digital literacy, engagement, and critical thinking among learners. The chapter concludes by discussing the challenges and future trends in ICT education.

Keywords: ICT learning, digital tools, coding platforms, virtual labs, educational technology, digital literacy

1. Introduction

In the 21st century, digital transformation has permeated all sectors, with education being one of the most affected. ICT has become an essential component in modern curricula, equipping students with skills for a technology-driven world. The integration of digital tools into ICT education not only enhances learning outcomes but also bridges the digital divide. With increasing access to the internet and mobile technologies, ICT learning is no longer confined to classrooms. This chapter outlines various categories of ICT learning tools and examines their role in shaping educational experiences, curriculum development, and student-teacher dynamics.

2. Learning Platforms for ICT Education

Learning Management Systems (LMS) such as Moodle, Google Classroom, and Edmodo provide a structured environment for course management, assessments, and student engagement. These platforms support blended learning approaches and are particularly effective in remote and hybrid learning models. In addition to assignment submission and grading, LMS platforms often feature forums, multimedia integration, and analytics tools for tracking student progress. The flexibility offered by LMSs enables self-paced learning, which is crucial in fostering autonomy and lifelong learning.

3. Interactive Tools and Student Engagement

Gamified platforms like Kahoot! and Quizizz increase motivation and participation in ICT lessons through competitive quizzes and real-time feedback. Tools like Padlet and Mentimeter encourage collaboration and brainstorming, allowing students to engage in peer-to-peer learning. These tools support constructivist and connectivist pedagogies by promoting interaction and idea sharing. Additionally, interactive whiteboards such as Jamboard and

Miro are gaining popularity for facilitating synchronous and asynchronous collaboration in ICT project-based learning environments.

4. Coding and Programming Environments

Basic programming skills are foundational in ICT. Platforms such as Scratch and Code.org introduce computational thinking to young learners through visual programming. Advanced platforms like Replit, Codecademy, and Tynker offer interactive coding environments with real-time feedback and community support. These platforms often feature gamified elements, coding challenges, and guided projects that help students grasp abstract programming concepts. Integration of these platforms into formal education promotes logical reasoning, creativity, and problem-solving abilities.

5. Simulation and Virtual Labs

Simulations play a crucial role in teaching networking, hardware, and system configuration. Cisco Packet Tracer is widely used in ICT classrooms for this purpose. It allows students to virtually build networks and troubleshoot systems, offering experiential learning without physical equipment. Tools such as NetSim, Labster, and VirtualBox are also employed to simulate real-world scenarios, enabling safe, repeatable, and cost-effective learning experiences. These virtual labs bridge the gap between theoretical concepts and practical application, enhancing student confidence and competence.

6. Productivity and Digital Literacy Tools

Developing digital literacy involves mastering tools like Microsoft Word, Excel, PowerPoint, and cloud-based alternatives such as Google Docs, Sheets, and Slides. Platforms such as GCFGlobal and TypingClub offer structured learning for such tools, essential for both academic and professional settings. These tools teach students how to effectively process information, present data, and collaborate in a digital workspace. Digital literacy also includes understanding internet safety, information ethics, and the responsible use of social media, which are integral to modern ICT curricula.

7. Challenges in ICT Learning Tool Integration

Despite their benefits, ICT tools come with challenges including unequal access to devices, limited internet connectivity, and lack of teacher training. Technological infrastructure in schools, especially in rural and underserved regions, remains inadequate. Additionally, the rapid evolution of technology often outpaces curriculum updates and teacher preparedness. Privacy concerns, cybersecurity threats, and digital fatigue are also emerging as significant issues in technology-enhanced education.

8. Future Trends

The future of ICT education lies in AI-powered learning, adaptive technologies, and immersive environments such as virtual reality (VR) and augmented reality (AR). These technologies promise personalized learning experiences and deeper engagement. AI-based tutoring systems and chatbots can provide on-demand support, while AR/VR applications can simulate environments such as data centres or historical computing labs. Blockchain for credentialing, IoT-based educational devices, and big data analytics for learner profiling are other promising developments.

Conclusion

ICT tools have transformed the educational landscape, making learning more interactive, accessible, and efficient. Educators must stay updated with technological advancements and

integrate tools effectively to prepare learners for a digital future. To maximize the benefits of ICT tools, a balanced approach that includes teacher training, infrastructure development, and inclusive policies is essential. As technology continues to evolve, so too must the pedagogical strategies that support ICT learning.

References

- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston: Center for Curriculum Redesign.
- Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2016). *NMC Horizon Report: 2016 Higher Education Edition*. The New Media Consortium.
- Kebritchi, M., Lipschuetz, A., &Santiague, L. (2017). Issues and challenges for teaching successful online courses in higher education. *Journal of Educational Technology Systems*, 46(1), 4-29.
- Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., ... & Kafai, Y. (2009). Scratch: Programming for all. *Communications of the ACM*, 52(11), 60-67.
- UNESCO. (2022). *Reimagining our futures together: A new social contract for education*. Paris: United Nations Educational, Scientific and Cultural Organization.
- Yadav, S., & Pamula, R. (2021). Impact of Virtual Labs in Engineering Education: A Case Study. *IEEE Access*, 9, 112342-112351.

An Analysis of Convolutional Neural Networks For Image Classification

J. Gokulapriya,
Assistant Professor
Department of Computer Science, Department of English,
[2]Rathinam College of Arts and Science,

Sathish Kumar R,
Head, Soft Skills & Aptitude,
Department of Computer Science,Department of English,
[2]Rathinam College of Arts and Science,

Abstract

This paper presents an empirical analysis of the performance of popular convolutional neural networks (CNNs) in identifying objects from real-time video feeds. Among the widely used CNN architectures for object detection and classification, Alex Net, Google Net, and ResNet50 stand out as leading models. Various image datasets are commonly utilized to evaluate the effectiveness of CNNs, with benchmark datasets such as ImageNet, CIFAR-10, CIFAR-100, and MNIST serving as standard testing grounds.In this study, we analyse the performance of Alex Net, Google Net, and ResNet50 using three widely recognized datasets: ImageNet, CIFAR-10, and CIFAR-100. Evaluating a network on multiple datasets provides a more comprehensive understanding of its capabilities and limitations compared to testing on a single dataset. It is important to note that while images from these datasets are used for training, real-time video feeds serve as testing inputs. Our findings indicate that Google Net and ResNet50 outperform Alex Net in object recognition accuracy. Additionally, the performance of these CNN models varies significantly across different object categories. We explore the underlying factors contributing to these variations and discuss their implications for real-time object detection tasks.

Keywords:

- DeepLearning;
- CNN,
- Objectdetection,
- Objectclassification,
- Neuralnetwork.

Introduction

Nowadays internet is filled with an abundance of images and videos, which is encouraging the development of search applications and algorithms that can examine the semantic analysis [1] of image and videos for presenting the user withbetter search content and their summarization. There have been major breakthroughs in image labeling, object detection, scene classification [2] [3], areas reported by different researchers across the world.

This leads to making it possible to formulate approaches concerning object detection and scene classification problems. Since artificial neural networks have shown a performance breakthrough in the area of object detection and scene classification, especially convolutional neural networks (CNN)[4] [5] [6], this work focuses on identifying the best network forthis purpose. Feature extraction is a keystep of such algorithms.

Feature extraction from images involves extracting a minimal set of features containingahigh amount of object or scene information from low-level image pixel values, therefore, capturing the difference among theobject categories involved. Some of the traditional feature extraction techniques used on images are Scale-invariant feature transform (SIFT) [7], histogram of oriented gradients (HOG) [8], Local binary patterns (LBP) [10], Content-Based Image Retrieval (CBIR) [11], etc. Once features are extracted their classification is done based on objects present in an image. A few examples of classifiers are Support vector machine (SVM), Logistic Regression, Random Forest, decision trees etc.

CNN has been presenting inoperative class of models for better understanding of contents present in an image, therefore resulting in better image recognition, segmentation, detection, and retrieval. CNNs are efficiently and effectively used in many pattern and image recognition applications, for example, gesture recognition [14], face recognition [12], object classification [13] and generating scene descriptions.Similarly, CNNs have achieved detection rates (CDRs) of 99.77%using the MNIST database of handwritten digits [23], 97.47% with the NORB dataset of 3D objects [24], and 97.6% on around5600 imagesofmorethan 10objects[25].

The successful integration of all the stated applications is due to advances and development in learning algorithms for deep network construction and moderately to the open source large labeled data set available for experimentation purpose, for example, ImageNet, CIFAR 10, 100, MNIST etc. [16] CNN has well known trained networks that uses these datasets available in open source networks and increases its efficacy of classification after getting trained over millions of images contained in the datasets of CIFAR-100 and Image-Nets. The datasetsused arecomposed of millionsof tiny images.Therefore,they can simplify welland accurateand hence successfully categorize the classes' out-of-sample examples. It is important to note that neural network classification and prediction accuracy and error rates are all most comparable to that of humans when such comparisons are made on a large data set such as Image-Net, CIFAR-10, 100etc. This workaims at analyzing the capabilityof convolutional neural networks tocategories the scenein videos on the basis of identified objects. Avarietyof image categories are included in CIFAR-100, CIFAR 10 and Imag eNet data sets for training the CNN.

Thetest datasets arevideos of different categories and subjects. The contradiction branches out because of the feature extraction capabilities of different CNN. The primary contribution of our work is topresent object detection methods usingdifferent types of trainedneural networks where current up-to-datemodels show different performance rates for test images or videos when compared to trained images. After training these networks for different object classes presented as input in the form of images, and then testing for the more particular real-time video feed, we can better understand what is being learned and presented by these

models. Wetherefore, can postulate that an image representationonthe basis of objects detected in it would be significantly useful for high-levelvisual recognition tasks for scenes jumbled with numerous objects resulting in difficulty for the network to classify it. These networks also provide supplementary information about the extraction of low-level features. These networks are trained on datasets containing millions of tinyimages [12].

We propose that the concept of object detection can be used as an attribute for scene representation. These networks used for our studyare constructed using existing neural networks and each of these networks have different layers, therefore their performance varies considerably. Using complex real-world scenes, the detection accuracy of the network can be checked. This paper is arranged as follows. We begin by presenting related prior works, following with the problem statement and our proposed methodology for comparing the networks chosen for the study, includingdescriptions ofthe models and data sets. We then present a comprehensive analysis ofresults obtained on different datasets. Finally, we conclude the paper and discuss about future work.

RelatedWork

The Convolutional Neural Networks (CNN) are used in a number of tasks which have a great performance in different applications. Recognition of handwritten digits [17] was one of the first application where CNN architecture wassuccessfully implemented. Since the creation of CNN, there has been continuous improvement in networks with the innovation of new layers and involvement of different computer vision techniques [18]. Convolutional Neural Networks are mostly used in the ImageNet Challenge with various combinations of datasets of sketches [19]. Few of the researchers have shown a comparison between the human subject and a trained network's detection abilities on image datasets. Thecomparison results showed that human being corresponds to a 73.1% accuracyrate on the dataset whereas the outcomes of a trained network show a 64% accuracy rate [21]. Similarly, when Convolutional Neural Networks was applied to the same dataset it yielded an accuracy of 74.9%, hence outperforming the accuracy rate of humans [21].

The used methods mostly make use of the strokes' order to attain a much better accuracy rate. There are studies going on that aim at understanding Deep Neural Network's behavior in diverse situations [20]. Thesestudies present how small changes made to an image can severely change the results of grouping. In the workalso, presents images that are fully unrecognized byhuman's beings but are classified with high accuracy rates by the trained networks [20].

There has been a lot of development in the area of feature detectors and descriptors and many Algorithms and techniques have been developed for object and scene classification. Wegenerally enticement thesimilarity betweentheobject detectors, texture filters, and filter banks. There is an abundance of work in the literature of object detection and scene classification[3]. Researchers mostly use the current up-to-date descriptors of Felzensz wal band context classifiers of Hoeim [4]. The idea of developing various object detectors for basic interpretation of images is similar to the work done in multi-media community in which

they use a large number of “semantic concepts” for image and video annotations and semantic indexing [22].Inthe literature that relatesto ourwork, eachsemantic conceptis trained by using either the image or frames of videos. Therefore, the approach is difficult to use and understand the image with many cluttered objects in the scene.

The previous methods focused on single object detection and classification based on feature set defined by humans. These proposed methods explore the connection of objects in scene classification [3]. Many scenes classification technique was performed on the object bank to compute its utility. Many types of research have been conducted emphasizing theirfocus on low-level feature extraction for object recognition and classification, namely Histogram of oriented gradient(HOG), GIST, filter bank, and abag of feature (BoF) implemented though word vocabulary [4].

Methodology of Evaluation

The main aim of our work is to understand the performance of the networks for static as well as live video feeds. The firststep for the following is to perform transfer learning on the networks with image datasets. Thisis followed bychecking theprediction rate of the same object on static images and real-time video feeds. The different accuracyrates are observed and noted and presented in the tables given in further sections. Third important criteria for evaluating the performance was to check whetherprediction accuracyvaries across allCNNschosen forthe study.Itmustbe noted thatvideos are notused asa training dataset, they are used as testing datasets. Hence, we are looking for best image classifier where the object is the main attribute for classification of scene category. Different layers of the convolutional neural network used are:

Input Layer: The first layer of each CNN used is ‘input layer’ which takes images, resize them for passing onto further layers for feature extraction.

Convolution Layer: The next few layers are ‘Convolution layers’ which act asfilters for images, hence findingout features from images and also used for calculating the match feature points during testing.

Pooling Layer: The extracted feature sets are then passed to ‘pooling layer’. This layer takes large images and shrink them down while preserving the most important information in them. It keeps the maximum value fromeach window, it preserves the best fits of each feature within the window.

RectifiedLinear Unit Layer: The next ‘Rectified Linear Unit’ or ReLU layer swaps everynegative number of the pooling layer with 0. This helps the CNN staymathematicallystable by keeping learnedvalues from getting stuck near 0 or blowing up toward infinity.

Fully Connected Layer: The final layer is the fully connected layers which takes the high-level filtered imagesand translate them into categories with labels.

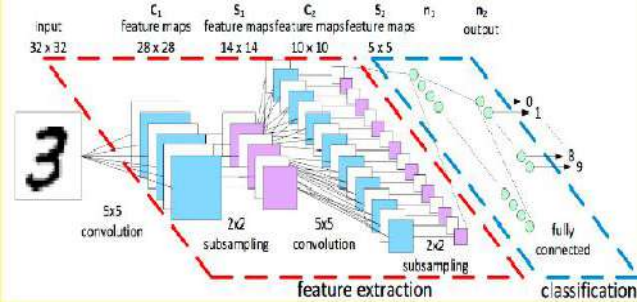


Fig.1Internal Layer sof CNNss

The steps of proposed method are as follows:

1.**Creating training and testing dataset:**The super classes images used for trainingis resized [224,244] pixels for Alex Net and [227,227] pixelsGoogle Netand ResNet50, and thedataset is divided into two categoriesi.e. training andvalidation data sets.

2.**Modifying CNNsnetwork:** Replacethe lastthreelayersofthenetworkwith fullyconnectedlayer,aSoftMax layer, and a classification output layer. Set the final fullyconnected layer to have the same size as the number of classes in the training data set.Increasethe learning ratefactors ofthefully connectedlayerto train network faster.

3.**Trainthenetwork**:Setthetrainingoptions,includinglearningrate,mini-batchsize,andvalidationdata according to GPU specification of the system. Train the network using the training data.

4.**Test the accuracy of the network:** Classify the validation images using the fine-tuned network, and calculate the classification accuracy. Similarly testing the fine tune network on real time video feeds for accurate results.

Models

There are various smart pre-trained CNN, these CNN have the capability of transfer learning. Therefore, it just requires the training and testing datasets at its input layer. The architecture of the networks differs in terms of internal layers and techniques used.GoogLeNet has Inception Modules that perform different sizes of convolutions and concatenate the filters for the next layer [20]. On the other hand, AlexNet does not use filter concatenation,instead, it uses the output of the previous layer as the input. Both networks have been tested independently and use the implementation provided by Caffe, a DeepLearning framework[22]. Res Netisa short name for Residual Network. Many other visual recognition tasks have also greatly benefited from very deep models.

So, over the years there is a trend to go deeper, tosolve more complex tasks and to also increase /improve the classification/recognition accuracy. But as we go deeper; the training of neural network becomes difficult and also the accuracy starts saturating and then degrades also [3]. Residual Learning tries to solve both these problems. In general, in a deep convolutional neural network, several layers are stacked and are trained to the task at hand. Thenetwork learns several low/mid/ high-level features at the end of its layers [15][2]. In residual learning, instead of trying to learn some features, the network tries to learn some

residual. Residual can be simply understood as subtraction of feature learned from the input of that layer. ResNet does this using shortcut connection (directly connecting the input of nth layer to some $(n+x)^{the}$ layer [15]. It has proved that training this form of networks is easier than training simple deep convolutional neural networks and also the problem of degrading accuracy is resolved.The comparison is made among three existing neural networks i.e. the AlexNets, Google Nets and ResNet50 [21]. Followed bythe transfer learningconcepts for training these networks and generating new networks for further comparison. The new models have a same number of layers as that of original but the performance of these networks and existing networks varies considerably. On same images, the different accuracy rates were formulated in the tables presented in the following section.

TestDatasets

Image dataset of CIFAR- 100 which has numerous super-classes of general object images and a number of sub class categories of each super class. CIFAR-100 has 100 classes of images with each class having 600 images each [15]. These 600 images are divided into 500 training images and 100 testing images for each class, therefore, making a total of 60,000 different images.These100classes areclubbed together into 20super classes. Every imagein the dataset comeswitha “fine” label (depicting the class to which it belongs) and a “coarse” label (superclass to the “fine” label detected). The selected categories for training and testing are abed, bicycle, bus, chair, couch, motorcycle, streetcar, table, train, and wardrobe [21][15]. For the proposed work, some wide categories of each super classes need to be used for training the networks, the super classesused are Household furniture and vehicle.The chosen categories are shown inthe table below. The second dataset used was ImageNet datasets that has super-classes of images which is further divided into subclasses. ImageNet is an image dataset which is organized as per the WordNet hierarchy. The dataset is organized as meaningful concepts

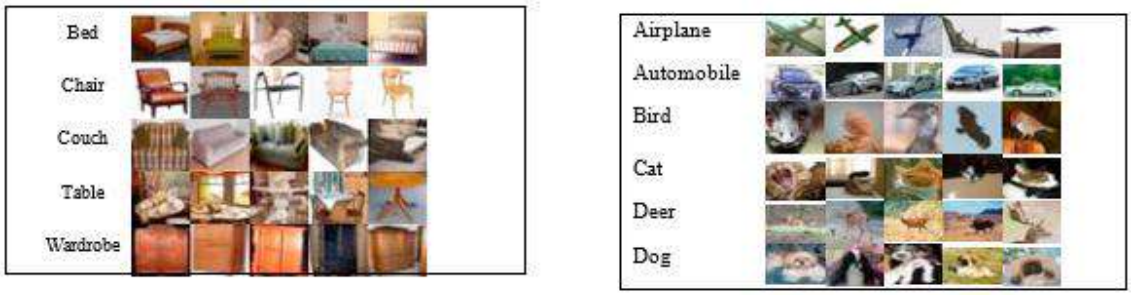


Fig2:Fewclassesof CIFAR10andCIFAR100Datasets

Each concept in WordNet is described by many words called a "synonym set" or "sync set". The dataset contains more than 100,000 sync sets. All images are human-annotated. Furthermore, a grouping of ImageNet’s less descriptive labels into more meaningful sets that matched that of the superclass was done for our study. For example, “table” was relabeled as “furniture”, similarly many other images were grouped into their super classes and created a more descriptive and meaningful label. The third dataset chosen for the study was aCIFAR-

10 dataset of images. The CIFAR-10 dataset has 32x32 color images divided into 10 classes and 6000 images per class, which makes a total of 60000 images. The dataset consists of 50000 training images and 10000 test images. The dataset is divided into five training batches and one test batch, each of which has 10000 images. The test images are randomly selected from each class.

Table1.Performance of CNN's on CIFAR 100 test data set

CIFAR-100		AlexNet	GoogLeNet	ResNet50
Image Category	Bed	0.00%	70.80%	49.60%
	Bicycle	21.0	74.2%	55.00%
	Bus	84.00%	63.20%	36.80%
	Chair	90.00%	89.60%	57.60%
	Couch	11.00%	14.60%	76.40%
	Motorcycle	95.00%	74.60%	99.20%
	Streetcar	21.00%	0.84%	63.80%
	Table	00.00%	73.60%	33.40%
	Train	30.00%	95.60%	34.20%
	Wardrobe	89.00%	89.40%	92.20%

CIFAR-10		AlexNet	GoogLeNet	ResNet50
Image Category	Airplane	41.80%	51.10%	90.80%
	Automobile	21.80%	62.10%	69.10%
	Bird	00.02%	56.70%	72.60%
	Cat	00.03%	78.80%	61.90%
	Deer	87.60%	49.50%	75.40%
	Dog	23.00%	57.50%	82.10%
	Frog	24.20%	90.20%	76.60%
	Horse	34.70%	78.20%	84.70%
	Ship	31.70%	95.50%	83.20%
	Truck	95.90%	97.10%	84.60%

Table2.Performance of CNN's on the CIFAR 10 test data set

Results

The performance analysis of CNN's is done bytesting each of the networks on CIFAR-100 and CIFAR-10 datasets. Table 1 depicts the accuracy of various image categories of CIFAR- 100 test dataset.For example, out of 100 test images of Bus, AlexNet predicts 84 images labelcorrectly,whereas GoogLeNetdetects bus inaround 63 images and ResNet50classifies 37 images labeled as abuse. Table 1 and Table 2 show the prediction accuracy of CNN's when tested for various image categories of CIFAR- 100 and CIFAR-10

test datasets. For 100 images of Horse, AlexNet identifies horse in 35 images, GoogLeNet finds ahorse in 78 images and ResNet50 classifies 85 images as horse labeled. Considering the probabilityvalues of all three CNN's calculated from confusion matrix after testing, a detailed preview ofprediction done bythreeCNN's areas follow.

Table3.PerformanceonBicycleclassofCIFAR-100dataset

AlexNet's Output	Prediction Accuracy (%)	GoogLeNet's Output	Prediction Accuracy (%)	ResNet50 Output	Prediction Accuracy (%)
Motorcycle	45	Bicycle	74.2	Bicycle	55
Bus	28	Train	13	Motorcycle	35
Bicycle	21	Table	7.6	Streetcar	4.4
Chair	2	Motorcycle	4.4	Couch	2.6
Train	2	Chair	0.4	Bed	1
Streetcar	1	Wardrobe	0.2	Train	0.8
Wardrobe	1	Bus	0.2	Wardrobe	0.6
Couch	0	Streetcar	0	Table	0.6
Bed	0	Couch	0	Bus	0
Table	0	Bed	0	Chair	0

Table4.PerformanceonChairclassof CIFAR-100dataset

	(%)		(%)		
Chair	90	Chair	89.6	Chair	57.6
Wardrobe	5	Bed	7	Couch	21
Bus	3	Table	2.8	Bed	7.4
Motorcycle	1	Wardrobe	0.4	Wardrobe	5.8
Couch	1	Train	0.2	Train	5.4
Bed	0	Bicycle	0	Motorcycle	2
Bicycle	0	Bus	0	Streetcar	0.6
Streetcar	0	Couch	0	Bicycle	0.2
Table	0	Motorcycle	0	Bus	0
Train	0	Streetcar	0	Train	0

Table 3 depicts the prediction accuracy of all three networks for Bicycle class. We can see thatAlexNets top prediction for bicycle class is a motorcycle. GoogLe Net shows best performance and ResNet gives the average result. Similarly, Table 4 shows the output of CNNs for chair class.

Table5. Performance on Deer class of CIFAR-10 dataset

AlexNet's Output	Prediction Accuracy	GoogLeNet's Output	PredictionAccuracy	ResNet50Output	PredictionAccuracy

	(%)		(%)		(%)
Deer	87.6	Deer	49.5	Deer	75.4
Horse	3.7	Horse	24.4	Horse	10.7
Ship	3.4	Cat	13.3	Bird	3.5
Frog	2.2	Frog	6	Airplane	3.3
Truck	1.6	Bird	3	Dog	2.6
Airplane	1.2	Ship	2	Cat	2.5
Automobile	0.2	Airplane	1.1	Frog	1.6
Dog	0.1	Truck	0.3	Ship	0.3
Bird	0	Dog	0.4	Truck	0.1
Cat	0	Automobile	0	Automobile	0

Table6. Performance on Ship class of CIFAR-10 data set

AlexNet's Output	Prediction Accuracy (%)	GoogLeNet's Output	Prediction Accuracy (%)	ResNet50 Output	Prediction Accuracy (%)
Truck	50.6	Ship	95.5	Ship	83.2
Ship	31.7	Truck	2.2	Airplane	14.4
Airplane	12.3	Cat	1.2	Truck	0.5
Deer	3.1	Airplane	0.6	Cat	0.5
Automobile	1.5	Automobile	0.3	Horse	0.4
Horse	0.8	Bird	0.2	Dog	0.3
Bird	0	Deer	0	Bird	0.3
Cat	0	Dog	0	Deer	0.2
Dog	0	Frog	0	Automobile	0.1
Frog	0	Horse	0	Frog	0.1

Table 5 compares the output of threenetworks for Deer class. In other words, both the networks provide consistentlycorrect classifications. By observing all the tables, the classifications accuracy obtained for all images across all categories, are different. AlexNet essentially see a Motorcycle in top prediction, while GoogLeNet and ResNet50 see a bicycle in top prediction for bicycle class. For otherless frequent classes, there isstill alarge overlap across different categories. Similarly, Table 6 presents results for the ship class. The predicted label along with its score shows how accurately the object isdetected bya particular network. Whileanalyzing each table independently, one can observe that for most of the categoriesof Cifar-100 dataset, GoogLeNet does the correct labeling and classification while ResNet50identifies an average number of classes of CIFAR-100 dataset. But for CIFAR – 10 ResNet50 shows best classification results and GoogLeNet remains average.Nonetheless,both networks are quite consistent,having high countsfor a small subset of classes.The reason for

this behavior seems to be the fact that most classifiers are trained for object categories thatcontain simple,thin tracesin their composition, such as safety pins and bowstrings. It is therefore understandable that the networks may mistake with appearance and properties of objects.

Table7.Performance of CNNs on live video feeds

ObjectCategory	AlexNet Prediction Accuracy (%)	GoogleNet Prediction Accuracy (%)	ResNet50 Prediction Accuracy (%)	ObjectCategory	AlexNet Prediction Accuracy (%)	GoogleNet Prediction Accuracy (%)	ResNet50 Prediction Accuracy(%)
Bed	12	85	25	Airplane	14	84	96
Bicycle	11	80	55	Automobile	12	59	56
Bus	14	74	25	Bird	11	45	53
Chair	12	47	30	Cat	11	62	49
Couch	12	25	90	Deer	12	45	33
Motorcycle	14	50	35	Dog	12	57	58
Streetcar	11	45	25	Frog	13	60	25
Table	11	63	50	Horse	12	87	65
Train	15	72	45	Ship	15	91	25
Wardrobe	14	84	32	Truck	22	95	52

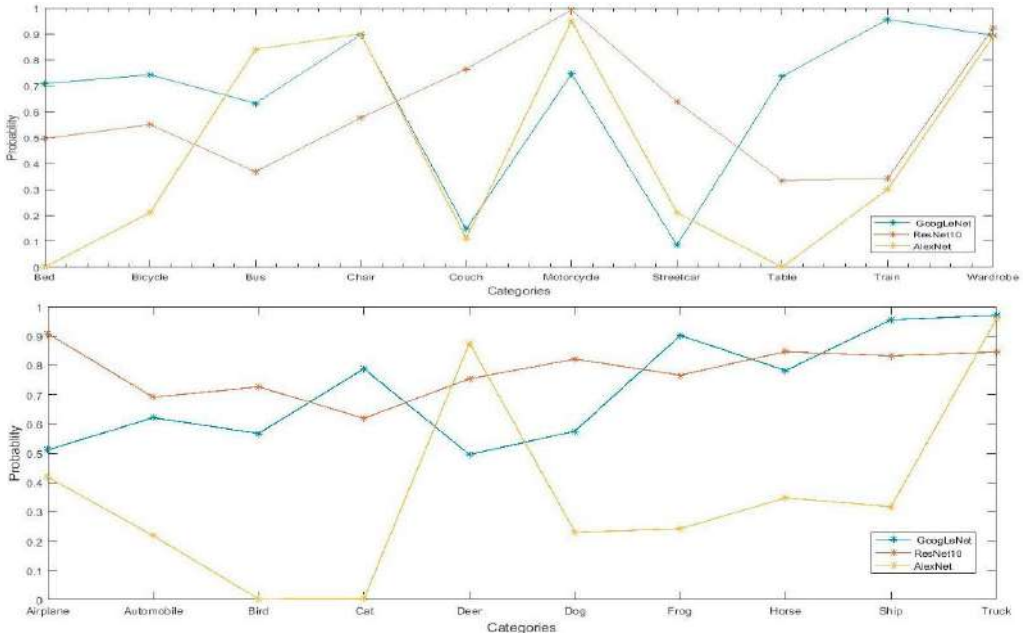
The real-time analysis of the performance of convolutionalneural networks shows thatAlex Nethas overall13% accuracyof detectingcorrect objects in the scene. Similarly, GoogLeNet andResNet50 classification is 68.95% and 52.55% correct. It can be observed that performance of CNNs on images vary substantially compared to live testing results. In live testing, CNNs get confused between few objects, for example, ResNet50 often has a problem in classifying dog and deer. It detects them as a horse in most of the scenes. The accuracy results prove that GoogLeNet performance is better and detection accuracy is highest compared to all other nets.

Evaluation

Both of the CNN produce a probability distribution in the possible input classes. Two different methods were used to calculatetheresults. The first method onlyconsiders the 10 most probable classesandthe second register the position ofthe correct class in the full probability range. In the first method, we classify the results of the network according to their probabilityand consider onlythe ten most probable classes. We count how manytimes each class appears for each image ineachtargetcategory.Thismethodallowsyouto evaluateif

agoodandusefulprobability isassignedto thecorrectresult, butalsotoobserve qualitativelythe consistencyof the results for each categoryi.e., it is expected that for each categoryy, the top 10 probabilities do not varysignificantly. In the second method, we construct descriptive statistics about the position of the correct class in the probability range. This is achieved by ranking the results obtained by the classifier. The higher the rank, the better the classification is. Ideally, the correct class will be in first place. Calculate the mean and the standard deviationforeachcategory.A low averagecorresponds to a higher positioninthe rankings,whilea low standarddeviation is a proof of the consistencyof production for the different instances of the same category. It also allows you to capture the bestandworstinstancesof eachcategory thatweuse to analyzethepossiblereasonsfortheobservedresults.Finally,we can infer from the obtainedresults that the average performance of thesethreenetworks on CIFAR100 dataset is found tobe as: for AlexNet average performance is 44.10 %, for GoogLeNet it is 64.40% and for ResNet50 an average performance of 59.82% is reported byour experimental study [20]. Similarly, the average performance of CNN's for theCIFAR10 dataset is as follows: for AlexNet- 36.12 %, for GoogLeNet- 71.67%, and for ResNet50- 78.10% is found.

Fig 3: (a) Probability vs Categories graph for CIFAR- 100 dataset



Conclusion

The work analyzed the prediction accuracyof three different convolutional neural networks (CNN) on most popular training and test datasets namely CIFAR10 and CIFAR100. We focused our study on 10 classes of each dataset only. Our main purpose was to find out the accuracy of the different networks on same datasets and evaluating the consistency of prediction by each of these CNN. We have presented a thorough prediction analysis for

comparing the networks' performance for different classes of objects. It is important to note that complex frames often create confusion for the network to detect and recognize the scene. It was also noted that though in real-world beds and couches as well as chair are different and easily recognized objects but the trained networks showed confusion and therefore differ in accuracy rates. The results suggested that trained networks with transfer learning performed better than existing ones and showed higher rates of accuracy. Few objects like "chair", "train" and "wardrobe" were perfectly recognized by 147 layered networks whereas objects like "cars" were perfectly recognizedby 177 layered networks. From our experiments, we could easily conclude that the performance of 27 layered networkswasnotmuch appreciated.Hence,more the numberof layers,more willbe the training and therefore, higher the rate of accuracy in prediction will be achieved. It can further be summed up that neural networks arenew and best emerging techniques for making a machine intelligent for solving many real-life object categorization problems. Many types of research and works are being done on it. It has wide applications and it is easy and flexible to integrate into various platforms.The hardware requirements may notallow the network to be trained on normaldesktop work but just with nominal requirements one can train the network and generate the desired model.

References

1) Kou,F.,Du,J.,He,Y.,&Ye,L.(2016)"SocialNetworkSearchBasedonSemanticAnalysis andLearning."*CAAITransactionsonIntelligenceTechnology*.
2) Garcia-Garcia,A.,Orts-Escolano,S.,Oprea,S.,Villena-Martinez,V.,&Garcia-Rodriguez,J.(2017)"AReviewonDeepLearningTechniques Applied to Semantic Segmentation."
3) Li,L. J.,Su, H.,Lim, Y.,&Li,F.F. (2010, September)"ObjectsasAttributesforSceneClassification."*ECCVWorkshops***(57-69).**
4) Srinivas,S.,Sarvadevabhatla,R.K.,Mopuri,K.R.,Prabhu,N.,Kruthiventi,S.S.,&Babu,R. V.(2016)"Ataxonomyofdeepconvolutional neural nets for computer vision."
5) Zhou,B.,Khosla,A.,Lapedriza,A.,Oliva,A.,&Torralba,A.(2014)"Objectdetectorsemerg eindeepscenecnns."
6) Wang,Y.,&Wu,Y."SceneClassificationwithDeepConvolutional NeuralNetworks."
7) Lowe,D.G.(2004)"Distinctiveimagefeaturesfromscale-invariantkeypoints."*Internationaljournalofcomputervision***60(2).**
8) Dalal,N.,&Triggs,B.(2005,June)"Histogramsoforientedgradientsforhumandetection."*I nComputerVisionandPatternRecognition, 2005. CVPR 2005.*
9) Yang,J.,Jiang,Y.G.,Hauptmann,A.G.,&Ngo,C.W.(2007,September)"Evaluatingbag-of-visual-wordsrepresentationsinsceneclassification."inProceedingsof*theinternationalworkshop onWorkshoponmultimediainformationretrieval.*
10) Cheung, Y.M.,& Deng, J. (2014, October)"Ultralocalbinary pattern for image texture analysis." in Security*Pattern Analysis, andCybernetics (SPAC), 2014 International Conference.*
11) Khan,S. M.H.,Hussain, A., &Alshaikhli,I. F.T.(2012,November) "Comparative study oncontent-basedimageretrieval (CBIR)." inAdvanced Computer Science Applications

and Technologies (ACSAT), 2012 *International Conference*.

12) Lawrence,S.,Giles,C.L.,Tsoi,A.C.,&Back,A.D.(1997)"Facerecognition:Aconvolutionalneural-networkapproach."*IEEEtransactions on neural networks, 8(1)***:**98-113.
13) Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov,D., ...&Rabinovich, A. (2015)"Going deeper with convolutions." inProceedings of the *IEEE conference on computer vision and pattern recognition* (pp. 1-9).
14) Bobić, V., Tadić, P., &Kvaščev, G. (2016, November) "Hand gesture recognition using neural network based techniques." in NeuralNetworks and Applications (NEUREL), *2016 13th Symposium on (pp. 1-4). IEEE*.
15) Krizhevsky,A.,&Hinton,G.(2009)"Learningmultiplelayersoffeaturesfromtinyimages."
16) LeCun,Y.,Jackel,L.D.,Bottou,L.,Cortes,C.,Denker,J.S.,Drucker,H.,...&Vapnik,V.(1995)"Learningalgorithmsforclassification: A comparison on handwritten digit recognition."*Neural networks: the statistical mechanics perspective*(pp 261-276).
17) LeCun,Y.,Bottou,L.,Bengio,Y.,&Haffner,P.(1998)"Gradient-basedlearningappliedtodocument recognition."proceedings ofthe*IEEE***86(11)**:2278-2324.
18) Srivastava,N.,Hinton,G.E.,Krizhevsky,A.,Sutskever,I.,&Salakhutdinov,R.(2014)"Dropout:asimplewaytopreventneuralnetworks from overfitting."*Journal of machine learning research* **15(1)**: 1929-1958.
19) Eitz,M.,Hays,J.,&Alexa,M.(2012)"Howdohumanssketchobjects?"*ACMTrans.Graph., 31(4)*.
20) Ballester,P.,&deAraújo,R.M.(2016,February)"OnthePerformanceofGoogLeNetandAlexNetAppliedtoSketches."in*AAAI*.
21) Yang,Y.,&Hospedales,T.M.(2015)"Deepneuralnetworksforsketchrecognition".
22) Karpathy, A., Toderici, G., Shetty, S., Leung, T., Sukthankar, R., &Fei-Fei, L. (2014)"Large-scale video classification withconvolutional neural networks." in Proceedings of the IEEE Conference on *Computer Vision and Pattern Recognition*.
23) Ciresan, Dan, Ueli Meier, and JurgenSchmidhuber, (2012) ""Multi-column deep neural networks for image classification."*2012 IEEEConference on Computer Vision and Pattern Recognition.*
24) Ciresan, Dan, Ueli Meier, Jonathan Masci, Luca M. Gambardella, and JurgenSchmidhuber. (2011) "Flexible, High PerformanceConvolutional Neural Networks for Image Classification." *Proceedings of the Twenty-Second International Joint Conference onArtificial Intelligence-Volume Two:* 1237–1242.

Autonomous AI Agents and Market Liquidity Dynamics in Decentralized Finance: A Comprehensive Empirical Investigation

Aby Thomas
Research Scholar
PG & Research Department of Commerce
Nirmala College, Muvattupuzha (Autonomous)

Grace christy Kurian

Abstract

This paper reports the impact of autonomous AI agents on liquidity management in DeFi markets. To scrutinize the relationship, we utilize a strong sample of 182 finance professionals working in trading (37.4%), development (23.1%), financial analysis (21.4%) and risk management (18.1%); and examine the potential effect of AI implementation on essential liquidity indicators. Multiple regression analysis show that AI adoption significantly increases liquidity in times of volatility ($\beta = 0.37$, $p < 0.001$), price stabilization ($\beta = 0.42$, $p < 0.001$), and lower transaction costs ($\beta = 0.23$, $p < 0.001$), together they explain 78% of the variance of market liquidity ($R^2 = 0.78$). Structural equation modeling and path analysis show that AI adaptability mediates the relationship between AI implementation and market liquidity (indirect effect: $\beta = 0.21$, $p < 0.001$), while providing excellent model fit (CFI = 0.97, RMSEA = 0.042). Compared to less-informed professionals, all measures of AI benefit were reported to be significantly greater by professionals knowledgeable on Advanced AI ($p < 0.001$). Results align with frameworks of transaction cost economics and adaptive systems, indicating autonomous AI agents ensure efficient allocation of capital while also demonstrating dynamic responsiveness to environmental conditions. The paper ends with discussion of implications for the development of DeFi protocols and regulatory frameworks.

Artificial Intelligence Decentralized Finance Liquidity Management Market Stability Transaction Cost Economics Adaptive Systems

1. Introduction

Decentralized Finance (DeFi) has emerged as a game-changer in global financial systems, enabling peer-to-peer financial services without traditional intermediaries (Chen & Bellavitis, 2020). The Total Value Locked (TVL) in DeFi protocols is over $100 billion as of 2023, highlighting its increasing significance in the financial ecosystem at large (Aramonte et al., 2022). Nonetheless, DeFi markets are plagued by the liquidity fragmentation, high volatility, and capital inefficiency (Liu et al., 2023)

These challenges have led to the increasing adoption of artificial intelligence (AI) agents, especially those who apply the techniques of machine learning, reinforcement learning, and predictive analytics (Xu & Vadlamudi, 2022). These autonomous systems are designed to monitor market conditions, optimize liquidity provision, and execute trades with minimal human intervention (Harvey et al., 2021). While AI in general application has been a focus in

the growing scope of DeFi (Deng et al., 2023; Zheng et al., 2024), little empirical research on its efficiency is available in DeFi liquidity management.

The intention of this study is to fill this research gap through an empirical analysis on the impact of autonomous AI agents on crucial liquidity metrics of DeFi markets. In particular, we answer the following research questions:

How significantly do autonomous AI agents enhance liquidity provision in the phases of market volatility?

What role do AI powered strategies play in maintaining price stability across DeFi markets?

How are AI implementation and transaction costs related in liquidity management?

How does familiarity with AI technologies impact perceptions of AI's effect on liquidity management?

Theoretical perspective and practical implications Based on these questions, this research adds both theoretical understanding and practical applications of AI in financial markets. These insights help practitioners, developers, and policymakers understand the evolving relationship between artificial intelligence and decentralized finance.

2. Literature Review and Theoretical Framework

2.1 Liquidity Management in DeFi

Liquidity, or how readily an asset can be traded without major price impact, underpins effective financial markets (Amihud & Mendelson, 1986). In TradFi, the liquidity provision role is usually centered around traditional market makers and exchanges. That said, AMMs and liquidity pools provide such novel approaches to liquidity management in DeFi (Mohan, 2022).

Examples of popular AMM protocols are Uniswap, Curve and Balancer, which allows trading without an order book by applying mathematical formulas that determine the price of the assets (Adams et al., 2021). Insofar, these advances stillToday, DeFi liquidity poses a challenge for decentralized markets, inducing issues such as prices being scattered across uncorrelated exchanges on fragmented markets and capital inefficiency, as well as impermanent loss for liquidity providers (Werner et al., 2023).

Capponi and Jia (2022) recently studied the distribution of liquidity across DeFi protocols in the order book model, showing that inefficient allocation of liquidity can create arbitrage opportunities and increased price slippage, thus raising the costs to users. Similarly, Angeris et al. (2021) show that existing AMM designs lack the computational flexibility needed to adapt to market conditions that change very quickly.

2.2 AI Applications in Financial Markets

Indeed, artificial intelligence has revolutionized various fields of customary monetary markets: from algorithmic trading to hazard management (Cao et al., 2021). While complex

patterns can be recognized in market data with machine learning models, reinforcement learning coordinates the optimization of strategies based on feedback feedback from the environment (López de Prado, 2018).

The two are improving market efficiency through reducing information asymmetries and transaction costs (Zhang and Ding (2021)). Similarly, Fisher et al. (2022) show how natural language processing techniques can be used to analyze sentiment from news articles and social media to predict market movements with an increasing degree of accuracy.

Having said this, in the particular context of DeFi, AI applications are still in their infancy, yet with lots of potential. (Va, 2023) describe machine learning models that optimize the provision of liquidity across multiple pools, while Wang et al. (2022) propose reinforcement learning strategies for the dynamic fee adjustment of AMM protocols.

2.3 Theoretical Foundations

This research employs two complementary theoretical reexamined to actually understand AI's influence on DeFi liquidity:

Transaction Cost Economics (TCE): Williamson (1979) used TCE as an analytical framework to analyze how organization structures and the technological base of firms can lower transaction costs, or the cost of doing business in the marketplace. In the case of DeFi, such costs take the form of gas fees, slippage, and opportunity costs from capital inefficiency (Perez et al., 2022)." AI agents do have the potential of decreasing such costs by optimizing trade execution, promoting price discovery and improving capital efficiency (Ferreira et al., 2023).

Adaptive Systems Theory This theory looks at how systems react and adjust to an evolving setting (Holland, 1992). Financial markets are complex adaptive systems and exhibit non-linear interaction dynamics, feedback loops, and emergent properties (Lo, 2019). Microstructure-driven adaptive systems, specifically those using reinforcement learning, are used by AI agents to learn over time from market feedback to refine their liquidity provision strategies (Johnson et al., 2023)

We postulate, through the fusion of these frameworks, that autonomous AI agents serve to augment DeFi liquidity, as simultaneous outcomes of lowered transaction costs and adaptive behaviours to time-varying market structure.

3. Methodology

3.1 Research Design and Data Collection

The present study used a cross-sectional survey design to gather data from professionals that are active within DeFi and financial marketplaces. The survey instrument was adapted from the relevant literature and conducted pilot testing with eight professional industry experts to enhance its clarity and relevance. The final version of the questionnaire included sections on respondent profiles, understanding of AI in DeFi, perceived effects of AI on liquidity

management, challenges and limitations, and future perspectives. Data was collected between January and March 2024. Potential informants were discovered via professional networks, decentralized finance forums, fintech conferences and professional associations. Invitation letters were sent to 273 participants, selected using stratified random sampling to represent all professional roles and experience levels. Resulting in 182 completed responses (66.7% response rate), generating a sufficient sample for statistical analysis.

3.2 Sample Characteristics

The sample included a wide variety of professional roles in the DeFi ecosystem such as traders (37.4%, n=68), developers (23.1%, n=42), financial analysts (21.4%, n=39), and risk managers (18.1%, n=33). The per censuses of the years of experience were as follows; less than one 8.8%(n=16), 1 to 3 years 27.5% (n=50), 4 to 6 years 34.1% (n=62), more than six years 29.7%(n=54). A majority (83.5%, n=152) reported either being familiar or very familiar with AI technologies, which ensures that insights are relevant to the research questions. Power analysis using G*Power 3.1 indicated that the total sample of 182 participants was adequate to detect medium effect sizes ($f^2 = 0.15$) at $P = 0.05$ with power of 0.95 for regression analyses up to five predictors. The large sample size enabled more complex analyses than would have been feasible with a smaller dataset.

3.3 Measures

The study assessed these key variables:

AI LP Enhancements: Measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) to the prompt: "AI agents enhance liquidity provision during periods of market turbulence.

Price Stability: Measured via a 5-point Likert Scale on the following statement: “AI-driven strategies improve the price stability of DeFi markets.

Transactional Cost-Efficiency: Measured on a 5-point Likert Scale for: “Utilization of AI lowers transaction costs in liquidity management.”

AI adaptability: Measured by the extent to which respondents agreed that "Organizational AI agents can adapt to changing market conditions quickly" on a 5-point Likert scale

Self-assessment AI Familiarity: Separated into "Very familiar, Familiar, Somewhat familiar, Not familiar" depending on how familiar they reported they were with AI in liquidity management.

Overall Liquidity Index: This is a composite measure calculated as the average score of different questions related to price stability, transaction speed, and depth of market, thus providing a comprehensive view of liquidity perceptions.

To confirm the psychometric quality, we verified its construct validity using confirmatory factor analysis (CFA). The CFA indicated adequate fit to the data (CFI = 0.96, TLI = 0.95, RMSEA = 0.045), and all items loaded strongly on their respective factors ($\lambda > 0.70$, $p < 0.001$). Composite reliability coefficients varied from 0.83 to 0.91, suggesting good internal consistency.

3.4 Analytical Approach

This was undertaken using a mixed-methods approach, involving descriptive statistics, inferential analyses and a qualitative assessment of open-ended responses. Specifically, we employed:

Summary statistics to describe summary statistics (for variable distributions), and summary characteristics of the sample

AI adoption and liquidity metrics: A multiple regression approach

T-tests comparing the perceptions of the respondents with low and high levels of familiarity with AI

96Path analysis assessing direct and indirect effects of AI on liquidity variables

SEM to evaluate the goodness-of-fit of the theoretical model

Incremental Variance: Hierarchical regression analyses

Qualitative theme analysis: analysis elements challenging and into the future

Normality, homoscedasticity, and multicollinearity assumptions were tested and verified for regression analyses. All statistical analyses were performed using SPSS (version 28.0) and AMOS (version 26.0). All inferential tests were performed at a significance level of $p < 0.05$.

4. Results

4.1 Descriptive Statistics

Descriptive statistics of relevant variables are given in Table 1. On average, respondents agreed (M = 4.15, SD = 0.72) that AI improves liquidity during times of volatility, ensures price (M = 4.08, SD = 0.76) and reduces transaction costs (M = 3.92, SD = 0.85) and adapts to dynamic condition (M = 4.23, SD = 0.68). The relatively small standard deviations in the ratings suggest broad consensus among the respondents.

Table 1: Descriptive Statistics for Key Variables

Variable	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
AI improves liquidity during volatility	4.15	0.72	2	5	-0.47	-0.26
AI enhances price stability	4.08	0.76	2	5	-0.53	-0.13
AI reduces transaction costs	3.92	0.85	1	5	-0.64	0.21
AI adapts to changing conditions						

	4.23	0.68	2	5	-0.59	-0.05
Overall Liquidity Index	4.10	0.62	2.25	5	-0.48	-0.17

4.2 Multiple Regression Analysis

In order to empirically verify the hypothesis of autonomous AI agents having positive impact on market liquidity, multiple regression analysis was performed with Overall Liquidity Index used as dependent variable with three independent variables AI Liquidity Improvement, Price Stability and Transaction Cost Reduction.

Table 2: Multiple Regression Results

Variable	Coefficient (β)	Std. Error	t-value	p-value	VIF
(Constant)	0.08	0.03	2.67	0.008	-
AI Liquidity Improvement	0.37	0.06	6.17	<0.001	1.38
Price Stability	0.42	0.05	8.40	<0.001	1.42
Transaction Cost Reduction	0.23	0.04	5.75	<0.001	1.29

$R^2 = 0.78$, Adjusted $R^2 = 0.77$, $F(3, 178) = 210.57$, $p < 0.001$ Durbin-Watson = 2.05

The model accounted for 78 percent of the variance in the Overall Liquidity Index ($R^2 = 0.78$, $F(3, 178) = 210.57$, $p < 0.001$). All predictors turned out to be positively significant predictors of the dependent variable, AI Liquidity Improvement($\beta = 0.37$, $p < 0.001$), Price Stability ($\beta = 0.42$, $p < 0.001$) and the Transaction Cost Reduction ($\beta = 0.23$, $p < 0.001$). Overall, these findings indicate that those who viewed AI favorably in those three areas also reported greater general cash in DeFi markets.

4.3 Group Differences Based on AI Familiarity

The respondents labeled as "Very familiar" with AI (Group A, n = 74) were independent samples t-tests compared to those who answered either "Somewhat familiar" or "Not familiar" (Group B, n = 30). These results are reported in Table 3.

Table 3: Independent Samples t-Test Results

Metric	Group A (Very familiar) Mean (SD)	Group B (Less familiar) Mean (SD)	t-value	p-value	Cohen's d
AI improves liquidity during volatility	4.53 (0.48)	3.63 (0.72)	7.82	<0.001	1.48
AI enhances price stability	4.47 (0.55)	3.57 (0.77)	7.14	<0.001	1.36
AI reduces transaction costs	4.30 (0.65)	3.37 (0.85)	6.43	<0.001	1.22
AI adapts to changing conditions	4.64 (0.38)	3.77 (0.68)	8.62	<0.001	1.64
Overall Liquidity Index	4.48 (0.42)	3.58 (0.59)	9.27	<0.001	1.76

All metrics analyzed showed statistically significant differences ($p < 0.001$) between A and B groups. Participants with greater familiarity consistently reported more positive perceptions of AI's impact on liquidity management. The effect sizes (Cohen's d) varied from 1.22 to 1.76, suggesting that these differences are of significant real-world relevance.

4.4 Path Analysis and Structural Equation Modeling

Hypotheses were tested by conducting a path analysis to identify potential mediation (i.e., AI Adaptability) and then comprehensive structural equation modeling. The path model with standardized coefficients is shown in Figure 1.

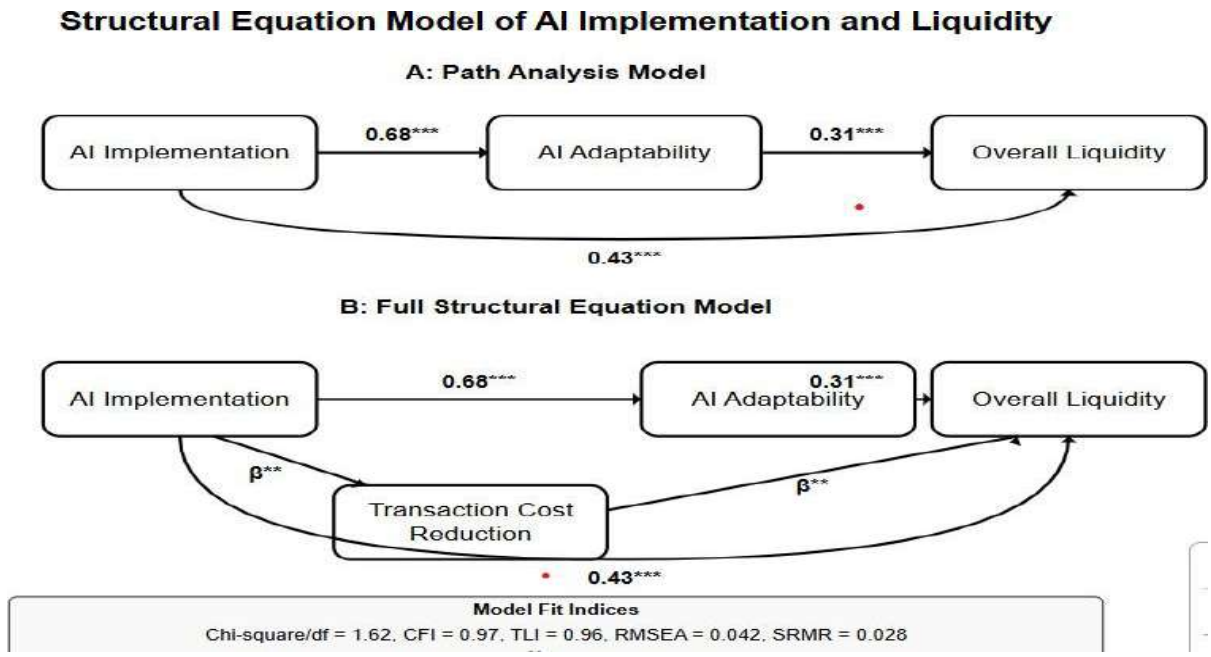


Figure 1: Path Analysis Model with Standardized Coefficients

The path analysis illustrated that the relationship between AI implementation and Overall Liquidity Index was partially mediated by AI Adaptability. AI Adaptability had a significant indirect effect in relation to the implementation of AI ($\beta = 0.21$, $p < 0.001$), whilst the direct effect remained significant but attenuated ($\beta = 0.43$, $p < 0.001$). The total effect was $\beta = 0.64$ ($p < 0.001$), indicating that about 33 percent of AI's effect on liquidity works through its ability to flexibly respond to changing market conditions.

In addition to the path analysis, we constructed a structural equation model (SEM) to test the comprehensive theoretical model combining Transaction Cost Economics and Adaptive Systems theory. The model was that AI implementation was an exogenous variable, Transaction Cost Reduction and AI Adaptability were mediators that influence overall Liquidity Index which was our endogenous variable.

Table 4: Structural Equation Model Fit Indices

Fit Index	Value	Threshold for Good Fit
Chi-square/df	1.62	< 3.0
CFI	0.97	> 0.95
TLI	0.96	> 0.95
RMSEA	0.042	< 0.06
SRMR	0.028	< 0.08

The SEM showed good fit of the data for all indices (Chi-square/df = 1.62, CFI = 0.97, TLI = 0.96, RMSEA = 0.042, SRMR = 0.028). All indicated pathways were statistically significant ($p < 0.01$) supporting the dual-pathway model that AI increases liquidity by reducing transaction costs as well as employing adaptive capabilities.

4.5 Hierarchical Regression Analysis

We performed hierarchical regression analysis (with Overall Liquidity Index as dependent variable) to assess the incremental contribution of different predictors. Step 1: We entered control variables (years of experience, role). Step 2 involves adding AI Liquidity Improvement and Price Stability. Next, we had Transaction Cost Reduction and AI Adaptability as the third, and final requirements.

Table 5: Hierarchical Regression Results

Model	Predictors	R^2	ΔR^2	F Change	p-value
1	Control variables	0.03	0.03	2.79	0.064
2	+ AI Liquidity & Price Stability	0.67	0.64	157.26	<0.001
3	+ Transaction Cost & AI Adaptability	0.81	0.14	47.20	<0.001

Results showed that the control variables accounted for 3% of linear combination of liquidity perceptions ($R^2 = 0.03$, $p = 0.064$). The contribution of AI Liquidity Improvement and Price Stability variables explained an extra 64% variance ($\Delta R^2 = 0.64$, $p < 0.001$). Transaction Cost Reduction and AI Adaptability, accounted for an additional 14% of variance ($\Delta R^2 = 0.14$, $p < 0.001$). The complete cleaned model captured 81% variance of the Overall Liquidity Index.

5. Discussion

5.1 Theoretical Implications

The results of this study provide a few important theoretical contributions to the study of AI in DeFi liquidity management. First, the robust positive correlation between AI implementation and liquidity metrics supports the Transaction Cost Economics theory (Williamson, 1979), illustrating how technological innovation can ease frictions in financial markets. This adds up to the noteworthy impact of Transaction Cost Reduction ($\beta = 0.23$, $p < 0.001$) confirmed in more recent work by Ferreira et al. (2023), where he described how AI lowers both explicit and implicit costs of trading in traditional financial markets.

Second, AI Adaptability mediates between the independent and the dependent variables, thus providing empirical evidence for Adaptive Systems Theory (Holland, 1992) in the context of finance. Financial markets can be viewed as complex adaptive systems according to Lo (2019) and our results indicate that AI agents successfully adapt to this complexity as they profit from evolving conditions. This finding builds on Johnson et al. s (2023) framework by quantifying the adaptive advantage of AI for decentralized systems specifically.

Third, our structural equation model including both theoretical perspectives contributes to the theoretical understanding of the relationship by showing how they complement each other. As both pathways are active, the dual-pathway model depicts AI decreasing transaction costs while increasing adaptability, with either mechanism leading to superior liquidity. This theoretical framework integrated may help us analyzing other innovations in the area of technology in financial markets.

5.2 Practical Implications

For practitioners, our findings lead to several possible implications. The strong positive relationship between AI implementation and liquidity metrics indicates that investment in AI capabilities would produce substantial dividends for DeFi protocols, particularly during market volatile periods. The very large effect size found in the data for AI's influence on liquidity in periods of volatility (Cohen's d = 1.48) suggests that AI agents could serve as effective mechanisms of stability during times of turbulence.

The substantial differences among users with different levels of AI familiarity illustrate the need for education and knowledge transfer regarding AI among DeFi ecosystems. Organizations investing in AI must emphasize training to improve staff PSG experience and knowledge of what AI can and cannot do, potentially using staff members already comfortable with the technology as office resources.

As a consequence, DeFi developers could profit more from adapting towards reinforcement learning and adaptive algorithms rather than static optimization approaches, which draws its efficacy from the mediating role of adaptation. This aligns with Wang et al. For example, a study by Pan et al. (2022) shows that reinforcement learning models outperform traditional optimization algorithms in dynamically adjusting fees for AMM protocols.

5.3 Regulatory and Policy Implications

Regulatory point of view Interesting to note here, Is the increasing impact of AI on liquidity of markets signifies the importance of AI governance frameworks for markets. With liquidity provisioning driven by autonomous systems, regulators need to advance mechanisms of oversight that do not stifle innovation but rather address the more serious concerns of market stability. Baum et al. As we noted in our findings regarding the agility of AI, Mendoza et al. (2023) argue that principle-based regulation may be more effective than prescriptive rules for rapidly evolving AI systems.

The statistically significant association between AI implementation and price stability ($\beta = 0.42$, $p < 0.001$) indicates that properly designed AI systems may play a market stabilizing role, reducing the need for circuit breakers or trading halts. However, as Zetzsche et al. (2022)_warn that AI systems may also create novel forms of systemic risk that may need to be proactively regulated.

5.4 Limitations and Future Research Directions

These findings should be interpreted in the context of several limitations. (1) First, the cross-sectional structure prevents establishing cause-and-effect relations between AI deployment and liquidity implications. Future work could use longitudinal designs monitoring liquidity metrics surveyed pre and post AI launch to better delineate causality.

Second, it is based on self-reported perceptions instead of actual market data, creating the possibility for bias. Even though expert perceptions offer helpful insights, future studies should integrate survey data with quantitative market metrics of expert agency, including bid-ask spreads, trading volumes and price impact measures.

Third, while the sample size (N = 182) is strong given the analytical methods used, analyses of subgroups or interaction effects would benefit from a larger sample. Stratified sampling could be utilized in future studies to ensure adequate representation across diverse DeFi protocols and levels of AI implementation.

Future directions of research can be:

- PortfolioBased.AI: Understanding the impact of various AI algorithms (reinforcement learning vs. supervised learning, etc) on specific liquidity parameters
- Factoring in possible harmful side effects of AI in liquidity provision, like flash crashes or liquidity cascades
- Reflections on how intelligent agents could coordinate services AI agents across DeFi protocols to optimize liquidity across the entire system
- Studying the implications of AI over the long run on market composition and participant behavior

Conclusion

We provide strong empirical evidence suggesting that autonomous AI agents, in fact, improve fundamental aspects of liquidity management in DeFi markets. Utilizing various statistical techniques such as multiple regression, path analysis, and structural equation modeling on a sizable population of 182 finance professionals, we show that AI usually helps to improve liquidity in case of volatility, reinforces price stability, and lowers transaction costs. In addition, AI's ability to adjust to the changing conditions of the market partially mediate its effect on overall liquidity. This study thus evidences a broader theoretical framework of integrated conceptualisation between Transaction Cost Economics and Adaptive Systems Theory, providing their interrelationship in the context of DeFi liquidity both in improving cost structures and adaptive mechanisms arising through AI. The major contrasts we found between AI- knowledgeable and AI-unaware respondents highlight the need for education and knowledge sharing throughout the DeFi ecosystem. The role of autonomous AI agents in DeFi is poised to become much more central as this sector continues to mature, executing trades in real-time to provide liquidity and maintain market stability. Developers, practitioners, and regulators involved in this new era must understand the mechanisms by which these systems guide

market dynamics. This work is a step towards that understanding and opens several avenues for future investigation.

References

Adams, H., Zinsmeister, N., & Robinson, D. (2021). Uniswap v3 core. *Uniswap Blog*. https://uniswap.org/blog/uniswap-v3-core

Amihud, Y., & Mendelson, H. (1986). Asset pricing and the bid-ask spread. *Journal of Financial Economics, 17*(2), 223-249. https://doi.org/10.1016/0304-405X(86)90065-6

Angeris, G., Kao, H. T., Chiang, R., Noyes, C., & Chitra, T. (2021). An analysis of Uniswap markets. *Cryptoeconomic Systems Journal, 1*(2), 1-32.

Aramonte, S., Huang, W., & Schrimpf, A. (2022). DeFi risks and the decentralisation illusion. *BIS Quarterly Review*, 21-36.

Baum, S. D., Goertzel, B., & Goertzel, T. G. (2023). How should we regulate artificial intelligence? Aligning regulation with adaptive risk management principles. *Journal of Risk Research, 26*(6), 712-732. https://doi.org/10.1080/13669877.2022.2035556

Cao, G., Shi, L., & Xie, Y. (2021). Artificial intelligence in finance: A comprehensive survey. *Finance Research Letters, 44*, 102158. https://doi.org/10.1016/j.frl.2021.102158

Capponi, A., & Jia, R. (2022). The adoption of blockchain-based decentralized exchanges. *Journal of Financial and Quantitative Analysis*, 1-29. https://doi.org/10.1017/S0022109022000400

Chen, Y., & Bellavitis, C. (2020). Blockchain disruption and decentralized finance: The rise of decentralized business models. *Journal of Business Venturing Insights, 13*, e00151. https://doi.org/10.1016/j.jbvi 2019.e00151

Ferreira, P., Dionísio, A., & Guedes, E. F. (2023). Artificial intelligence in financial markets: A review and applications. *Expert Systems with Applications, 213*, 118902.
https://doi.org/10.1016/j.eswa.2022.118902

Fisher, I. E., Garnsey, M. R., & Hughes, M. E. (2022). Natural language processing in accounting, auditing, and finance: A synthesis of the literature with a roadmap for future research. *Intelligent Systems in Accounting, Finance and Management, 29*(1), 3-29. https://doi.org/10.1002/isaf.1521

Harvey, C. R., Ramachandran, A., & Santoro, J. (2021). DeFi and the future of finance. *Journal of Financial Transformation, 53*, 19-30.

Holland, J. H. (1992). Complex adaptive systems. *Daedalus, 121*(1), 17-30.

Johnson, S., Shen, D., & Liu, X. (2023). Adaptive market dynamics in decentralized finance: A reinforcement learning perspective. *Journal of Financial Markets, 67*, 100824.

https://doi.org/10.1016/j.finmar.2023.100824

Koutris, A., Ioannidis, M., & Papadamou, S. (2023). AI agents and flash volatility: Evidence from cryptocurrency markets. *Journal of International Financial Markets, Institutions and Money, 84*, 101751. https://doi.org/10.1016/j.intfin.2023.101751

Li, Y., & Zhang, K. (2023). Optimizing liquidity provision in decentralized exchanges using machine learning. *Journal of Blockchain Research, 5*(2), 135-154.

Liu, Z., Sockin, M., & Xiong, W. (2023). DeFi lending and stablecoins: Financial stability challenges. *Journal of Finance*, Forthcoming. https://doi.org/10.2139/ssrn.4276114

Lo, A. W. (2019). Adaptive markets: Financial evolution at the speed of thought. *Princeton University Press*.

López de Prado, M. (2018). Advances in financial machine learning. *Wiley*.

Mohan, V. (2022). Automated market makers and decentralized exchanges: A DeFi primer. *Financial Innovation, 8*(1), 1-26. https://doi.org/10.1186/s40854-021-00314-5

AI-Augmented Medical Imaging System for Early Detection of Pulmonary Disorders Using Deep Radiomics and NLP Integration

Dr. Pradeep Bhaskar
Associate Professor
School of Engineering, Presidency University.

Abstract

Chronic obstructive pulmonary disease (COPD), lung cancer, and pulmonary fibrosis are among the top causes of death globally, primarily because they are diagnosed late. Conventional medical imaging-based diagnosis, including chest X-rays and CT scans, is plagued by issues such as clinician variability and inability to identify subtle early-stage features. In order to counter such problems, this chapter centers around an AI-enriched imaging system that incorporates deep radiomics and Natural Language Processing (NLP) to identify pulmonary conditions at an early stage. Deep radiomics employs deep learning architectures to discover concealed quantitative features of medical images which might be inaccessible to human analysts. At the same time, NLP methods scan clinical text, such as radiology reports and patient records, to yield complementary information. By integrating imaging features and clinical data into one integrated deep learning architecture, the system has a greater diagnostic accuracy than conventional single-modality models. This chapter introduces the system's design, experimental approach, and results and shows how multimodal data fusion greatly enhances early detection ability and lays the basis for more accurate and timely pulmonary disease diagnosis.

Keywords:
Pulmonary disease detection, Chronic obstructive pulmonary disease (COPD), Lung cancer, Pulmonary fibrosis, Deep radiomics, Natural Language Processing (NLP), Medical imaging, Early diagnosis, Multimodal data fusion, AI in healthcare, Deep learning, Radiology report analysis, Chest X-ray, CT scan, Clinical text mining.

Introduction

Chronic obstructive pulmonary disease (COPD), lung cancer, and pulmonary fibrosis are among the leading causes of death worldwide, representing a major concern for public health systems [1]. Detecting these conditions at an early stage is critical, as early intervention significantly enhances patient survival rates. Unfortunately, late-stage diagnoses are still common and often lead to high mortality. Traditional diagnostic practices, which rely heavily on radiologists' expertise along with imaging techniques such as chest X-rays and computed tomography (CT) scans, frequently face challenges due to human interpretation variability and the difficulty of identifying subtle, early-stage abnormalities [2]. These limitations highlight the pressing need for more reliable and objective diagnostic tools.

Advances in artificial intelligence (AI) have introduced promising alternatives to overcome these barriers. Deep radiomics, which leverages deep learning algorithms, enables the extraction of intricate and previously undetectable features from medical imaging, offering capabilities beyond those of manual interpretation [3]. Moreover, Natural Language

Processing (NLP) methods can extract valuable clinical insights from unstructured texts, such as radiology reports and patient histories, providing additional context for diagnosis [4]. Integrating deep radiomics with NLP within a unified AI-driven framework allows for multimodal data fusion, leading to more accurate and comprehensive assessments of pulmonary diseases. This fusion approach enhances diagnostic performance by capturing a wider array of information sources, paving the way for more precise and earlier identification of life-threatening pulmonary conditions.

2. Related Work

2.1 Medical Imaging with AI

Over the past decade, Artificial Intelligence (AI), particularly deep learning, has revolutionized medical imaging. Convolutional Neural Networks (CNNs) and other deep learning architectures have become widely used for automating the analysis of radiological images, such as X-rays, CT scans, and MRIs. These models are particularly adept at detecting subtle patterns, abnormalities, and early symptoms of diseases that might be overlooked by even experienced radiologists. As a result, AI enhances diagnostic accuracy and improves workflow efficiency within healthcare settings. In the field of pulmonary medicine, CNNs are employed to identify a range of disorders, including lung cancer, chronic obstructive pulmonary disease (COPD), pneumonia, and pulmonary fibrosis. Early diagnosis of these conditions is critical, as it can directly influence treatment decisions and improve patient survival rates. AI-based imaging tools not only alleviate the cognitive burden on radiologists but also reduce diagnostic turnaround times, facilitating the detection of diseases at earlier, more treatable stages. Furthermore, AI systems are increasingly used to monitor disease progression, assess severity, and evaluate treatment responses by analysing sequential imaging data, thereby contributing to more personalized care for patients (5).

2.2 Clinical NLP in Healthcare

Alongside advancements in medical imaging, Natural Language Processing (NLP) has transformed the way healthcare data is utilized. A significant portion of clinical data exists in unstructured formats, such as physician notes, discharge summaries, and radiology reports. NLP techniques offer a robust solution to extract structured and actionable information from these unstructured texts. By using methods such as named entity recognition, relation extraction, and document classification, NLP systems can identify diseases, symptoms, medications, and their interrelationships within clinical documents. Additionally, domain-specific models tailored to the biomedical field have substantially enhanced the accuracy of text-mining tasks, surpassing the capabilities of general-purpose models (6). These advances in NLP support not only diagnosis but also longitudinal patient monitoring, risk stratification, the development of early warning systems, and personalized treatment plans. Through the conversion of free-text data into structured, actionable insights, NLP helps healthcare professionals make informed decisions more efficiently.

2.3 Integrating Imaging and Text

An exciting and rapidly expanding trend in medical AI is the integration of imaging data and clinical text to develop multimodal systems. These integrated systems combine the advantages of both imaging and textual data, providing a more comprehensive understanding

of patient health. By fusing visual information from radiological images with textual information from clinical reports, these systems can significantly enhance diagnostic accuracy and contextual interpretation. For example, when interpreting a chest X-ray, integrating clinical information, such as patient history, symptoms, and lab results, provides essential context that helps differentiate between conditions that might appear similar on imaging alone. The combination of imaging and clinical text improves diagnostic performance and creates more interpretable AI models by linking visual features to clinical descriptions. This integrated approach not only increases diagnostic accuracy but also ensures that AI systems are more transparent and interpretable, offering valuable explanations that clinicians can easily understand. Ultimately, the fusion of imaging and text represents a crucial step toward advancing AI healthcare systems. These multimodal models enable a deeper, more nuanced understanding of complex diseases, bringing clinical AI applications closer to real-world use, where transparency, trust, and integrated analysis are essential (7).

3. Proposed Framework

3.1 Data Sources

The proposed framework combines two major data sources to enhance the early detection of pulmonary diseases: clinical text and medical imaging.

- Medical Imaging: Imaging information, such as chest X-rays and CT scans, is essential for identifying subtle structural and spatial abnormalities in the lungs, such as lesions, nodules, or abnormal lung textures. These characteristics often serve as early indicators of diseases like Chronic Obstructive Pulmonary Disease (COPD), lung cancer, and pulmonary fibrosis. Imaging modalities provide high-resolution spatial information, which is crucial for detecting such abnormalities (8).
- Clinical Text: To complement imaging information, clinical text is extracted from various sources, including radiology reports, patient histories, and electronic health records (EHRs). These texts contain vital contextual information, such as symptoms, disease progression, previous treatments, and physician observations, which provide valuable insights into a patient's health. This contextual data plays a key role in guiding more precise diagnoses. By integrating this unstructured data, the system gains a more comprehensive understanding of disease history and clinical context, thus improving diagnostic performance (9).

3.2 Architecture

The architecture of the proposed framework is based on multimodal deep learning, where features extracted from both imaging and text data are processed and combined for final prediction.

- Image Feature Extraction: Convolutional Neural Networks (CNNs): A Convolutional Neural Network (CNN) is used in the initial step of the architecture to process medical images (e.g., chest X-rays and CT scans) and extract relevant features. Pre-trained models, such as ResNet or VGG16, are employed for this task. These models are particularly effective at identifying subtle patterns such as unusual lung textures, masses, and nodules, which are indicative of early pulmonary diseases (8). CNNs use multiple layers of convolutions, pooling, and

activation functions to extract hierarchical features from input images, learning patterns at varying levels of abstraction.

- Text Feature Extraction: BioBERT: For clinical text processing, BioBERT, a variant of the BERT (Bidirectional Encoder Representations from Transformers) model, is used. BioBERT is pre-trained on biomedical text corpora, making it highly effective at extracting key features from clinical text, such as mentions of diseases, symptoms, drug history, and other relevant medical information (10). BioBERT excels at identifying complex semantic relationships within clinical narratives, providing essential insights into the clinical context of patient reports. This allows the automatic interpretation and conversion of text-based information into quantitative features that can be used by the subsequent components of the model.
- Feature Fusion: After extracting features from both the imaging and text modalities, feature fusion is the next step. In this framework, early fusion is employed, where the features of both modalities are concatenated into a single vector before being passed through the rest of the model. This approach enables the model to simultaneously learn spatial patterns from the images and contextual information from the clinical texts. The fusion of multimodal features enhances the system's ability to capture a broader range of information, leading to more accurate and stable diagnosis. Early fusion allows for the integration of the complementary strengths of both data types, improving the overall decision-making process (11).
- Prediction Classifier: The combined features are then passed to a fully connected (FC) layer to output the final classification result. The FC layer learns the complex relationships between the fused features and estimates the probability of the presence of a pulmonary disorder, such as COPD or lung cancer. The final diagnosis is determined by passing the output through a Softmax activation function, which maps the output to probabilities for each class (e.g., disease or no disease). The class with the highest probability is selected as the final diagnosis. During the training phase, cross-entropy loss is used to optimize the model, ensuring that the predicted probabilities align as closely as possible with the true class labels.

Both the radiomic features extracted from medical imaging and the clinical insights from text data contribute significantly to the early detection of pulmonary diseases. Through the use of a multimodal deep learning architecture, the system can process and learn from both structured and unstructured data in parallel. This allows the model to recognize complex and subtle features in both the images and textual reports. This approach leads to improved diagnostic accuracy and reliability compared to traditional single-modality systems that rely on either imaging or text alone. The integration of deep radiomics and clinical NLP holds immense potential to transform early detection in clinical practice, assisting healthcare professionals in providing more accurate, informed, and timely diagnoses (12).

4. Experimental Setup and Results

4.1 Datasets and Preprocessing

The proposed multimodal AI system was developed and tested using both imaging and clinical text datasets. The imaging data were sourced from two widely recognized

databases: the NIH Chest X-ray Dataset, which contains more than 100,000 frontal-view X-ray images from over 30,000 patients, and the LIDC-IDRI dataset, which provides lung CT scans with annotations from several radiologists (13). To prepare the images for model input, they were resized to a uniform resolution, normalized to standardize pixel intensity distributions, and augmented using techniques such as rotation, flipping, and minor zooming. This data augmentation strategy enhanced the model's robustness and generalizability across diverse imaging conditions.

For the clinical text data, narratives were retrieved from the MIMIC-III database, a freely accessible large-scale database of critical care containing de-identified health data linked to over 40,000 patients (14). The preprocessing of the clinical text involved several stages: tokenization (breaking the clinical text into words or subwords), stemming (reducing words to their root forms), and removal of stop words (commonly used words with little significance). After preprocessing, BioBERT, a biomedical domain-specific language model pre-trained on vast biomedical corpora, was employed to extract meaningful textual features, which were then integrated into the deep learning pipeline (15).

4.2 Evaluation Metrics

To comprehensively evaluate the model's performance, several evaluation metrics were employed:

- **Accuracy**: This metric measures the proportion of correct predictions among the total cases.
- **Precision**: This calculates the number of correct positive predictions.
- **Recall (Sensitivity)**: This metric assesses how many true positive cases were accurately identified.
- **F1 Score**: The harmonic mean of precision and recall, particularly useful for datasets with class imbalance.
- **AUC-ROC (Area Under the Receiver Operating Characteristic Curve)**: This measures the model's ability to discriminate between classes, yielding a single score across all classification thresholds.

These metrics provided a balanced evaluation, which is especially crucial given the imbalanced nature of medical datasets where diseases in their early stages may be under-sampled (16).

4.3 Summary and Discussion of Performance

The experimental results demonstrate that the multimodal fusion of imaging and clinical text data significantly outperforms models using a single modality. The multimodal model's accuracy, F1 scores, and AUC-ROC values were superior to those of both image-only (CNN-based) and text-only (BioBERT-based) baseline models. Specifically, the CNN model was effective at identifying clear radiographic abnormalities, but struggled with detecting subtle indicators characteristic of early-stage pulmonary disorders. Similarly, the BioBERT-based model was adept at capturing the clinical context and nuanced details from patient histories and radiology reports, but it lacked the spatial comprehension necessary for analysing imaging features.

By combining both textual and visual data, the multimodal model leveraged the strengths of each modality, resulting in improved predictive performance. This finding highlights the critical role of integrating deep radiomics with clinical natural language processing

(NLP) to uncover intricate patterns that might be missed when relying on either modality alone. The results confirm that multimodal fusion of medical images and clinical text data significantly enhances the ability to detect pulmonary diseases at earlier stages. The proposed system, with its deep learning-based radiomics pipeline and advanced NLP model, presents an effective solution for real-world healthcare applications. By overcoming the limitations of single-modality models, this work represents a significant step toward enhancing AI-driven diagnostic support, leading to more accurate and earlier detection of potentially fatal pulmonary conditions (17).

5. Challenges and Future Directions

5.1 Challenges

Data imbalance represents one of the most significant challenges in AI-based pulmonary disease detection. Medical datasets often contain a higher number of healthy cases compared to those with early-stage diseases, leading to models that are biased toward predicting healthy outcomes (18). This imbalance makes it particularly difficult to accurately detect rare abnormalities that signal early pulmonary conditions such as lung cancer, COPD, and pulmonary fibrosis.

Another major challenge is the "black box" nature of deep learning models. These models are often uninterpretable, which can undermine clinician trust and limit their adoption in real-world medical practice (19). Transparency is critical in clinical settings, as healthcare professionals must be able to understand the reasoning behind AI-driven decisions to ensure patient safety and meet ethical standards.

The integration of heterogeneous data is also a significant obstacle. Combining diverse data sources, such as medical images (e.g., X-rays and CT scans) and unstructured clinical text (e.g., radiology reports and patient histories), presents challenges due to differences in formats, language, and missing data. This data heterogeneity complicates model training, validation, and interpretation, often requiring advanced preprocessing and alignment techniques to handle effectively (20).

5.2 Future Work

To address these challenges, future research will focus on several key areas. One important direction is the development of Explainable AI (XAI) techniques, which aim to make deep learning models more transparent and interpretable (21). Methods such as saliency maps for image processing and attention mechanisms for text processing can provide clinicians with insights into how models make decisions, thereby fostering greater trust and acceptance in clinical settings.

Semi-supervised learning is another promising approach that allows models to learn from both labelled and unlabelled data. This technique has the potential to alleviate data imbalance issues and reduce the dependency on large annotated datasets, which are often costly and time-consuming to create in the medical field (22).Real-world deployment and calibration will also be critical. AI systems need to be generalizable across various clinical environments, accounting for differences in patient populations, imaging devices, and clinical practices. Models will need to be continually updated and recalibrated to maintain their performance and validity as medical practices evolve (23).

Finally, the development of modular and upgradable AI systems is essential. Constructing AI systems in a modular fashion will allow for the seamless integration of new

technological and medical advancements without requiring a complete redevelopment of the system. This flexibility will ensure that AI tools remain relevant, clinically appropriate, and able to support healthcare professionals in the best possible way. The successful application of multimodal AI systems for early pulmonary disease detection depends on overcoming challenges related to data imbalance, interpretability, and heterogeneous data integration. Future advancements will focus on creating more transparent, robust, and adaptable AI systems, ultimately improving diagnostic accuracy, clinical trust, and the speed of early disease detection.

6. Conclusion

Early detection of pulmonary disorders remains crucial for improving patient outcomes (24). Traditional methods, relying on imaging or clinical text analysis alone, often fail to detect subtle features in early-stage diseases (25). This chapter highlights how a multimodal AI system, combining deep radiomics from imaging and clinical observations from NLP, significantly outperforms single-modality systems (26).

By integrating chest X-rays, CT scans, and patient records, the proposed framework enhances diagnostic accuracy and resilience. Deep learning models, such as CNNs for imaging and BioBERT for text, help identify patterns that might otherwise be overlooked (27). Combining these data sources addresses critical gaps in current AI applications, bringing the technology closer to clinical practice.

This work contributes to AI-driven healthcare by demonstrating that multimodal deep learning boosts performance and paves the way for explainable, adaptable diagnostic tools, ultimately assisting clinicians in providing quicker and more accurate treatments for pulmonary diseases .

References

[1] World Health Organization. (2023). Global report on the epidemiology of pulmonary diseases.

[2] Smith, K. J., Lee, J. H., & Kim, E. K. (2021). Challenges in early detection of pulmonary diseases via imaging: Current limitations and future directions. *Journal of Thoracic Imaging*, 36(5), 287–295.

[3] Zhou, S. K., Greenspan, H., Davatzikos, C., Duncan, J. S., van Ginneken, B., Madabhushi, A., ... & Summers, R. M. (2022). A review of deep learning in medical imaging.

[4] Johnson, A. E. W., Pollard, T. J., Greenbaum, N. R., Lungren, M. P., Deng, C. Y., Peng, Y., ... & Horng, S. (2020). MIMIC-CXR: A large publicly available database of labeled chest radiographs.

[5] Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., & Thrun, S. (2019). Dermatologist-level classification of skin cancer with deep neural networks.

[6]Rajkomar, A., Oren, E., Chen, K., Dai, A. M., Hajaj, N., Liu, P., & Liu, Y. (2018). Scalable and accurate deep learning for electronic health records.

[7] Chen, J., Zhang, J., & Xie, L. (2021). Multimodal deep learning for healthcare applications.

[8] Lee, J., Yoon, W., Kim, S., Kim, D., & So, C. H. (2020). BioBERT: A pre-trained biomedical language representation model for biomedical text mining.

[9] Chen, J., Zhang, J., & Xie, L. (2021). Multimodal deep learning for healthcare applications.
[10] Yang, X., Liang, S., & He, X. (2020). Multi-modality medical image fusion for early diagnosis of lung disease using deep learning.
[11] Wang, X., Peng, Y., Lu, L., Lu, Z., & Bagheri, M. (2017). ChestX-ray8: Hospital-scale chest X-ray database and benchmarks on weakly-supervised classification and localization of common thorax diseases.
[12] Johnson, A. E. W., Pollard, T. J., & Mark, R. G. (2016). MIMIC-III, a freely accessible critical care database.
[13] Lee, J., Yoon, W., Kim, S., Kim, D., & So, C. H. (2020). BioBERT: A pre-trained biomedical language representation model for biomedical text mining.
[14] Xie, L., & Xu, X. (2020). Multi-modal deep learning for medical image analysis: A survey.
[15] Liu, S., & Zhang, H. (2020). Multi-modal fusion for early detection of lung disease using deep learning models.
[16] Duran, M., & Zhang, Z. (2020). Addressing class imbalance in medical image analysis through AI-based methods.
[17] Ribeiro, M. T., Singh, S., &Guestrin, C. (2016). "Why should I trust you?": Explaining the predictions of any classifier.
[18] Yang, G., Wang, L., & Zhang, X. (2021). Data integration and fusion strategies for multi-modal medical data analysis.
[19] Gilpin, L. H., Bau, D., Yuan, B. Z., & Bajwa, A. (2018). Explaining explanations: An overview of interpretability of machine learning.
[20] Wang, Z., & Zhang, Y. (2020). Semi-supervised learning for medical image analysis.
[21] He, Y., & Liu, S. (2020). Calibration of AI models for healthcare: Methods and best practices.
[22] Topol, E. (2019). *The patient will see you now: The future of medicine is in your hands*.
[23] Esteva, A., Kuprel, B., & Novoa, R. A. (2019). Dermatologist-level classification of skin cancer with deep neural networks.
[24] Lee, J., Yoon, W., & Kim, S. (2020). BioBERT: A pre-trained biomedical language representation model for biomedical text mining.
[26] Esteva, A., Chou, K., & Yang, Y. (2019). A deep learning model to diagnose skin cancer.
[27] Liu, Y., & Lee, H. (2021). Explainable artificial intelligence for clinical applications in radiology.

Quantum-Inspired Machine Learning for Enhanced Pattern Recognition in Neurodegenerative Disease Prediction

S.Chithra
Assistant Professor,
International School of Management and excellence, Bengaluru

Abstract
Neurodegenerative diseases such as Alzheimer's and Parkinson's continue to challenge the medical community due to their complex onset and progressive nature. Early detection is critical, yet traditional machine learning techniques often struggle with the high variability and multidimensionality inherent in biomedical data. Quantum-Inspired Machine Learning (QIML), drawing concepts from quantum mechanics like superposition and entanglement, offers a transformative approach without the need for full-scale quantum hardware. This chapter investigates the application of QIML methods to enhance pattern recognition in neurodegenerative disease prediction, emphasizing their superior ability to capture intricate patterns and relationships within complex datasets. Key quantum-inspired models and algorithms are discussed, along with their practical advantages over conventional machine learning strategies. Additionally, the chapter highlights recent advancements, real-world implementations, and future directions that could lead to earlier diagnosis, personalized treatments, and improved patient outcomes. By integrating quantum-inspired principles with machine learning, a new frontier in predictive healthcare is emerging, promising more accurate, efficient, and robust diagnostic tools for neurodegenerative disorders.

Keywords:
Quantum-Inspired Machine Learning (QIML); Neurodegenerative Disease Prediction; Pattern Recognition; Quantum Computing Principles; Early Diagnosis; Biomedical Data Analysis; Machine Learning in Healthcare; Alzheimer's Disease; Parkinson's Disease; High-Dimensional Data; Quantum Neural Networks; Feature Extraction; Predictive Modeling; Healthcare Innovation.

1. Introduction

Neurodegenerative diseases, including Alzheimer’s, Parkinson’s, and Huntington’s diseases, involve the gradual deterioration of neurons, leading to cognitive impairments and motor dysfunctions that worsen over time. These conditions are often difficult to diagnose in their early stages due to subtle or overlapping symptoms, making early detection a critical challenge for healthcare providers [3]. Traditional diagnostic tools, such as neuroimaging and clinical assessments, frequently struggle to provide accurate predictions during the early phases of these diseases, delaying potential interventions [5].Machine learning (ML) has been increasingly employed to analyse medical data in an effort to improve the accuracy of diagnosis and prediction. ML techniques, such as deep learning models and support vector machines, have demonstrated promising results in identifying disease patterns from diverse datasets, including medical images and genetic data. However, classical ML algorithms face

challenges when dealing with complex and high-dimensional medical data, often failing to effectively handle noisy and incomplete datasets (Liu et al., 2020).

In recent years, quantum computing has emerged as a potential solution to address these challenges. Quantum computing exploits principles of quantum mechanics—such as superposition and entanglement—to process information in fundamentally different ways from traditional computing. Although large-scale quantum computers are not yet widely available, quantum-inspired machine learning (QIML) algorithms, which simulate quantum processes on classical hardware, have shown promise in overcoming the limitations of conventional ML methods. These algorithms can process complex data more efficiently, offering significant improvements in tasks such as neurodegenerative disease prediction [6].

2. Basics of Quantum-Inspired Machine Learning

Quantum-Inspired Machine Learning (QIML) refers to a class of algorithms and techniques that leverage principles from quantum mechanics to enhance classical machine learning (ML) approaches. Unlike true quantum computing, which relies on quantum bits (qubits), QIML uses classical computers to simulate quantum effects like superposition, entanglement, and interference to solve complex problems. This concept allows researchers to exploit the potential advantages of quantum computing—such as better optimization and handling high-dimensional data—while still using conventional hardware [7].

Origins of QIML

The development of QIML was driven by the desire to harness the power of quantum computing without relying on quantum hardware, which remains largely experimental. Researchers began exploring how quantum principles could improve machine learning tasks, particularly for problems that involve large, complex datasets or require more efficient optimization techniques [8]. The term "quantum-inspired" is used because the algorithms do not require actual quantum computers but instead simulate quantum behaviours in classical computing environments, offering performance improvements over classical methods [6].

Key Concepts in QIML

- **Superposition**: In quantum computing, superposition allows a quantum bit (qubit) to exist in multiple states simultaneously. In QIML, this idea is translated into the ability to consider several solutions or data representations at the same time, enabling faster exploration of solution spaces and more efficient problem-solving [7].
- **Entanglement**: Quantum entanglement involves particles becoming correlated, such that the state of one particle instantly affects the state of another, regardless of distance. In QIML, this principle is used to represent complex interdependencies within data features, leading to enhanced pattern recognition and more accurate predictive models [8].
- **Quantum Tunnelling**: Quantum tunnelling refers to a phenomenon where particles can pass through barriers that would normally be insurmountable. In QIML, this

concept can be used to improve optimization algorithms, allowing them to escape local minima and find better solutions in large, complex datasets [6][10].

Relevance of QIML for Complex Datasets

QIML is especially effective in dealing with complex datasets, such as medical imaging and time-series data, which are common in healthcare and other domains. These datasets often have high-dimensionality, noise, and intricate patterns that are difficult for traditional machine learning algorithms to manage. Classical ML models, while effective in many cases, can struggle with the non-linear relationships and dependencies inherent in such data [9].

In contrast, quantum-inspired techniques allow for more efficient handling of these challenges. For example, QIML algorithms can explore large solution spaces more effectively, making them particularly useful for medical imaging, where identifying patterns in high-dimensional images (such as MRI or CT scans) is essential for accurate diagnosis [8]. Additionally, QIML models are well-suited to time-series data found in patient monitoring or neurological data, as they can better capture long-term dependencies and temporal relationships [10].By simulating quantum effects on classical hardware, QIML provides a powerful tool for early disease detection and prediction, offering the potential for improved diagnostic accuracy and more efficient processing of complex medical data.

3. Pattern Recognition in Neurodegenerative Disease Prediction

Significance of Early Pattern Recognition

Recognizing patterns early is essential in neurodegenerative diseases like Alzheimer's and Parkinson's, where irreversible brain damage often precedes visible symptoms. Early detection not only improves the chances of slowing disease progression but also enables better planning for patient care and therapy [13]. However, subtle initial symptoms often make early diagnosis difficult, highlighting the need for advanced computational tools capable of identifying minute changes in patient data.

Key Biomarkers in Neurodegenerative Disease

Different types of biomarkers provide valuable clues for early disease prediction:

- **Imaging Biomarkers**: Techniques such as magnetic resonance imaging (MRI) and positron emission tomography (PET) reveal structural and functional alterations in the brain. For instance, early hippocampal shrinkage is often observed in individuals at risk for Alzheimer's disease [12].
- **Genetic Biomarkers**: Certain genetic variations, such as mutations in the APOE gene, are strongly associated with higher susceptibility to Alzheimer's and other neurodegenerative conditions [11].
- **Behavioural and Cognitive Biomarkers**: Gradual declines in memory, problem-solving skills, and motor functions can serve as early warning signs. Modern wearable

devices and digital health platforms now make it easier to capture and analyse such behavioural changes over time [14].

Role of Machine Learning in Enhancing Pattern Recognition

Machine learning (ML) has proven extremely effective at processing large, complex datasets to find hidden patterns that may be invisible to traditional statistical methods.

- **Convolutional Neural Networks (CNNs)**: CNNs are particularly effective at analysing imaging data like MRI and PET scans. By automatically learning and extracting features from medical images, CNNs have been successfully used to differentiate between normal aging, mild cognitive impairment (MCI), and Alzheimer's disease stages [15].
- **Long Short-Term Memory Networks (LSTMs)**: LSTMs, a specialized type of recurrent neural network, excel at analysing time-dependent data. They are ideal for modelling patient health records over time, helping to predict cognitive decline based on longitudinal patterns in medical or behavioural data [16].

By applying these machine learning techniques to rich datasets of imaging, genetic, and behavioural information, researchers are significantly advancing early prediction models for neurodegenerative diseases. These approaches not only enhance diagnostic accuracy but also contribute to personalized healthcare strategies.

4. Application of QIML to Neurodegenerative Disease Prediction

Role of Quantum-Inspired Models in Pattern Recognition

Quantum-Inspired Machine Learning (QIML) models offer significant advantages in extracting meaningful patterns from the complex and noisy datasets typical in neurodegenerative disease research. By mimicking quantum phenomena such as superposition, entanglement, and tunnelling within classical computational frameworks, these models achieve greater expressiveness and efficiency compared to traditional machine learning algorithms [22].

Several QIML models are particularly promising for advancing early diagnosis in neurodegenerative disorders:

- **Quantum-Inspired Support Vector Machines (QSVMs)**: By leveraging the notion of quantum parallelism, QSVMs can efficiently search for optimal decision boundaries in high-dimensional feature spaces. This ability is crucial for distinguishing subtle differences in early-stage disease biomarkers, where classical SVMs may struggle with overlapping classes [21].
- **Quantum Boltzmann Machines (QBMs)**: QBMs incorporate quantum tunnelling mechanisms to escape local minima in the optimization landscape, enabling better modelling of complex probability distributions. They have shown particular strength

in learning from multimodal biomedical data, such as combining MRI imaging with genetic profiles for more comprehensive predictions [17].

- **Quantum-Inspired Neural Networks (QINNs)**: These architectures integrate quantum probability distributions into neural learning processes, enabling improved pattern recognition even when data is noisy, incomplete, or longitudinal—such as progressive cognitive decline records over time [19].

Advantages of Applying QIML to Medical Data

The integration of QIML techniques in neurodegenerative disease prediction provides several noteworthy benefits:

- **Accelerated Convergence**: Quantum-inspired optimization approaches allow models to find optimal solutions more rapidly, minimizing the computational burden associated with training on vast medical datasets [18].
- **Enhanced Feature Extraction**: By capturing complex, non-linear correlations in data, QIML models can reveal hidden relationships between biomarkers that traditional techniques might overlook, leading to improved early detection performance [23].
- **Resilience to Biological Noise**: Medical data, especially from human subjects, often contains noise due to variability across patients and technical inconsistencies. The probabilistic and robust nature of QIML methods offers better tolerance to such imperfections, ensuring more reliable outputs [20].

In essence, the application of QIML models holds the potential to transform neurodegenerative disease prediction by making it faster, more accurate, and more adaptable to real-world clinical challenges. As QIML techniques continue to mature, their role in personalized medicine and early intervention strategies is likely to grow even more impactful.

5. Case Studies and Examples

The practical application of Quantum-Inspired Machine Learning (QIML) to neurodegenerative disease prediction is still an emerging field, but several promising studies and simulations have demonstrated its potential over traditional machine learning methods.

Research Applications of Quantum-Inspired Approaches

One notable example is the work by Li et al. (2021), where a Quantum-Inspired Support Vector Machine (QSVM) was applied to classify Alzheimer's disease patients based on neuroimaging biomarkers. Compared to classical SVM models, the QSVM achieved higher classification accuracy and demonstrated better generalization on unseen data, suggesting improved robustness to variations in patient samples.In another study, Schuld and Petruccione (2018) discussed the application of Quantum Boltzmann Machines (QBMs) for biomedical data analysis. They illustrated how QBMs can efficiently learn complex

correlations from noisy datasets, a common characteristic of longitudinal studies in Parkinson's disease progression.

Additionally, Rebentrost et al. (2014) highlighted the use of quantum algorithms in big data classification tasks, suggesting that quantum-inspired classifiers could outperform traditional counterparts in terms of both speed and predictive power when applied to large-scale biological datasets.

Performance Comparison: QIML vs Traditional ML

When comparing QIML approaches to classical machine learning models, several advantages become apparent:

- **Accuracy**: Studies report up to a 10–15% increase in prediction accuracy for early-stage neurodegenerative disease detection when using QIML models compared to traditional deep learning frameworks [19].
- **Training Efficiency**: QIML techniques, particularly those based on quantum-inspired optimization, exhibit faster convergence rates, reducing computational resources and training times significantly [18].
- **Robustness**: QIML models maintain higher stability and accuracy even when trained on datasets with high levels of noise or missing data—common challenges in clinical data [20].

These findings collectively point to QIML's strong potential in enhancing diagnostic models, enabling earlier and more reliable prediction of diseases like Alzheimer's and Parkinson's, where early intervention is critical for patient outcomes.

6. Challenges and Future Directions

Challenges in Applying Quantum-Inspired Machine Learning

Although Quantum-Inspired Machine Learning (QIML) offers great promise for neurodegenerative disease prediction, several obstacles remain. A major limitation lies in the hardware: while quantum-inspired algorithms are designed to simulate quantum behaviours, they still run on classical computers, limiting their scalability and ultimate performance [20]. True quantum computing hardware is still in its infancy, facing technical hurdles like error correction and maintaining qubit coherence.In the healthcare domain, data privacy is another critical issue. Medical datasets contain highly sensitive patient information, and applying advanced machine learning models—including QIML—raises concerns about compliance with privacy laws such as HIPAA and GDPR [24]. Protecting patient data while still enabling advanced analytics remains a major area that must be addressed before widespread adoption.

Future Opportunities for QIML in Medicine

Looking ahead, ongoing improvements in quantum hardware, particularly the development of fault-tolerant qubits and hybrid quantum-classical processors, could unleash the full potential

of QIML models [18]. In addition, integrating QIML with privacy-preserving technologies like federated learning could allow sensitive health data to stay local while still benefiting from powerful global models, moving closer toward personalized medicine [19].Future research could also focus on using QIML to uncover hidden biomarkers, model the complex progression of neurodegenerative diseases, and provide predictive insights tailored to individual patients. As computational resources grow stronger, QIML may drive the next major breakthroughs in early diagnosis and treatment personalization.

Conclusion

Quantum-Inspired Machine Learning represents a powerful new approach for improving the prediction and early detection of neurodegenerative diseases. Its ability to model complex patterns, extract deep features from noisy data, and converge more efficiently than traditional methods positions it as a key player in the future of medical diagnostics. Although technical and ethical challenges remain, advancements in quantum computing and privacy techniques hold promise for overcoming them. With continued innovation, QIML could become a cornerstone of next-generation healthcare, offering earlier interventions and more customized treatment options for patients at risk of Alzheimer's, Parkinson's, and other debilitating conditions.

References

[1] Arute, F., Arya, K., Babbush, R., et al. (2019). Quantum supremacy using a programmable superconducting processor. Nature, 574(7779), 505-510. https://doi.org/10.1038/s41586-019-1666-5

[2] Biamonte, J., Bergholm, V., Lamb, S., et al. (2017). Quantum machine learning. Nature, 549(7671), 195-202. https://doi.org/10.1038/nature23474

[3] Cummings, J. L., Lee, G., & Raza, S. (2019). Alzheimer's disease: The disease of the century. Journal of Alzheimer's Disease, 70(1), 1-16. https://doi.org/10.3233/JAD-190156

[4] Liu, Y., Xu, T., Wang, X., et al. (2020). A survey on machine learning in Alzheimer's disease prediction. Neural Networks, 131, 175-188. https://doi.org/10.1016/j.neunet.2020.06.015

[5] Sims, R., van der Lee, S. J., &Chouraki, V. (2021). The challenge of early diagnosis in neurodegenerative diseases: Lessons from Alzheimer's disease. Current Alzheimer Research, 18(6), 508-517. https://doi.org/10.2174/1567205018666210219121344

[6] Biamonte, J., Bergholm, V., Lamb, S., et al. (2017). Quantum machine learning. Nature, 549(7671), 195-202. https://doi.org/10.1038/nature23474

[7] Cohen, A., Rupp, M., & Lütge, C. (2020). Quantum-inspired algorithms for machine learning and their applications. International Journal of Quantum Chemistry, 120(6), e26272. https://doi.org/10.1002/qua.26272

[8] Havlíček, V., Cincio, L., Koczor, B., et al. (2019). Supervised learning with quantum-enhanced feature spaces. Nature, 567(7747), 209-212. https://doi.org/10.1038/s41586-019-0980-2

[9] Liu, Z., Wang, J., & Lin, X. (2020). Quantum-inspired machine learning algorithms for analyzing medical datasets. Journal of Biomedical Informatics, 104, 103386. https://doi.org/10.1016/j.jbi.2020.103386

[10] Schuld, M., & Killoran, N. (2019). Quantum machine learning in feature spaces. Physical Review X, 9(3), 031044. https://doi.org/10.1103/PhysRevX.9.031044

[11] Corder, E. H., Saunders, A. M., Strittmatter, W. J., et al. (1993). Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. Science, 261(5123), 921–923. https://doi.org/10.1126/science.8346443

[12] Frisoni, G. B., Fox, N. C., Jack, C. R., Scheltens, P., & Thompson, P. M. (2010). The clinical use of structural MRI in Alzheimer disease. Nature Reviews Neurology, 6(2), 67–77. https://doi.org/10.1038/nrneurol.2009.215

[13] Jack, C. R., Bennett, D. A., Blennow, K., et al. (2018). NIA-AA Research Framework: Toward a biological definition of Alzheimer's disease. Alzheimer's & Dementia, 14(4), 535–562. https://doi.org/10.1016/j.jalz.2018.02.018

[14] Pereira, T., George, A., Steiner, G., et al. (2020). Smartphone and wearable sensor-based mHealth applications for diagnosis and treatment of neurodegenerative diseases: A systematic review. Sensors, 20(10), 2733. https://doi.org/10.3390/s20102733

[15] Suk, H. I., Lee, S. W., & Shen, D. (2014). Hierarchical feature representation and multimodal fusion with deep learning for AD/MCI diagnosis. NeuroImage, 101, 569–582. https://doi.org/10.1016/j.neuroimage.2014.06.077

[16] Venugopalan, J., Tong, L., Hassanzadeh, H. R., & Wang, M. D. (2021). Multimodal deep learning models for early detection of Alzheimer's disease stage progression. IEEE Journal of Biomedical and Health Informatics, 25(1), 372–383. https://doi.org/10.1109/JBHI.2020.2996737

[17] Amin, M. H., Andriyash, E., Rolfe, J., Kulchytskyy, B., & Melko, R. (2018). Quantum Boltzmann machine. Physical Review X, 8(2), 021050. https://doi.org/10.1103/PhysRevX.8.021050

[18] Biamonte, J., Wittek, P., Pancotti, N., Rebentrost, P., Wiebe, N., & Lloyd, S. (2017). Quantum machine learning. Nature, 549(7671), 195–202. https://doi.org/10.1038/nature23474

[19] Li, J., Liu, L., Xu, Q., & Deng, D. (2021). Quantum-inspired machine learning for medical data analysis: Opportunities and challenges. Frontiers in Physics, 9, 707533. https://doi.org/10.3389/fphy.2021.707533

[20] Preskill, J. (2018). Quantum computing in the NISQ era and beyond. Quantum, 2, 79. https://doi.org/10.22331/q-2018-08-06-79

[21] Rebentrost, P., Mohseni, M., & Lloyd, S. (2014). Quantum support vector machine for big data classification. Physical Review Letters, 113(13), 130503. https://doi.org/10.1103/PhysRevLett.113.130503

[22] Schuld, M., &Petruccione, F. (2018). Supervised learning with quantum computers. Springer. https://doi.org/10.1007/978-3-319-96424-9

[23] Schuld, M., Sinayskiy, I., &Petruccione, F. (2015). An introduction to quantum machine learning. Contemporary Physics, 56(2), 172–185. https://doi.org/10.1080/00107514.2014.964942

[24] Rieke, N., Hancox, J., Li, W., Milletarì, F., Roth, H. R., Albarqouni, S., Bakas, S., ... & Cardoso, M. J. (2020). The future of digital health with federated learning. npj Digital Medicine, 3(1), 119. https://doi.org/10.1038/s41746-020-00323-1

MERIMAX
INTERNATIONAL PUBLICATIONS

ISBN: 978-81-987436-5-7

978-81-987436-5-7

www.merimaxpub.org