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**International Conference on Management and Business
Practices – 2025
(ICMBP 2025)**

**“Approaches to SDGs through
Sustainable Innovations: Transforming
India to Viksit Bharat”**

Held by,
**DEPARTMENT OF MANAGEMENT AND
BUSINESS ADMINISTRATION
Aliah University**



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(ICMBP 2025)**

on

**‘Approaches to SDGs through Sustainable Innovations:
Transforming India to Viksit Bharat’**

Organised by:

Department of Management and Business Administration

ALIAH UNIVERSITY

Kolkata

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About the University

Aliah University - an autonomous institution under the Department of Minority Affairs and Madrasah Education, Government of West Bengal - started in 2008-09. Its roots can be traced back to the Mohammedan College of Calcutta (1780) that was upgraded to Calcutta Madrasah College and then to Aliah University. Located at New Town, Park Circus and Haji Md Mohsin Square, the University offers graduation, post-graduation and PhD programmes in Engineering, Management, Journalism and Mass Communication, different branches of sciences and humanities as well as Arabic and Islamic Theology. It is hoped that this University will emerge as a unique institution of higher studies and research for all with special emphasis on socially and educationally backward classes belonging to the Minorities.

About the Department

The Department of Management & Business Administration offers five year full-time Integrated Masters in Business Administration course as well as Doctoral programme in Management. Within a short span of time, the Department has made its mark in the field of management education with its students placed in benchmarked industries. By 2024, the Department has already organized six international conferences, ICSSR-sponsored Capacity Building Programme, Faculty Development programmes, State-level Seminars and various other academic and training programmes.

About the Conference

The seventh International Conference on Management & Business Practices (ICMBP- 2025) intends to offer a platform to exchange ideas and to discuss emerging concepts of management and new business practices for the practitioners as well as the academicians. The Conference also aims to stimulate discussion on various contemporary issues affecting business, covering every aspect of economics, technology, behaviour, society and management.



Aliah University
جامعة عليا
আলিয়া বিশ্ববিদ্যালয়

Prof. (Dr.) Rafikul Islam
Vice-Chancellor

No. AU/VC/067/25

Date: 30/06/2025

Message

It's a pleasure to see the selected papers from the 7th International Conference on Management and Business Practices (ICMBP-2025) being published in Pen Acclaims.

The theme—"Approaches to SDGs through Sustainable Innovations: Transforming India to Viksit Bharat"—reflects a timely and much-needed focus on sustainable and inclusive development. I'm proud that our university is encouraging research that addresses real-world challenges through innovation and insight.

My heartfelt thanks to all the contributors, editors, and the organizing team. I hope this special issue inspires continued scholarly engagement and meaningful impact.

Vice Chancellor
Aliah University

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Message from the Chairman

In an era marked by rapid technological advancements and growing environmental concerns, the pursuit of sustainable development has emerged as a defining challenge of our times. The United Nations' 17 Sustainable Development Goals (SDGs) provide a comprehensive framework to address pressing global issues ranging from poverty and inequality to climate action and responsible consumption. For India, the vision of 'Viksit Bharat' (Developed India) presents a transformative opportunity to integrate these goals into its developmental narrative, ensuring that economic progress goes hand-in-hand with ecological balance and social equity. The 7th International Conference on Management and Business Practices (ICMBP), themed '*Approaches to SDGs through Sustainable Innovations: Transforming India to Viksit Bharat*,' underscores the critical role of innovation in achieving these objectives. Sustainable innovations are not limited to technological breakthroughs; they encompass systemic changes in governance, business models, and community engagement. By reimagining traditional practices in sectors like agriculture, energy, healthcare, and infrastructure, we can create solutions that are both scalable and inclusive. For instance, renewable energy technologies can reduce carbon emissions while providing affordable power to underserved regions and precision agriculture can enhance food security while conserving resources. The vision of Viksit Bharat is rooted in the principle of 'leave no one behind.' This requires a deliberate focus on social justice and equity, ensuring that marginalized communities benefit from developmental strides. Sustainable innovations must, therefore, be designed with inclusivity at their core. The private sector, academia, and civil society must collaborate to tailor these innovations to local contexts, addressing disparities in access and opportunity. Despite the promise of sustainable innovations, several challenges persist. Funding gaps, regulatory hurdles, and resistance to change often hinder their adoption. To overcome these barriers, policymakers must create enabling environments through incentives for green technologies, robust regulatory frameworks, and public awareness campaigns. As we stand at the crossroads of opportunity and responsibility, the journey toward Viksit Bharat demands collective action. The SDGs are not just global targets but a shared commitment to a better future. By harnessing the power of sustainable innovations, India can emerge as a global leader in equitable and environmentally conscious development.

Arup Kumar Baksi
Chairman, 7th ICMBP, 2025

Message from the Editor's Desk

It is a great privilege for me to present the proceedings of the **International Conference on Management and Business Practices, 2025** held by **Aliah University** to all authors and delegates. I hope that it will be useful, exciting and inspiring. The collection of proceedings contains the papers submitted to the International Conference for 'Approaches to SDGs through Sustainable Innovations: Transforming India to Viksit Bharat'. There was a significant international representation, with participants coming from different states of India. The Conference aims to provide a platform for discussing the issues, challenges, opportunities and findings of research on sustainable innovations helpful in transforming India. Hopefully, it will also spark innovative ideas, foster research relations or partnership between the various institutions. Viksit Bharat and enhancement in sustainability has become an increasingly important issue. One of the most important contributions resides in what and how we learn through the improvement of educational processes. Our International Conference seeks to provide some answers and explore the processes, actions, challenges and outcomes of learning, teaching and human development. Our goal is to offer a worldwide connection between teachers, students, researchers and lecturers, from a wide range of academic fields, interested in exploring and giving their contribution in sustainability issues.

I would like to extend my gratitude to Aliah University, to provide Pen Acclaims with this outstanding opportunity and to the convenors of the conference for their incessant support throughout the process.

On a final note, I would like to thank all the Authors, who have extended their unwavering co-operation in making of this Issue. On behalf of the Editorial Board of Pen Acclaims, I salute each and every one of you for your extensive research and dissemination of knowledge. I assure you; we shall keep striving to achieve excellence and focus all our efforts to maintain high academic excellence standards.

I look forward to a long walking journey with you.

Happy writing!

Dr. Pooja Roy Dasgupta
Chairperson/Editor-in-Chief
Pen Acclaims

Index

S. No.	Title	Page No.
1	Women at the Heart of Sustainable Development: Building a Viksit Bharat Guriya Kumari Research Fellow, Department of English, Lalit Narayan Mithila University, Darbhanga Dr. Tanima Kumari Assistant Professor, Department of English, Lalit Narayan Mithila University, Darbhanga	1
2	Digital Innovations in Sustainable Tourism: Insights from Generation Z and Millennials Manali Chowdhury Research Scholar, Dept. of Management and Business Administration, Aliah University, Kolkata Subhashree Sanyal Assistant Professor, Dept. of Social Work, Visva-Bharati Arup Kumar Baksi Professor, Dept. of Management and Business Administration, Aliah University, Kolkata Chairman, ICMBP	7
3	A systematic review: The role of responsible tourism in transforming India in the journey towards the goals of Viksit Bharat Suchismita Maity Research Scholar, IISWBM, Kolkata	22
4	Comparative Analysis of Indian Commercial Banks: A case study of HDFC Bank and State Bank of India using Common Size Statement Yasmin Parveen Student, Department of Management & Business Administration, Aliah University, Kolkata, India. Dr. (CA)Ayan Majumdar Assistant Professor, Department of Management & Business Administration, Aliah University, Kolkata, India.	36
5	Sustainable Innovative Practice to Enhance the Properties of Pavement Quality Concrete Asif Ali Sahaji Student, Department of Civil Engineering, Aliah University, Kolkata, India. Abhijit Mondal Assistant Professor, Department of Civil Engineering, Aliah University, Kolkata, India. Nilufa Yasmin Student, Department of Civil Engineering, Aliah University, Kolkata, India.	51
6	Self-Help Group Movement a Pathway to Social Justice Arpan Mukherjee Assistant Professor & HOD, Dept. of Business Administration Bengal Institute of Technology & Management, Santiniketan, West Bengal	69

	Dr. Manik Chatterjee Professor, Dept. of Business Administration, Bengal Institute of Technology & Management, Santiniketan, West Bengal	
7	Managing Environmental Footprint in Highway Construction Abhijit Mondal Assistant Professor, Department of Civil Engineering, Aliah University Saptarsi Batabyal M.Tech Student, Department of Civil Engineering, Aliah University	77
8	Interdisciplinary Approaches to Energy Management: Transitioning from Non-renewable to Renewable Energy for Sustainable Business Practices Anustup Chatterjee Assistant Professor, Department of Mechanical Engineering, Techno International New Town, New Town, Kolkata. Samrat Banerjee Assistant Professor, Department of AEIE, Techno International New Town, New Town, Kolkata. Abhijit Kumar Bhagat Assistant Professor, Department of AEIE, Techno International New Town, New Town, Kolkata. Prasenjit Mondal Student, Dept. of Mechanical Engineering, Techno International New Town, New Town, Kolkata Faisal Hussain Student, Dept. of Mechanical Engineering, Techno International New Town, New Town, Kolkata	89
9	Exploring Sustainable Solutions for the Rural Remote Villages of the Sundarban Delta: A Literature Review Based Study Arijit Banerjee Assistant Professor, Department of MBA, Swami Vivekananda Institute of Science and Technology, Kolkata. Averi Banerjee Assistant Professor, Department of Basic Science & Humanities, Techno International New Town, Kolkata. Anindita Ray Assistant Professor, Department of Basic Science and Humanities, Techno International New Town, New Town, Kolkata. Indranil Mukherjee Associate Professor, Dept. of Civil Engineering, Aliah University, Kolkata Kakali Ghosh Associate Professor, Department of Basic Science and Humanities, Techno International New Town, New Town, Kolkata. Dr. Moumita Dey Associate Professor, Dept. of MBA, IMS Business School	97
10	Trackless Autonomous Trams: A Catalyst for Sustainable Innovation and Technology Prasun Majumder Techno International New Town, New Town, Kolkata.	107

11	Impact of Mergers and Acquisitions on the Economic Value Added in Chemical Industry: Case Study Based on the Pidilite Chemical Company and Himadri Speciality Chemical Ltd Biswadeep Dutta State Aided College Teacher I, Scottish Church College, Department of Commerce Prof. Somnath Chatterjee Aliah University, Department of Management and Business Administration	130
12	Green Bonds and the Path to Sustainable Finance: Innovations and Impact Dr. Manta Dey Associate Professor, Amity University, Kolkata Navtej Tiwari Student, Amity University, Kolkata Rupsha Dey Research Associate, CAFRAL, Reserve Bank of India	144
13	SWOT Analysis: The manner in which Female-Centered Advertisement Influences Female Audiences in a Psychological Sense Pooja Ghosh Assistant Professor, Dr. B. C. Roy Academy of Professional Courses, Durgapur (MAKAUT) Dr. Sayantani Ghosh Assistant Professor, Dr. B. C. Roy Academy of Professional Courses, Durgapur (MAKAUT)	158
14	A Study on Work-Life Balance to Determine How it Influences the Wellness of Employees in the Information Technology Sector Saubhik Chakraborty Assistant Professor, Dr. B. C. Roy Academy of Professional Courses, Durgapur (MAKAUT) Dr. Sayantani Ghosh Assistant Professor, Dr. B. C. Roy Academy of Professional Courses, Durgapur (MAKAUT)	168
15	Achieving sustainability in energy and environment-Key step to reach target of Vikshit Bharat Somnath Chakraborty Assistant Professor, Department of Business Administration, Narula Institute of Technology	176
16	Social Media Influence on the Buying Behaviour among Gen Z consumers: A Study Joy Sarkar Student, Department of Management and Business Administration, Aliah University, New Town, Kolkata, West Bengal Ayesha Uddin Student, Department of Management and Business Administration, Aliah University, New Town, Kolkata, West Bengal Dr. Somnath Chatterjee Assistant Professor, Department of Management and Business Administration, Aliah University, New Town, Kolkata, West Bengal	186
17	The Role of Women Empowerment in Viksit Bharat's Economic Ambition in West Bengal	194

	Dr. Ajanta Sarkar Guest Faculty, Department of Social Work, Visva-Bharati Tirtha Ghosh Research Scholar, Department of Social Work, Visva-Bharati	
18	Climatic disasters and Environmental Migration in the Sundarbans: Challenges, Responses and Future Pathways Tirtha Ghosh Research Scholar, Department of Social Work, Visva-Bharati University Dr. Ajanta Sarkar Guest Faculty, Department of Social Work, Visva-Bharati University	203
19	Defining the factors and Scale formulation for implementing effective User Experience in travel websites as sustainable innovation in Digital Marketing Subhrosil Dey Research Scholar, Dept. of Management and Business Administration, Aliah University Arup Kumar Baksi Professor, Dept. of Management and Business Administration, Aliah University	213
20	The Role of Smart and Sustainable Packaging in Shaping Consumer Purchase Intentions: A Structural Equation Modelling Approach Ankita Ghosh Research Scholar, University of Kalyani	235
21	Impact of Spiritual Ethics on Employees' Creativity Shahbaz Afzal Junior superintendent & Research Scholar, Aliah University, Kolkata, West Bengal Rasheed K Assistant Professor, Aliah University, Kolkata	252
22	The Influence of Corporate Governance on the Performance of Family and Non-Family Firms: An Indian Perspective Divyani Datta Assistant Professor, Post Graduate & Research Department of Commerce, St. Xavier's College (Autonomous), Kolkata.	257
23	The Evolving Digital Marketing Landscape in India: Growth, Trends, and Strategic Imperatives Dr. Mustak Ahamed Professor & HOD, Swami Vivekananda Institute of Science and Technology, Kolkata, West Bengal. Dr. Amitabha Gupta Director, Executive Development Programs, Parul University Md Ataur Rahaman Safi Laskar Assistant Professor, Dept. of Electronics and Communication Engineering, Swami Vivekananda Institute of Science and Technology, Kolkata, West Bengal	273
24	Adoption wise Variations in Technical Efficiency of Pond Aquaculture in West Bengal Jaydev Misra Assistant Professor, Department of Economics, Syamaprasad College, Kolkata	287
25	Role of Nurse in the hospital in Quality Patient's care management	300

	Dr. Usha Mallick Associate Professor, Dept. of Nursing, Aliah University	
26	Industrial Management Growth in India Tanmoy Ghosh Assistant professor, Swami Vivekananda Institute of Science and Technology, MBA Department	306
27	A Comparison Between the SERVQUAL and HEALTHQUAL Models for Evaluating Patient Satisfaction regarding Services received from Public and Private Healthcare Institutions in Malda Under the Government Health Scheme Dr. Md Ismail Shaikh Research Scholar, Department of Management & Business Administration, Aliah University, Kolkata. Dr. Asima Sarkar Assistant Professor, Department of Management & Business Administration, Aliah University, Kolkata.	316
28	Transforming Financial Education through Conversational AI: A Study on ChatGPT Abu Sayeed Mondal MBA Student, Dept. of Management and Business Administration, Aliah University, Kolkata Dr. Gholam Syedain Khan Assistant Professor, Dept. of Management and Business Administration, Aliah University, Kolkata	328
29	Fostering Sustainable Development of Higher Education Institutions Through Faculty Development Programmes Kahkashan Anwar Ph.D. Scholar, Department of Management & Business Administration, Aliah University Dr. Parveen Ahmed Alam Professor, Department of Management & Business Administration, Aliah University Dr. Rasheed K. Assistant Professor, Department of Management & Business Administration, Aliah University	343

WOMEN AT THE HEART OF SUSTAINABLE DEVELOPMENT: BUILDING A VIKSIT BHARAT

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Abstract

In the journey towards Viksit Bharat (Developed India), it is imperative to recognize women's empowerment and active engagement as vital components for fostering sustainable and inclusive growth. Women bring invaluable perspectives, resilience, and innovative solutions essential in addressing challenges across various sectors, including education, healthcare, environmental sustainability, and economic development. This paper seeks to illuminate the significant contributions of women in advancing India's sustainable development goals, focusing on their roles in building resilient communities, promoting environmental stewardship, and enhancing local economies through the celebration of local art and culture. Women are pivotal in driving the three R's—reduce, reuse, and recycle—making them essential actors in the realm of sustainable development. By examining key areas such as art and painting, where women's engagement has led to transformative results, this paper aims to underscore the importance of women's entrepreneurship in the broader framework of Viksit Bharat. Madhubani Painting, a traditional art form of Bihar, India has historically been a domain of women. This paper in the context of Madhubani Painting aims to analyse how women entrepreneurship in this sector has provided a sustainable livelihood for women increasing their financial independence and improved their well-being. This paper through the reference of several women painters who have empowered themselves as well as other women through this art form also aims to emphasise on the socio economic benefits for women, the preservation of cultural heritage, and the overall economic growth that this sector has produced.

Keywords: *Empowerment, environmental sustainability, inclusive growth, Viksit Bharat.*

Introduction

“The progress of humanity is incomplete without the empowerment of women.”-

PM Narendra Modi

India is a conglomeration of ethnic traditions and variegated cultures and has an extensive repository of handicrafts representing its vibrant culture, multi-faceted artistic expressions, and diverse history. Handicraft plays an instrumental role in the country's economy and is a source of employment for about 7.3 million people as mentioned in the records of the Ministry of Textiles, Government of India. India, with its rich cultural tapestry, boasts a diverse array of traditional art forms. Among these, the Madhubani Painting, originating from the Mithila region of Bihar, stands as a testament to the artistic prowess of Indian women. Historically, this intricate form has been a significant contributor to the socio-economic fabric of rural

communities, primarily practiced by women within their homes. However, the contemporary context demands a shift towards economic livelihoods and economic empowerment, particularly for women. This paper explores the potential of women entrepreneurship in Madhubani painting as a crucial pathway towards achieving the vision of “Viksit Bharat”- a developed India.

Art has had a powerful bearing in sustaining the country’s variegated cultural traditions and the women have used it as a channel to articulate their artistic perceptions and cultural sensibilities. The art does not remain limited to one generation only but is passed down through generations with women learning the techniques from their mothers and grandmothers. In this way, women act as preservers of cultural identity and tradition of the society emphasising the concept of sustainability. Women all over the world also utilise their skills and expertise in the realm of arts and crafts to gain economic independence and contribute to their national economies. In India arts like Mithila Painting, Warli, Bamboo designing, etc. have paved the way for women to become self-sufficient as well as become entrepreneurs and also in the context of art, *artepreneurs*.

Mithila region of India is referred to by several poets as “Pag Pag Pokhar Machh Makhan/ Saras Bol Muski Mukh Pehchan/E Thhek Mithilak Pehchan”. According to the lines, Mithila is famous for ponds, the sweet language Maithili, fisheries, and *Makhana*/lotus seed. However, there is one more thing for which the land of Janaknandini is famous and that is Madhubani Painting. Madhubani Painting which has a golden history and dates back to more than 2500 years ago finds mention in the records of Ramayana. It is said that King Janak wanted to record the moment of Janaknandini Sita and Rama’s wedding. So he ordered to record the event in the painting and this painting later came to be known as Mithila Painting also popularly known as Madhubani Painting. In the past days, these paintings depicted mythological figures and incidents such as Rama’s wedding, Shiva Parvati bonding, Krishna Rasleela, etc. However, today this painting has also been the medium for depicting social issues prevalent in society. The painting is now not just limited to homes but it has reached the world stage. But in the past days, it was generally used by women to decorate their homes. As Mahasundari Devi says—

I have seen years of struggle when we painted on cow-dung-smearred walls and hours of our work washed by the rain. But we didn’t think there was any option. Then came paper. It changed our lives. What can one ask for? (*Mithila Painting: The Evolution of an Art Form*, 35)

Madhubani Painting once used to be a medium for women to decorate the walls of their homes. Women used to paint the walls with cow dung, and natural colours extracted from leaves, flowers, etc. However, this decoration could not remain permanent because of the downpour of rain used to wash all the figures. But after the arrival of paper in the area there began a revolution which not only changed the scenario of the lives of these women but also for the coming generations. It provided women practicing Madhubani Painting with the opportunity to carve out a niche for themselves in the world of art at the national as well as the international level with several accolades. The intricate geometric patterns, vibrant colours, and symbolic motifs of Madhubani reflect the rich cultural heritage of the region. The women artists of the region have enriched the art and contributed to creating new opportunities for women by

training and building the women of the community as confident and self-sufficient. In this paper with the example of several Madhubani painters, it will be analysed how women entrepreneurship in the area is providing employment and contributing to the vision of “Viksit Bharat”.

Women Entrepreneurship and Madhubani Painting

Women entrepreneurship plays a vital role in economic growth and social development. When women start businesses, they create jobs for themselves and others, contribute to innovation and competitiveness, and often address unmet needs within their communities. Women entrepreneurs also bring unique perspectives and skills. In India, women dominate entrepreneurship in the field of cultural artefacts like art, culture, clothing, etc. The women of the Mithila community nowadays are becoming financially independent through Madhubani Paintings. But Madhubani painting was once confined to the walls of homes and temples, remaining largely unrecognized beyond the local community. It was due to the efforts of a British Indian Civil Service officer, W. G. Archer who was fascinated by the art form that he wrote an article on Madhubani Paintings in 1949 which was published in the journal titled *Marg*. The photographs taken by Archer in 1940 are the oldest available Madhubani paintings for earlier the paintings adorned walls and decoration of the rooms. The Handmade paper which these days artists use was not available at that time. However, it was only in the 1960s that the art form gained national and international attention, thanks to the efforts of art enthusiasts and government initiatives. This recognition opened up new avenues for women artists, who began to explore the commercial potential of their craft and were encouraged by the All India Handicrafts Board to paint on paper rather than on floors and walls, these women carved a space for themselves in the cultural history of Mithila.

Role of Jitwarpur and Ranti: Emergence of Madhubani Painting at the Global Stage

When it comes to Madhubani Painting and women's economic independence the women of Jitwarpur and Ranti must be mentioned. The emergence of Madhubani Painting from local to global could not have happened without the notable women figures of Jitwarpur. Jitwarpur is the hub of Madhubani Painting and is also the abode of several Padamshree awardees who were honoured for their contribution to globalising Madhubani Arts. To name a few Ganga Devi, Bauaa Devi, Dulari Devi, etc. Bauaa Devi in an interview recalls his mother and how his mother was interested in crafts works and had inherited the art from her mother and grandmother. After her marriage when she came to Jitwarpur, she used to draw *Ahpan* at several occasions. Once Bhaskar Kulkarni a researcher from Delhi came to the area he was fascinated by the art and craft of the region. He asked for some designs and even paid her for the piece. He began to give orders and handmade papers for the painting and took them to the Delhi ministerial office. Later he established a department in Patna for the access to paintings. Now the women who knew the art began to earn money for their piece opening the doors of empowerment and also exploring the area of research in the field. The women who once were closed within their homes were called to the world stage and showed their expertise at Berkeley Centre, Japan Denmark, etc. The honour, popularity, and financial dependence that women of Jitwarpur and Ranti got also encouraged other women irrespective of their caste, category, etc. To encourage women and empower them Mithila Painting School at Ranti and Mithila

Chitralakha Sansthan at Saurath were established. Padamshree awardees like Pushpa Devi and others help students to learn art and get a diploma or degree in the sector.

Pushpa Kumari, Padamshree awardee in an interview speaks about how she had earned 1.50 rupees from her paintings and now she has even got 1.25 lakh for her painting. She also says that nowadays paintings are being sold per feet at 5000 to 8000 rupees reflecting how the area has served as a means for the livelihood of the community. This has further encouraged the entrepreneurship in the field. Nowadays in the region of Mithila, Madhubani Paintings and women entrepreneurs are complementary to each other and can be mounted up for the economy of Mithila by making some improvements. Women traditionally have been playing a crucial role in the family as well as in the field of entrepreneurial areas also, but their contribution has not fully acknowledged. These women are still to make tremendous progress in the manufacture of Madhubani Paintings. In the present age of globalisation where each and every economy of the world is giving emphasis on women empowerment which is not possible by creating employment opportunities for them but by motivating them to create their own enterprises. Such an example of motivation can be seen in the government schemes which encourage women to participate in the training programmes and later they even help them financially.

Case Study of Asha Jha: Madhubani Paints Enterprise Darbhanga

One such encouragement can be seen in the case of national awardee Asha Jha. Asha Jha with her two children was left by her in-laws and further, her father to save her from rumors of the society sent to Darbhanga. In her earlier days, she was struggling hard to earn her bread. She even tried to serve as a house help but her daughters told her to not do such jobs. She had some creativity and further encouraged by an officer, she and her daughter joined training classes for Madhubani Paintings which opened the door to their financial independence. After that day, Asha Jha emerged as an entrepreneur, helping other women uplift themselves. Today 150 women are working under her enterprise of Mithila Paintings near the Petrol pump, Darbhanga. It also signifies that she is feeding one hundred and fifty families through the business of Madhubani Paintings. As one Harijan woman states “Children from our community had never been to school before, but now due to some money in hand and awareness due to art tourism, our children are getting educated”.

Case Study of Mithilasamhita

Madhubani Painting is not just an art form but the expression of these artists' dreams, desires, stories, expectations, etc. However, during the last decades there has been a forgery in painting as artists being encouraged by companies started to use machines to paint quickly instead of the freehand drawing for which it was widely known. To avoid this Ishitashri started Mithilasamhita, which means pride of Mithila, and tried to build a community of women artists for the development and popularity of the art form. Mithilasamhita also aimed to aware women of the emerging popularity of the work and give the artist their due respect by signing the artist's name on the work and creating a women *artepreneur* community. The community of women of Mithilasamhita aimed to sell original paintings and a profit was invested for the sustainability of the business model. So, at a commercial platform, Mithilasamhita helped women artists achieve the objective of women empowerment and rural livelihood generation

by selling high-quality Madhubani art and also helped them gain recognition as artists. It also collaborated with other artists to meet market demands by carving the art form on scarves, shawls, sarees, etc. The art gallery of Mithilasamhita in Bangalore is suggested as one of the must-visit places of the area. Mithilasamhita made sure that their visitors were told about the stories related to the scenes depicted in the painting. With the offline domain, Mithilasamhita also has an online e-commerce store which was started in May 2012. To encourage people Mithilasamhita also organises exhibitions of Madhubani Paintings.

Itihashri, the CEO of Mithila Samita gave a statement in an interview about her problems in the beginning days. She says “Earlier, we had only one online store for all customers. International customers find our products too Indian, and Indian customers find our products too expensive”. However, after four years of hard work, Itihashri had carved her own niche. Mithilasamita was invited to give lectures and presentations by many prestigious institutes such as Google, Infosys, Acumen funds, Headstart Foundation, Bangalore, and the government of Bihar. Itiashri's selection in prestigious programs such as India fellowship programs such as India fellowship program at Acumen Funds, and the ISB 10,000 Women Entrepreneurs program helped her sharpen her entrepreneurial skills. In 2014, Mithilasamhita became a member of the “Alliance for Artisan Enterprise”, a USA Government Initiative hosted by Aspen Institute, USA.

Limitations

Madhubani Painting emerged as a weapon for the empowerment of the women of Mithila. These women while painting also shared their ideas, experiences, and desires creating a community bond. Many of these women have won accolades and honours but a majority of them are there who have not gotten their due share of awards and recognition and even many are there who have not still achieved the status of an artist. Many pieces of craftwork have been limited to the decoration of table covers and showing the talent of daughters in the prospect of finding a suitable groom. Many of the artists are shunned behind the doors for their in-laws and husbands are self-sufficient and do not allow the exhibition of the skill of their daughter-in-law in the market. Also, the GI tag, of India which Madhubani Painting acquired in 2007 and becoming the first product from Bihar to be registered under the tag, it becomes a herculean task for women to prevent themselves from imitating. Also, the business overseas is not affordable for everyone due to the heavy imposition of tax. Even, in India people are ready to buy a painting from some renowned artist for 2 lakhs but when the same painting is sold by some local artist at 2,000 rupees, they hesitate to buy it. Even with the emergence of the trend of vocal for local, these artists are facing challenges in the area of their expertise.

Government and Non-Government Initiatives to Empower Women

Prime Minister Modi says, “We cannot achieve success if 50 percent of our population being women are locked at home. The government of India focuses on women-led development instead of women’s development. When we talk of Madhubani Paintings, it is generally an unorganised sector. To provide security and welfare to these artists Unorganised Workers Social Security Act, of 2008 has been the most inclusive act in this sector. PM schemes like Mudra Yojna, Annapurna Scheme, Stree Shakti, Standup India Scheme, Women Enterprise Development, Mahila Udyam Nidhi Scheme, Udyogini Scheme, etc. are helpful in the

development of women entrepreneurship in the sector. SEWA Model by Gauri Mishra one of the non-government initiatives helped in the upliftment of women. Sewa Mithila one of the NGOs of SEWA and Bihar Mahila Udyog Sangha needs to be mentioned. Bihar Mahila Udyog Sangha helps women with the opportunities to exhibit and market their products through Udyog Melas organised twice a year. This is very important for women entrepreneurs, being mostly based in their homes, and face a lot of problems in marketing their products.

Conclusion

Every woman embodies the spirit of entrepreneurship through her ability to manage, organize, and take on the responsibilities of running a household. By preserving traditions and promoting artistic innovation, women have significantly enriched the cultural landscape of India. Their contributions to art and culture play a vital role in the quest for a “Viksit Bharat,” a nation that honors its heritage while embracing creativity. This study has focused on Madhubani Painting, highlighting its role in fostering women’s entrepreneurship within the sector, thereby enhancing their economic stability and preserving the cultural identity of Mithila. The vision of a Viksit Bharat can be realized through the empowerment of women, and Madhubani Painting serves as a valuable medium for the women of this region to elevate their status and contribute meaningfully to society.

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DIGITAL INNOVATIONS IN SUSTAINABLE TOURISM: INSIGHTS FROM GENERATION Z AND MILLENNIALS

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Abstract

This research aims at identifying how sustainable tourism, technological innovation, Generation Z, and Millennial tourists' behaviour can offer new paradigms to the tourism sector. Based on systematic literature review and bibliometric analysis, this study reveals the role of emerging technologies such as virtual reality, augmented reality, AI technologies, and smart tourism systems in promoting sustainability and offering differentiated travel experiences. The study explores the affective and behavioural commitment of younger generations and their connection with digital media regarding the sustainability tourism models. It underscores how the use of new technologies, including AI-based personalization, enhance the customer experience and are consistent with the sustainable values of these key consumer segments. In addition, the research shows how social media and virtual environments contribute to the construction of relevant tourist experiences and reshape the sector's paradigm of destination management. These results offer useful guidelines for policymakers and other industry players to develop long-term tourism paradigms that will satisfy the environmental, social, and economic demands of Gen Z and Millennials.

Keywords: *Social Media; Virtual Platforms; Digital Engagement; Destination Management; Eco-tourism; Metaverse; Co-creation.*

1. Introduction

The tourism industry is undergoing a paradigm shift, due to the integration of digital technology and the changing consumer behaviour of Generation Z and Millennials (Buhalis & Karatay, 2022). Such consumer groups expect the experiences to be both innovative and customized as well as environmentally and socially responsible (Allam et al., 2022). As sustainability is now one of the most important global concerns, the tourism industry needs to respond to the environmental, social, and economic demands of these powerful generations. This paper aims at discussing how the current technologies like augmented and virtual reality (AR/VR), artificial intelligence (AI) and predictive analytics are revolutionizing the tourism industry and providing solutions to increase customer satisfaction while adopting sustainable practices (Fatema et al., 2024). However, there are still a number of barriers to implementing these technologies effectively into the management of destinations and tourism planning. Challenges

including infrastructure constraints, high implementation costs, as well as cultural factors should be dealt with, to fully harness such innovations (Stornelli et al., 2021). This research aims at exploring sustainable tourism, digital innovation, and generational preferences for policy makers, industry players and local communities.

1.1 Research Questions

The study addresses the following research questions:

- **RQ1:** Do social media and digital co-creation platforms affect Generation Z and Millennials' environmentally responsible action and participation in sustainable tourism?
- **RQ2:** Can AR/VR technologies be used to support cultural heritage and pre-visit experience of the tourists?
- **RQ3:** Does predictive analytics play in optimizing sustainable destination management and aligning with the preferences of tech-savvy generations?
- **RQ4:** How digital co-creation platforms empower local communities while fostering authentic and sustainable tourist experiences?

2. Theoretical Background

2.1 Social Media, Eco-Conscious Tourism, Co-Creation and Generational Preference

Social networks have become essential instruments for promoting sustainable tourism, as these help destinations create stories that would appeal to the sustainable tourists. Studying like Thailand as a World Top Tourism Destination discusses how the social tools like Instagram and YouTube play a central role in the promotion of sustainable practices by highlighting cultural and historical sites, nature tourism and sustainable tourism activities (Zuo et al., 2023). Social media not only captures audience's affective response, but also fosters co-creation of tourism experiences through shared narratives between tourists and the host communities (Huang et al., 2024). These platforms enable destinations to support the brand image with sustainability and encourage sustainability through influencer marketing, user-generated content, and engagement. Such a co-creation process helps to establish ownership of tourists and local stakeholders for the protection of ecosystems and cultural heritage (Singh & Kaunert, 2024). Generation Z and Millennials, who are native users of the Internet, these platforms provide a genuine environment for staking out, participation, and sharing. They appreciate experiential travel which they support due to their environmental and social responsibility policies. Their choice of customised, socially responsible experiences has forced destinations to incorporate new narrative approaches that align with these generational values (Seyfi et al., 2024).

2.2 AR/VR, Cultural Heritage Preservation, Pre-Visit Engagement and Generational Preference

New technologies such as Augmented Reality (AR), Virtual Reality (VR) and the metaverse are changing how travellers interact with travel destinations. These tools facilitate pre-trip engagements, where travellers are able to virtually visit cultural attractions, engage with

reconstructed historical representations and appreciate the ecological implications of cultural tourism (Jia et al., 2023). The Impact of Green Management on Sustainable Development Goals, and AR/VR technologies are described to create emotions and engage people to be informed, which can help to minimize the physical pressure on ecosystems that are sensitive (Allam et al., 2022). AR/VR in the form of edutainment improves promoting environmental sustainability whereby people make environmentally friendly decisions (Paatlan & Ranga, 2024). To the younger generation, AR/VR is relevant because it encompasses what they love most; technology enhanced learning and entertainment. These tools meet their demand for discovery and identity formation, providing value for travel destinations and minimizing their environmental footprint (Fan et al., 2022).

2.3 Digital Co-Creation Platforms and Empowering Local Communities

Digital co-creation platforms act as a connection between the tourists and the locals so that everyone is inclusive in the tourism process. These platforms that are combined with AR/VR and social networks allow travellers to become the main directors of their experiences, as well as contribute to the development of the local economy (Dada et al., 2024). For instance, storytelling and participating activities help to create awareness and involvement of tourists to the cultural and natural resources. This approach also decentralises the management of heritage and devolves it to the local people, who in return become the stewards of the local tourism resources for the sustainable future (Svitlichna et al., 2024). Generation Z and Millennials are particularly interested in co-creation activities that will enable them to make a positive difference in local communities. They want real experiences, and prefer locations that enable them to interact with locals in ways that are meaningful and mutually beneficial and that support environmental purposes (Calderón-Fajardo et al., 2024).

2.4 Predictive Analytics and Sustainable Destination Management

Predictive analytics, AI, and digital twin technologies in the form of predictive analytics are set to become a revolutionary solution to sustainable destination management. It demonstrates how real-time data, and AI-derived insights improve resource management, risk avoidance, and overcrowding, in order to achieve sustainability goals (Bibri et al., 2024). However, the use of predictive analytics in complex and disintegrated systems of the tourism sector is still a problem due to the need for infrastructure and cooperation between sectors. Thus, overcoming these challenges, predictive analytics will allow destination managers to achieve economic development and environmental conservation, corresponding to the principles of the triple bottom line in sustainable development (Liu & Li, 2024). To the Generation Z and Millennials, the use of predictive analytics makes it possible to customise travel to their tastes and patterns. This customization helps them to get the travel that they need with focusing on their sustainability values, providing the convenient, culturally rich and environmentally friendly travels (Das et al., 2024).

3. Methodology

This research utilizes bibliometrics to analyze the combined interest of AR, VR, sustainable tourism, and generational concerns with emphasis on the Millennial and Gen Z. The

bibliometric analysis makes use of graphical displays to explain relationships between bibliometric variables in the field. Thus, using a systematic approach the relevant articles were retrieved from Dimensions.ai, the research provides a comprehensive understanding of emerging trends and developing themes.

3.1 Data Collection

The Dimensions.ai database was chosen because it covers academic publication and citation records to provide access to research from around the world. The last search was done on January 4, 2025, and included articles from the year 2020 to 2025. The search query utilized Boolean operators and included the terms: "Augmented Reality" OR "Virtual Reality" AND "Sustainable Tourism" OR "Ecotourism" OR "Green Tourism" AND "Millennials" OR "Generation Z" OR "Young Travelers" AND "Social Media." This search focused on the title, abstract and indexing terms so as to capture articles that addressed the research objectives. The articles under study were selected from the English language journals only. Our first search provided 3,427 sources. To further filter the dataset, only articles from peer reviewed journals were considered and as such the dataset was brought down to 701. Higher refinement was attained by filtering out the articles from the journals which are enlisted in the UGC Journal list group II, which gave 553 articles. Finally, publications classified under "Commerce, Management, Tourism, and Services" were selected, yielding a final dataset of 467 articles.

3.2 Data Analysis

The curated dataset was converted into a plain text format for bibliometric analysis using Biblioshiny. Co-citation analysis was employed to quantify the frequency of joint citations between articles, identifying influential studies and methodologies in the field. Highly cited papers often represent significant theoretical or methodological contributions. Co-word analysis was also performed to examine keyword co-occurrence patterns, identifying commonly linked concepts and thematic trends. Frequent co-occurrence of keywords such as "AR/VR," "sustainable tourism," and "social media" highlighted the interconnectedness of these domains.

Table 1: Article Inclusion and Exclusion Criteria

Selection Criteria	Exclude	Include
Database: Dimensions.ai Date of Search: 04-01-2025 Period of Publications: 2020–2025		
Search Term: (("Augmented Reality" OR "Virtual Reality") AND ("Sustainable Tourism" OR "Ecotourism" OR "Green Tourism") AND ("Millennials" OR "Generation Z" OR "Young Travelers")) AND "Social Media"	-	3,427
Publication Type: Article	2,726	701
Journal List: "UGC Journal List Group II"	148	553
Field of Research: Commerce, Management, Tourism and Services	86	467

4. Results

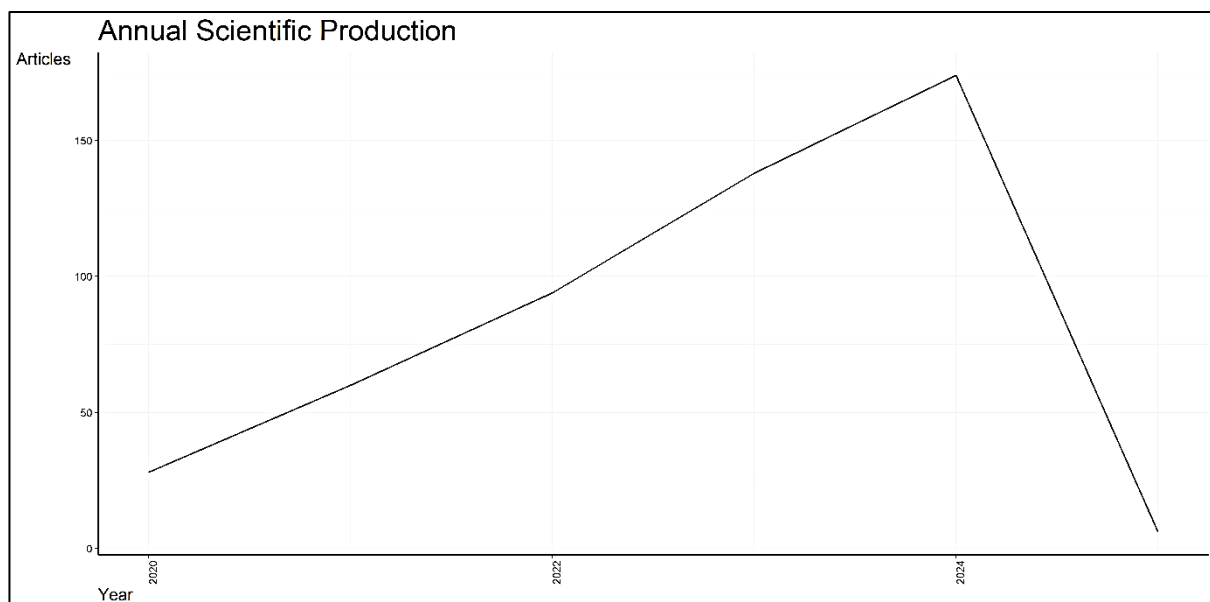
4.1 Annual Scientific Production

The annual scientific production of articles from 2020 to 2025 (Table 2; Figure 1), indicates a steadily growing interest in the convergence of AR/VR technologies, sustainable tourism, and generational preferences. A total of 174 articles were published in 2024, marking the peak of scholarly output, with the research trajectory reflecting the increasing adoption of immersive technologies in tourism management.

Table 2: Annual Scientific Production of Articles

Year	Articles
2020	28
2021	60
2022	94
2023	138
2024	174
2025	6

Figure 1: Annual Scientific Production (2020- 2025)



4.2 Contribution of Authors, Affiliations, and Countries to Research on Sustainable Tourism and Digital Innovations

Prominent authors contributing significantly to this domain include Han H, who authored 12 articles and achieved 224 total citations, focusing on eco-tourism adoption among younger generations. Zhu C and Buhalis D also emerge as influential contributors, examining AR/VR's impact on tourism and destination management. Notable affiliations include the University of Macau, Bournemouth University, and Sejong University, highlighting the geographic diversity of research contributions. China leads in terms of scholarly output, followed by the USA, the UK, and South Korea, emphasizing the global interest in integrating immersive technologies and sustainable practices in tourism.

Table 3: Most Influential Authors, Affiliations, and the Countries over the time

Authors	TP	Articles Fractionalized	TC	Organization	Country
Han H	12	2.94	224	Sejong University	South Korea
Zhu C	9	1.87	133	University of Macau	China
Buhalis D	8	1.89	514	Bournemouth University	United Kingdom
Fong LHN	7	1.42	97	University of Macau	China
Hall CM	7	1.42	59	University of Canterbury; University of Oulu; Linnaeus University; Lund University; Kyung Hee University	New Zealand, Finland, Sweden, and South Korea
Koupaei SN	5	0.97	35	University of Canterbury	New Zealand
Law R	5	1.23	94	University of Macau	China
Wang Y	5	1.34	57	University of Central Florida	United States
Zhang J	5	1.53	32	University of Technology	Malaysia
Cham T	4	1.07	36	UCSI University	Malaysia

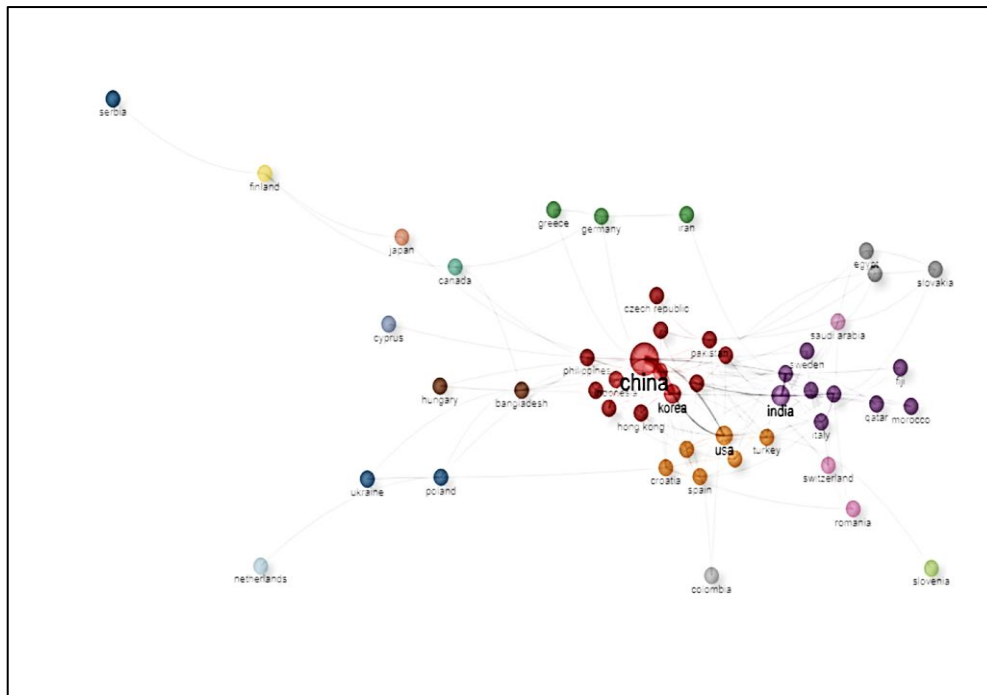


Figure 2: Countries with Greatest Impact

4.3 The Most Influential Journals in Sustainable Tourism Research

Research contributions in this field are published in highly regarded journals. *Sustainability* leads with 54 articles, followed by “Current Issues in Tourism” and “International Journal of Contemporary Hospitality Management”. These journals provide critical insights into the interplay of technology, sustainability, and tourism behaviour (Table 3).

Table 4: Most Influential Journals

Sources	Publisher	Articles
Sustainability	MDPI	54
Current Issues in Tourism	Taylor & Francis	27
International Journal of Contemporary Hospitality Management	Emerald	21
Tourism Review	Emerald	20
International Journal of Tourism Research	Wiley	13
Journal of Destination Marketing & Management	Science Direct	12
Asia Pacific Journal of Tourism Research	Taylor & Francis	11
International Journal of Tourism Cities	Emerald	11

Journal of Hospitality and Tourism Management	Science Direct	11
Journal of Sustainable Tourism	Taylor & Francis	11

4.4 Understanding Thematic Clusters in Sustainable Tourism and Digital Innovations

The bibliometric analysis identified five thematic clusters based on keyword co-occurrence. These clusters provide insights into the major research themes:

Cluster 1: Social media and Sustainable Tourism: This cluster emphasizes the role of social media in driving sustainable tourism through influencer marketing, destination branding, and user-generated content. Campaigns such as New Zealand’s “100% Pure” initiative utilized Instagram and YouTube to promote eco-tourism, generating both local community engagement and international awareness (Afren, 2024). Such platforms enable destinations to associate their branding with that of sustainable tourism consumers, especially the young generation. Keywords like “social media,” “user engagement,” and “eco-conscious tourism” were dominant in this cluster.

Cluster 2: AR/VR and Immersive Experiences: AR and VR technologies feature prominently in this cluster, with Keywords like “virtual reality,” “cultural heritage,” and “augmented reality” were frequently identified, emphasizing the role in preserving cultural heritage and enhancing tourist engagement. For instance, the UNESCO World Heritage site of Machu Picchu sells a VR tour to investors so that tourists can virtually tour the place without physically visiting it and hence reducing congestion and impact of the physical visitors on the place (Nag & Mishra, 2024). Likewise, there are the AR applications in Italy, which give guests a chance to see the ruins of ancient Rome and better immerse in cultural sites.

Cluster 3: Generational Preferences and Green Tourism: This cluster revolves around the behaviours of the Millennials and Generation Z travellers, with regards to their custom, technology integration, and eco-conscious travelling. Keywords like “Millennials,” “Generation Z,” and “young travellers” dominated this cluster. Initiatives such as Airbnb’s “Live Anywhere” program cater to targets the young travellers by promoting sustainable travel and remote work vacations (Basu, 2024). These preferences add pressure that forces the tourism operator to embrace sustainable and transparent business practices.

Cluster 4: Eco-Tourism and Community Engagement: This theme deals with the effectiveness of eco-tourism in understanding the concept of empowering the locals through participatory tourism. Keywords such as “community engagement,” “eco-tourism,” and “sustainability” are central. Eco-tourism projects, as seen in Costa Rica, are community based in that they involve the community directly in the running of the project. These projects deploy digital co-creation platforms to present local arts and novelties and promote sustainable economic and cultural development (Khater et al., 2024).

Cluster 5: Smart Tourism and Technological Innovation: IoT and AI technologies are the key enablers of smart tourism systems that help to enhance destination management.

Frequently used keywords include “IoT,” “destination management,” and “smart tourism,” highlighting the use of advanced technologies such as predictive analytics and IoT. Singapore’s “Smart Nation” initiative exemplifies how smart tourism systems enhance visitor experiences through real-time data and AI-driven personalization (Gretzel & Koo, 2021). Further, Barcelona’s Smart City Project makes use of big data to control tourist traffic reducing overcrowding at certain tourist attractions and making sure that tourists have a great experience. Several destinations have implemented AI technologies including the virtual and smart assistants and chatbots, and tailored suggestions to enhance travellers’ satisfaction. All these innovations contribute to proper utilization of resources and in striving for economic development without depletion of earth’s natural capital, and in accommodating the young generations’ preference towards technological advancement.

Table 5: Thematic Clusters and Influential Research in Sustainable Tourism

Cluster Name	Author	Title	Total Citations
Social media and Sustainable Tourism	Zhu et al., 2022	“How does celebrity involvement influence travel intention? The case of promoting Chengdu on TikTok”	29
	Jiang & Phoong, 2023	“A ten-year review analysis of the impact of digitization on tourism development (2012–2022)”	28
	Hui et al., 2023	“Exploring Regenerative Tourism Using Media Richness Theory: Emerging Role of Immersive Journalism, Metaverse-Based Promotion, Eco-Literacy, and Pro-Environmental Behaviour”	27
AR/VR and Immersive Experiences	M. Lee et al., 2020	"Quality of virtual reality and its impacts on behavioural intention"	269
	Behl et al., 2022	"Gamification and e-learning for young learners: A systematic literature review, bibliometric	223

		analysis, and future research agenda"	
	Gössling, 2021	"Technology, ICT and tourism: from big data to the big picture"	213
	Loureiro et al., 2022	"Past, present, and future of pro-environmental behaviour in tourism and hospitality: a text-mining approach"	170
Generational Preferences and Green Tourism	Bargoni et al., 2023	"Family firms' characteristics and consumer behaviour: An enquiry into millennials' purchase intention in the online channel"	47
	Essiz & Senyuz, 2024	"Predicting the value-based determinants of sustainable luxury consumption: A multi-analytical approach and pathway to sustainable development in the luxury industry"	21
	Chin et al., 2023	"Exploring the usage intention of AI-powered devices in smart homes among millennials and zillennials: the moderating role of trust"	15
Eco-Tourism and Community Engagement	Lee et al., 2021	"Sustainable intelligence, destination social responsibility, and pro-environmental behaviour of visitors: Evidence from an eco-tourism site"	113

	Wismantoro et al., 2023	"Virtual Reality Destination Experiences Model: A Moderating Variable between Wisesa Sustainable Tourism Behaviour and Tourists' Intention to Visit"	13
Smart Tourism and Technological Innovation	Lee et al., 2020	"Smart Tourism City: Developments and Transformations"	292
	Shafiee et al., 2021	"Smart tourism destinations: a systematic review"	114
	Madzik et al., 2023	"Digital transformation in tourism: bibliometric literature review based on machine learning approach"	58
	Bhuiyan et al., 2022	"Smart Tourism Ecosystem: A New Dimension toward Sustainable Value Co-Creation"	72

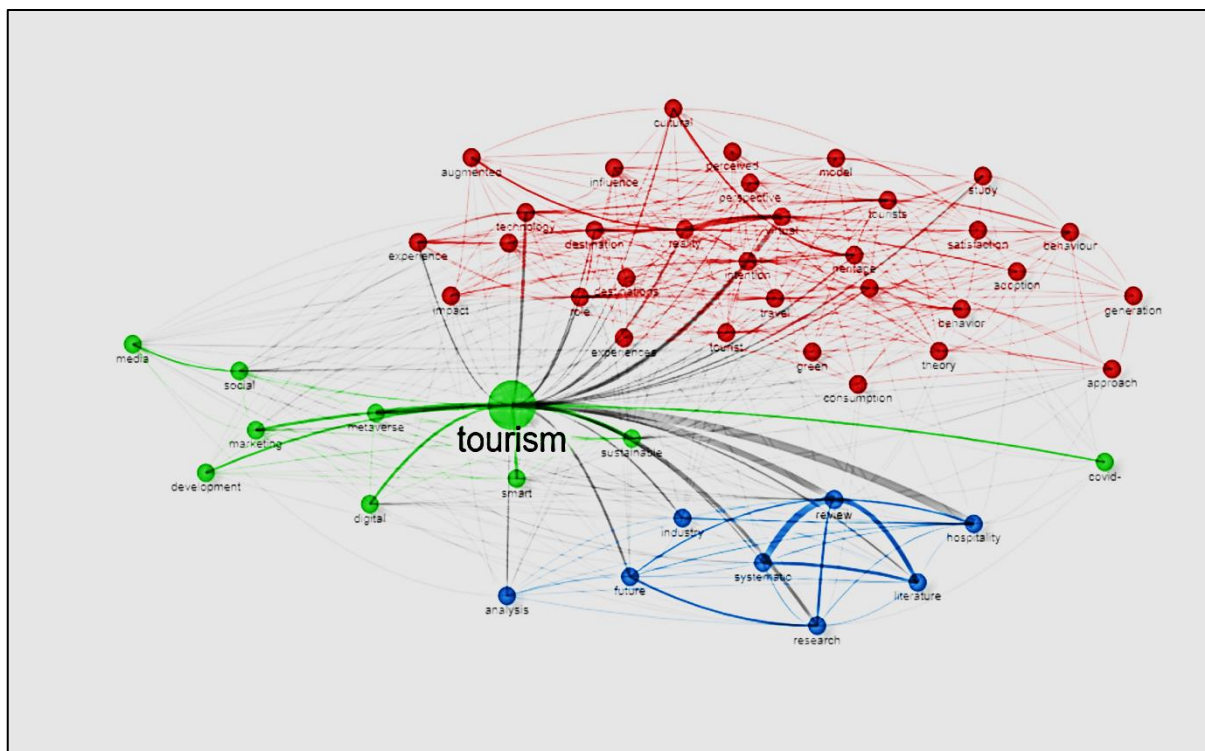


Figure 3: Influential Themes on Sustainable Tourism

5. Theoretical and Practical Implications

The study contributes significantly into sustainable tourism literature by combining knowledge on AR/VR, social media, and predictive analytics. It expands on theories such as Technology Acceptance Model to demonstrate how technology utilization provides impetus to sustainability. The research contributes knowledge of digital platforms and their effects on the behaviour of younger generations and their readiness to embrace sustainable objectives. From the practical perspective, the findings provide practical implications to the tourism operators, policy makers and community stakeholders. AR/VR can be used by operators to improve the cultural experience, while predictive analytics can be used to gain efficiency in the use of resources. Social media enhances better community interaction hence supporting the participatory models of tourism that are helpful to visitors and host communities.

6. Conclusion, Limitations, and Future Recommendations

Thus, this study proves the importance of digital innovations for the future of sustainable tourism development. It reveals that the application of AR/VR, the use of predictive analytics, and digital co-creation platforms can support sustainable business and satisfy the needs of new generations. However, the focus on bibliometric analysis restricts the investigation of the qualitative characteristics and also depends on only a single database, (Dimensions.ai), which might exclude some of the articles. Furthermore, this study is limited to certain technologies, which may exclude other innovative solutions that can be valuable to sustainable tourism. Additionally, further studies should continue to investigate on how to achieve broader coverage through multiple databases. Further, more longitudinal research into AR/VR and the metaverse effects on tourism after their implementation might be valuable. The study would also benefit from extending the theoretical understanding to embrace social and economic factors on sustainable tourism.

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A SYSTEMATIC REVIEW: THE ROLE OF RESPONSIBLE TOURISM IN TRANSFORMING INDIA IN THE JOURNEY TOWARDS THE GOALS OF VIKSIT BHARAT

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Abstract

With the current deteriorating conditions of the environment, sustainable development goals have been developed by the United Nations to address climatic issues while simultaneously focusing on economic growth and social development. On similar grounds, the Vikshit Bharat initiative was introduced in India in 2023, with a main focus on developing India in all disciplines. One of the key goals of Vikshit Bharat is to ensure that it adheres to sustainable development goals (SDGs). With the rising tourism industry in India, responsible tourism has become necessary in the recent context of Vikshit Bharat as well as SDGs to bring development that aligns with the SDG targets. Responsible tourism outlines the concept of travelling, which takes into consideration the impact on the environment, society, and economy. Thus, the focus would be to reduce carbon footprint, reduce waste and pollution, and promote local business and culture. Thus, the systematic review and qualitative analysis would help in critically exploring the role of responsible tourism in serving as a catalyst for boosting economic conditions and social growth and addressing ecological concerns. Hence, the systematic review will study the impact of responsible tourism on SDG 12, SDG 8, and SDG 13.

Objectives:

- To systematically review and identify responsible tourism initiatives in India.
- To examine the conformance of responsible tourism in India to SDGs.
- To determine the role of responsible tourism in contributing towards the goals of Vikshit Bharat.

Methodology: The study has used systematic review considering peer-reviewed articles, online news articles and government reports. Qualitative analysis is chosen and thematic analysis is being used.

Findings: The systematic review highlighted that various initiatives have been undertaken by different state governments to meet SDG goals in tourism. Responsible tourism in recent times in India, as evidenced in Kerala and Rajasthan, has boosted local culture and heritage tourism alongside local community engagement. Further, the ban on the use of plastic water bottles in tourist areas in South India reflected the need to address environmental concerns. In summary, responsible tourism has been strongly contributing to the goals of Vikshit Bharat.

Keywords: *responsible tourism, sustainable tourism, Viksit Bharat 2047, Sustainable development goals.*

1. Introduction

a. Research rationale

Tourism is one of the growing sectors all across the world. According to the reports of IBEF (2024), the tourism industry in India will expand, reaching an expected value of 523 billion US dollars within a decade. Currently, the Indian tourism industry is worth 256 billion US dollars (The Economic Times, 2024). Thus, in the coming decade, tourism will contribute to economic growth along with social growth in the form of the generation of 18 million new job opportunities (IBEF, 2024), further giving jobs to 63 million people (The Economic Times, 2024). In addition, tourism in India is presently contributing to 7 per cent of the national economy. The recent launch of the initiative under Viksit Bharat 2047 envisions overall development and growth in India, promoting sustainability and social welfare (Mohapatra & Pohit, 2024; IIPE, 2023). The initiative strongly advocates for measures and actions that will deliver economic development hand in hand with the social and cultural development of the local communities. In addition, Viksit Bharat 2047 also aims to achieve the Sustainable Development Goals, which promote decent work and economic development, climatic action and responsible consumption (IIPE, 2023; Rai, Brown, & Ruwanpura, 2019). Tourism, which is found to be delivering economic growth, is further expected to generate employment opportunities, which would thereby enable the achievement of the goals of Viksit Bharat. However, Baloch et al. (2022) reflected the adverse implications of rising tourism on environmental conditions. The study asserted that tourism resulted in overcrowding and air and noise pollution alongside encroachment for local communities. Overutilisation of resources in tourist areas is leading to social vulnerability. Hence, the concept of responsible tourism emerged, which is defined as a type of tourism that promotes practices to lower adverse implications on ecology, promote sustainability and social development, and maximise economic outputs (Mihalic, 2016). The United Nations further associated tourism with SDGs fostering responsible tourism under the **"2030 Agenda for Sustainable Development and the Sustainable Development Goals"** (United Nations, 2024). It inculcates the use of advancing knowledge, promoting sustainability, economic and social development, and encouraging tourism.

b. Aims and objectives

The systematic review aims to study the impact of responsible tourism on SDG 12, SDG 8, and SDG 13 and potential contributions to achieve the overarching goals of Viksit Bharat 2047, with key focus on sustainability and economic development.

Objectives:

- To systematically review and identify responsible tourism initiatives in India.
- To examine the conformance of responsible tourism in India to SDGs.
- To determine the role of responsible tourism in contributing towards the goals of Vikshit Bharat.

c. Research questions

- What are the initiatives introduced to achieve responsible tourism in India?
- What is the extent to which responsible tourism in India is aligned to meet the objectives of SDGs?
- What measures and to what extent is responsible tourism in India contributing to Viksit Bharat 2047 goals?

2. Literature review

a. Overview of responsible tourism

With the aim to reduce the harmful implications of growing tourism, the practice of responsible tourism was conceptualised by Jost Krippendorf (Fang, 2020; Lane, 2003). Responsible tourism is outlined as the practice that fosters economic and social development, promoting tourism and reducing negative impacts on the environment (Mondal & Samaddar, 2021). Furthermore, responsible tourism counters against encroachment over local tribes and promotes the social development of local communities, fostering local culture and preserving natural heritage. Responsible tourism, in a nutshell, aims to preserve the the environment, develop cultural respect, empower local communities, and bring economic and social growth. Evaluating evidence from a global perspective, Bhutan effectively introduced the practices of responsible tourism under the "high value, low impact" model of tourism (Times of India, 2024). As per the model, tourists will not be restricted; however, to promote quality tourism and preserve the environment, a sustainable development fee is to be levied. Thus, higher tariff rates help limit the number of tourists alongside earning revenue, which assists in the preservation of the environment and bringing social development. Responsible tourism in India was initiated by Kerela back in 2008 (UN Tourism, 2018). The responsible tourism initiative was enacted as a pilot program in four tourist spots: Kovalam, Kumarakom, Thekkady, and Wayanad. The pilot initiative of the Government of India initiated and fostered responsible tourism through *the Swadesh Darshan* scheme, which stresses sustainable future development in the tourism industry (Press Information Bureau, 2024). Under this, the focus is to collaborate with local communities and other stakeholders to promote tourism responsibly and sustainably.

b. Overview of Viksit Bharat and SDGs

The initiative of Viksit Bharat 2047 has been launched with the overarching objective of transit and transformation into a developed nation. The Viksit Bharat plans to foster equality and equity within society in all spheres, delivering social development and economic expansion (Mohapatra & Pohit, 2024; IPE, 2023). The initiative further encompassed wide levels of disciplines and industries from education to manufacturing, facilitating economic growth in coordination with environmental sustainability.

The United Nations has developed 17 goals under the paradigm of Sustainable Development Goals (Bebbington & Unerman, 2018). Each of the goals focuses on delivering development and equity, focusing on a specific dimension. Alongside economic, healthcare, education, and

infrastructural development, SDGs strongly focus on climatic action under SDG 3 (Dagron, 2022). Viksit Bharat has been envisioned to achieve the aims of SDGs, and the blueprint of the initiative reflects measures to achieve sustainability, underpinning the need for eco-friendly practices, inclusivity, and a strong economic framework for the nation. Thus, Viksit Bharat and SDGs align with each other, working together to achieve three aspects: economic, social, and environmental prosperity.

c. Impact of responsible tourism on sustainability

Responsible tourism has exhibited a positive impact on socio-economic conditions. As already stated by IBEF (2024), with the surge in the tourism industry, 18 million job opportunities will be generated; thus, it can be directly reflected that individuals will get the opportunities to boost their source of income. In addition, with the creation of job opportunities in tourist areas, the local communities will benefit from the value chain, gaining a source of income and strengthening economic conditions. Samaddar, Mondal, & Sharma (2022) highlighted that responsible tourism fosters local culture. Thus, responsible tourism would strengthen local craftsmanship and the exchange of cultural experiences alongside the promotion of local cuisine and businesses. Furthermore, hiring local people in responsible tourism would assist in uplifting marginalised communities residing in remote areas, such as tribal people, developing communities and empowering them to earn. Besides, UNEP (2024) highlighted the significant impact of responsible tourism in addressing the issue of plastic pollution. According to the report, tourism is the largest contributor to plastic and accounts for 8 million tonnes of plastic being discarded and added to the ocean every year owing to tourist activities (UNEP, 2024). However, the Transforming Tourism project initiated by the "German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety" framed a novel model that optimises resource utilisation alongside eliminating single-use plastic materials. A similar initiative can be witnessed in Ooty in South India, which gets lakhs of tourists each year, banning the use of single-use plastics, thus aiming to become a plastic-free zone (Times of India, 2019). Banning the use of plastic in Ooty exhibits adherence to responsible tourism, inspiring people to adopt sustainable measures in the long term.

d. Theoretical concepts

The theoretical perspective that strongly underpins the belief in responsible tourism is the Triple Bottom Line Framework, known as the TBL framework. The TBL framework is the model that advocates achieving profit and development for people without compromising on the needs of the planet (Schulz & Flanigan, 2016). Thus, the TBL model focuses on the 3Ps: people, planet, and profit. It is further argued by Atif, Yin, & Hassan (2024) that without profit in the project or business, social development is not possible. Therefore, economic profit is one of the legs of the TBL model. On the other hand, the TBL model also asserts the need for social growth, ensuring fair compensation and development of the local area. In addition, the TBL model, strengthening the concept and need for sustainability, advocates the necessity to take measures that preserve ecology for long-term viability. The TBL model suits the fundamental concept of responsible tourism, which emphasises the environment, local development and economic profit. As highlighted by (Randhave, 2022), responsible tourism stresses the need

and opportunity for developing local areas as tourist spots for generating employment opportunities. Besides, with the inflow of tourists, the local communities get assistance for community development and upliftment of the marginalised communities, mitigating economic differences within the society. Furthermore, responsible tourism strongly fosters positive social impact, aiming to address existing social inequalities. For example, heritage walks have become prominent in recent times and promote cultural insight into the local communities (Javed, 2024). It helps boost local traditions, craftsmanship, and art. Initiatives under responsible tourism, such as "high value, low impact" by Bhutan (Times of India, 2024) or plastic free zone initiative by Ooty (Times of India, 2019), have helped in lowering the production of plastic pollutants and decline in carbon footprint, thus achieving environmental improvement.

3. Research methodology

a. Research design

The research used a systematic literature review as the study design to carry out the investigation to understand the impact of responsible tourism in achieving the goals of Viksit Bharat 2047 and the SDGs. Systematic Literature review is the methodological process that searches the database extensively to study the existing research evidence for carrying out organised and systematic analysis (Jahan et al., 2016). SLR would assist in understanding the present outcome and impact of responsible tourism and areas that further need to be improved to achieve the aims of Vikshit Bharat and attain the SDG goals. The approach taken is qualitative research, wherein thematic analysis is being conducted.

b. Data sources

The databases used for the study are online sources. Online databases offered ease of searching and extensive availability of research papers. The research databases searched for the study are Google Scholar and Sci-hub, as these are free sources. Further, EBSCOhost is used to access paid sources. Government databases such as PIB, NITI AYOOG, and Vikshit Bharat web pages have also been used.

c. Search strategy

The key terms used for searching and locating research articles included "responsible tourism", "sustainable tourism", "tourism", "sustainability", "Viksit Bharat 2047", "SDGs", and "Sustainable development goals". Boolean operators "and," "or," and "not" are used for an extensive search of results.

d. Inclusion and exclusion criteria

Criteria	Inclusion criteria	Exclusion criteria
Publishing year	2012-2024	Before 2012
Language of publication	English	Any other language
Type of paper	Peer-reviewed journal articles, government reports, and credible news articles	Non-peer-reviewed papers and blogs or commercial pages
Accessibility	Access to full-text	Full text not accessible

e. Selection of research papers

Papers were selected using a two-step process. Screening is the first step, where the title and abstract of the study are reviewed. In the full-text selection, the PRISMA technique has been applied.

f. Data extraction

Data have been extracted using a pre-designed extraction template, which included author, year, title, research methods, key findings, and limitations.

g. Data analysis

Thematic analysis was used to analyse the data extracted, and interpretation was presented through themes.

h. Ethical consideration

Data misrepresentation has been avoided. Any bias towards the selection of the paper has been avoided. Further, all sources have been referenced to avoid any plagiarism or copyright issues.

4. Findings and Analysis

a. Summary of findings

The research papers selected for the systematic literature review consist of 5 studies. The research was conducted in India to study responsible tourism and its impact; a summary of the findings is presented in Table 1.

Author/ Year/ Title	Aim of the research	Area	Study design	Sample	Key findings	Limitations
Mathew, P. V., & Sreejesh, S. (2017). Impact of responsible tourism on destination sustainability and quality of life of community in tourism destinations. <i>Journal of Hospitality and Tourism Management</i> , 31, 83–89. doi: 10.1016/j.jhtm.2016.10.001	To inspect the influence of responsible tourism on perceived quality of life of local communities in tourist areas and study the mediating part played by tourist region sustainability.	Kovalam, Kumarakom and Thekkady	Questionnaire-based survey	432	Local communities identified responsible tourism to promote local and community development. Significant influence of responsible tourism was found on local hosts, which promoted environmentally friendly approaches and also the skill development initiatives ensured realising direct benefit to local hosts.	Considered the viewpoint of the local residents, however, lacked focusing on the viewpoint of other stakeholders such as businesses. It lacked studying the perception of the visitors and their satisfaction level.
Menon, R., Patri, R., Kaladharan, S., Shivdas, A., & Menon, D. (2024). Fuzzy Assessment of Sustainable and Responsible Tourism: Tourist Behaviour in South	To evaluate responsible tourist behaviour observed in tourist regions	South India	fuzzy logic methodology	Not Defined	The findings of the study indicated need for higher awareness and more	Lack of clarity in demographic details and population sampling

India. In J. Choudrie, P. N. Mahalle, T. Perumal, & A. Joshi (Eds.), <i>ICT for Intelligent Systems</i> (pp. 301–315). Singapore: Springer Nature. doi: 10.1007/978-981-97-6681-9_27					sensitisation for green practices and responsible behaviour towards preserving heritage, protection of local culture and to conform with regulations of responsible tourism.	
PK, M. (2015). Prospects Of Responsible Tourism in Kerala: Evidence from Kumarakam in Kottayam District. 3(1), 54–59.	To examine the prospects and impact of responsible tourism on the local community of the Samrudhi group	Kottayam district	Descriptive analytical, case study methodology	Stakeholders of the 'Samrudhi' group: 15	Income of Samrudhi' group increased. Education did not limit starting business in tourism industry. Domestic tourists are more inclined towards local cuisine; however, the foreign tourists benefit mostly the resort businesses instead of local	The generalizability of research findings is questionable.

					businesses .	
Prakash, A., Engheepi, V., & Sinha, S. (2024). Intersecting pathways: Eco-feminist perspectives on intersectionality, water management, and responsible tourism for gender-inclusive community development. <i>Current Research in Environmental Sustainability</i> , 7, 100254. doi: 10.1016/j.crsust.2024.100254	To understand the role of local administration in implementing responsible tourism and influencing growth in the tourist destination.	Sikkim	quantitative and qualitative data methods	204 households	Water scarcity is deepened by increasing tourism in Sikkim. Local management practices play a wider role in implementing ecofeminism practices in conformance with the responsibility to addressing water scarcity in the area. Women played dominant role in water resource management as part of responsible tourism; however, participation of women in responsible tourism	Lack of investigation on socio-cultural dynamics, impact of traditional practices, absence of consideration of integration between modern technology with traditional approaches and inclusive governance structure.

					is highly neglected.	
Chettiparamb, A., & Kokkranikal, J. (2012). Responsible tourism and sustainability: The case of Kumarakom in Kerala, India. <i>Journal of Policy Research in Tourism, Leisure and Events</i> , 4(3), 302–326. doi: 10.1080/19407963.2012.711088	To evaluate the successful implementation of responsible tourism in Kerala and determine the practical contribution to growth.	Kerela	Case study-based research approach	Not Defined	Several environmental limitations deterred the effective adoption of responsible tourism in the Kumarakom case. Proactive and local government support is needed alongside informed decisions for effective, responsible tourism practices. The absence of proper and extensive awareness about safeguarding environmental and social assets deterred the realisation of responsible tourism.	Lack of extensive consideration of case studies

Table 1: Summarisation of research findings (Source: developed by self)

b. Analysis and discussion

i. Impact of responsible tourism in community development and economic growth adhering to SDG 8

SDG 8 focuses on providing opportunities for decent work (Rai, Brown, & Ruwanpura, 2019). Decent employment opportunities would assist in earning income, address economic inequality in society, and bring both economic growth and development to society. Viksit Bharat's vision stresses creating opportunities that would ascertain achieving SDG 8 through the creation of jobs, income opportunities and development of the communities (IPE, 2023; Rai, Brown, & Ruwanpura, 2019). Responsible tourism in India has demonstrated an extensive ability to generate jobs for the local communities (Mathew & Sreejesh, 2017). Responsible tourism encouraged the growth of local businesses and thus generated a source of income for local communities. Besides, as seen in the study of PK (2015), the income of the local people increased despite poor educational attainment, reflecting the scope for income generation, economic development, and community advancement, meeting the agendas of Viksit Bharat and SDG 8.

ii. Impact of responsible tourism promoting sustainable practices and optimal resource usage adhering to SDG 3 and SDG 12

SDG 3 focuses on climatic actions and emphasises improving the environment (Dagron, 2022). On a similar note, Viksit Bharat also emphasises adopting green measures, promoting sustainability, reducing deterioration of the environment and further aiming to deliver eco-friendly long-term practices (Mohapatra & Pohit, 2024; IPE, 2023). Responsible tourism, which fortifies the actions to reduce carbon footprint and plastic pollution and promote the use of green practices (Times of India, 2019), directly reflects adhering to SDG 3 and Viksit Bharat goals. Further, the study of Prakash, Engheepi, & Sinha (2024) strongly exhibited role and implementation of responsible tourism strategies to address environmental concerns such as water scarcity.

SDG 12 highlights responsible consumption, therefore indicating optimal use of resources for saving for the upcoming generation (UN SDGs, 2024). Responsible tourism strongly demonstrates responsible consumption and resource management. Water scarcity is a major issue in Sikkim, which is further aggravated by extensive tourism. Nonetheless, Prakash, Engheepi, & Sinha (2024) exhibited the role of local management in promoting responsible tourism, supporting ecofeminism practices to address the issue, thereby reflecting effective resource management.

iii. Barriers to responsible tourism in India

Though responsible tourism has reflected progress in meeting the agendas of Viksit Bharat 2047 and SDG 3, SDG 12, and SDG 8, in the Indian scenario, studies have reflected substantial barriers hindering effective adoption. As per the study of Chettiparamb & Kokkranikal (2012), a lack of informed decisions engaging other stakeholders affected the initiative. Furthermore,

Menon et al. (2024) argued that a lack of adequate awareness among tourists about cultural and environmental assets hinders the adoption of responsible tourism practices. In addition, the absence of integration with socio-cultural dynamics existing in Indian society has limited the effectiveness of responsible tourism. Lack of awareness about the need, practices, and actions associated with responsible tourism initiatives has restricted the adoption and success of responsible tourism in India.

5. Conclusion and Recommendation

The research paper studied responsible tourism in India and found a strong role in working towards meeting the agenda of Vikshit Bharat 2047 and SDG 8, 12, and 3. On the one hand, responsible tourism has supported the growth of the tourism sector, thereby strengthening economic and social advancement in the country; on the other hand, responsible tourism has addressed environmental concerns associated with expanding tourism. However, due to a lack of adequate awareness and socio-cultural integration, the full potential of responsible tourism is yet to be achieved. To achieve the full potential of responsible tourism in India, meeting the objectives of Viksit Bharat and SDGs, strong tourism policies and frameworks need to be developed and strictly implemented in coordination with local administration. Additionally, informed decision-making is crucial for effective implementation and hence requires multi-stakeholder involvement and engagement with the initiative.

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COMPARATIVE ANALYSIS OF INDIAN COMMERCIAL BANKS: A CASE STUDY OF HDFC BANK AND STATE BANK OF INDIA USING COMMON SIZE STATEMENT

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ABSTRACT

The Indian banking system is a complex network of financial institutions, including commercial banks, regional rural banks, urban cooperative banks, and primary agricultural credit societies. As an Indian central bank, the Reserve Bank of India (RBI) oversees and regulates the country's banking sector. The current study shall examine the financial performance of two commercial banks, HDFC Bank and State Bank of India (SBI), the two leading Indian banks, over the past five years (2020-2024) using common-size statements. Common size statements present financial statement items as a percentage of a base figure, allowing for a direct comparison of the relative importance of each item across different-sized companies or across time for the same company. This study will focus on key areas like profitability, liquidity, solvency, and efficiency to identify the strengths and weaknesses of each bank. The study aims to assess and compare the financial performance of these two prominent banks in the Indian banking sector. The paper seeks to offer valuable insights for investors, regulators, and policymakers. The findings of this study contribute to the existing literature on comparative banking analysis and provide a foundation for further research in this field. The insights derived from this comparative analysis have significant implications for investors, regulators, and policymakers, aiding in informed decision-making. By contributing to the body of knowledge on comparative banking analysis, this study provides a valuable resource for academics, practitioners, and stakeholders interested in the Indian banking sector.

Keywords: *Common size statements, HDFC Bank, State Bank of India*

1. INTRODUCTION

India is fast expanding economic powerhouse in addition to being the largest independent democracy in the world. An effective banking system is necessary for any nation to maintain a healthy economy. For a nation's economy to grow, banks are essential. Individuals' idle funds are gathered and rendered investable by them.

As a fundamental pillar of the nation's economy, the Indian banking sector performs a wide range of tasks necessary for the expansion and stability of the financial sector. These responsibilities include receiving deposits from both individuals and companies, offering different kinds of loans and credit facilities to satisfy financial requirements, assisting with payment settlements via various channels, providing investment and advisory services for wealth management, facilitating foreign exchange transactions for global trade, generating

credit to stimulate economic activity, and offering custodial services for the safekeeping of priceless assets.

HDFC BANK- PROFILE

The HDFC Bank was incorporated on August 1994 by the name of 'HDFC Bank Limited', with its registered office in Mumbai, India. HDFC Bank commenced operations as a Scheduled Commercial Bank in January 1995. The Housing Development Finance Corporation (HDFC) was amongst the first to receive an 'in principle' approval from the Reserve Bank of India (RBI) to set up a bank in the private sector, as part of the RBI's liberalization of the Indian Banking Industry in 1994.

HDFC Bank Limited (also known as HDFC) is an Indian banking and financial services company headquartered in Mumbai. It is India's largest private sector bank by assets and the world's tenth-largest bank by market capitalization as of May 2024. The Reserve Bank of India (RBI) has identified the HDFC Bank, State Bank of India, and ICICI Bank as Domestic Systemically Important Banks (D-SIBs), which are often referred to as banks that are “too big to fail”.

As of April 2024, HDFC Bank has a market capitalization of \$145 billion, making it the third-largest company on the Indian stock exchanges. It is also the sixteenth largest employer in India with over 173,000 employees, following its takeover of parent company HDFC.

SBI- PROFILE

The roots of the State Bank of India lie in the 19th century when the Bank of Calcutta (later renamed as Bank of Bengal) was established on June 2, 1806. The Bank of Bengal was one of three Presidency banks, the other two being Bank of Bombay and Bank of Madras. These three Presidency banks were incorporated as joint-stock companies. They have the exclusive right to issue paper currency until 1861 when the right was taken over by the Government of India. The three Presidency banks amalgamated on January 27, 1921 and were named Imperial Bank of India. The Imperial Bank of India remained a joint-stock company without Government participation. All in all, the SBI was formed after the merger of approximately twenty banks.

According to the State Bank of India Act of 1955, the Reserve Bank of India, acquired a controlling interest in the Imperial Bank of India and the Imperial Bank of India became the State Bank of India on July 1, 1955.

State Bank of India (SBI) is an Indian multinational public sector bank and financial services statutory body headquartered in Mumbai, Maharashtra. SBI is the 45th largest bank in the world by total assets and ranked 221st in the Fortune Global 500 list of the world's biggest corporations of 2020, being the only Indian bank on the list. It is a public sector bank and the largest bank in India with a 23% market share by assets and a 25% share of the total loan and deposits market. It is also the tenth largest employer in India with nearly 250,000 employees.

2. OBJECTIVES OF THE STUDY

In the present study, an attempt has been made to measure, evaluate and compare the financial performance of HDFC and SBI. Specifically, the present study has the following objectives:

- To study the financial performance of HDFC Bank and SBI.
- To compare the financial performance of HDFC BANK and SBI.

3. RESEARCH METHODOLOGY

The purpose of the study is to compare HDFC Bank and SBI Bank using similar size financial statements for the 5 years i.e. 2020–2024. The study is based on secondary data that has been collected through annual reports of the respected banks, websites, journals, documents and other published information. Ratio analysis has been applied to analyse and compare the trends in financial performance. This analysis shall focus on common size income statement and balance sheet. By converting financial figures of a common base, these statements facilitate a standardised comparison between the two banks.

4. ANALYSIS AND INTERPRETATIONS

Ratio analysis of HDFC bank and SBI from its annual reports for the year 2020, 2021, 2022, 2023 and 2024 is presented below-

4.1 Non-Performing Asset Ratio- Non-Performing Assets (NPA) are assets for which interest is overdue for more than 90 days. It includes-

4.1.1 Gross Non-Performing Asset Ratio-

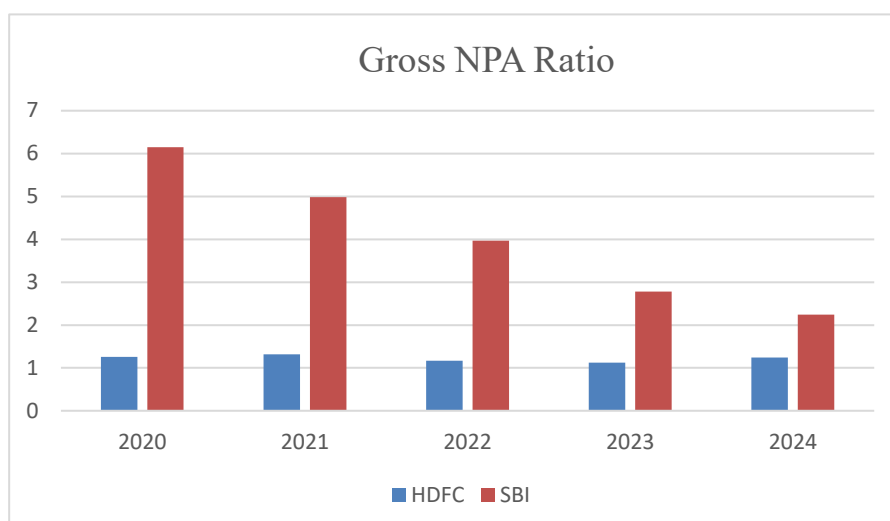
Gross non-performing loans are the sum of all the loans that have been defaulted by the individuals who have acquired loans from the financial institution. This means that all loans defaulted are added together to form gross non-performing assets.

Gross NPA Ratio= $(A1 + A2 + A3 + A_n) / \text{Gross Advances}$.

(A1 stands for loans given to person number one, A2 for loans given to person number two etc.)

YEARS	HDFC	SBI
2020	1.26	6.15
2021	1.32	4.98
2022	1.17	3.97
2023	1.12	2.78
2024	1.24	2.24
AVERAGE	1.222	4.024

(Table 4.1.1. shows the % of Gross NPAs of HDFC and SBI for last five years)



(Graph 4.1.1. shows the % of Gross NPAs of HDFC and SBI for last five years)

Interpretation- Both HDFC and SBI have shown a general decline in Gross NPA ratios from 2020 to 2024, indicating improved asset quality. HDFC's average Gross NPA is 1.222, suggesting a relatively stable and low level of non-performing assets. SBI's average Gross NPA is 4.024, reflecting a significant improvement in asset quality despite a higher average compared to HDFC.

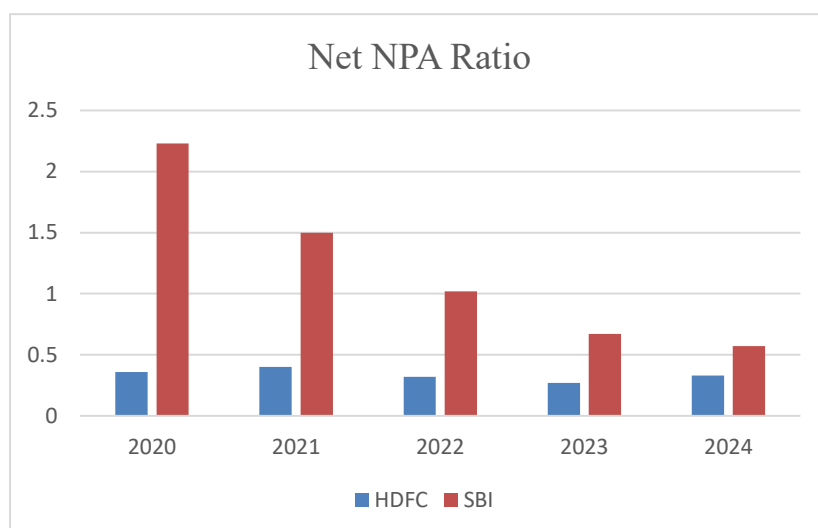
4.1.2 Net Non-Performing Asset Ratio-

Net non-performing assets are the amount that is realized after provision amount has been deducted from the gross non- performing assets. It is the actual loss that the organization incurs after loan defaults.

Net NPA Ratio = (Total Gross NPA) – (Provision for Unpaid Debts)/Gross Advances

YEARS	HDFC	SBI
2020	0.36	2.23
2021	0.40	1.50
2022	0.32	1.02
2023	0.27	0.67
2024	0.33	0.57
AVERAGE	0.336	1.198

(Table 4.1.2. shows the % of Net NPAs of HDFC and SBI for last five years)



(Graph 4.1.2. shows the % of Net NPAs of HDFC and SBI for last five years)

Interpretation

HDFC Bank: Consistently low Net NPA ratios demonstrate strong credit risk management and high asset quality.

SBI: Shows significant improvement in Net NPA ratios, decreasing from 2.23% in 2020 to 0.57% in 2024, indicating effective measures to reduce NPAs.

HDFC Bank outperforms SBI in terms of Net NPA ratios, but both banks have shown a positive trend in reducing non-performing assets.

4.2 Profitability Ratios

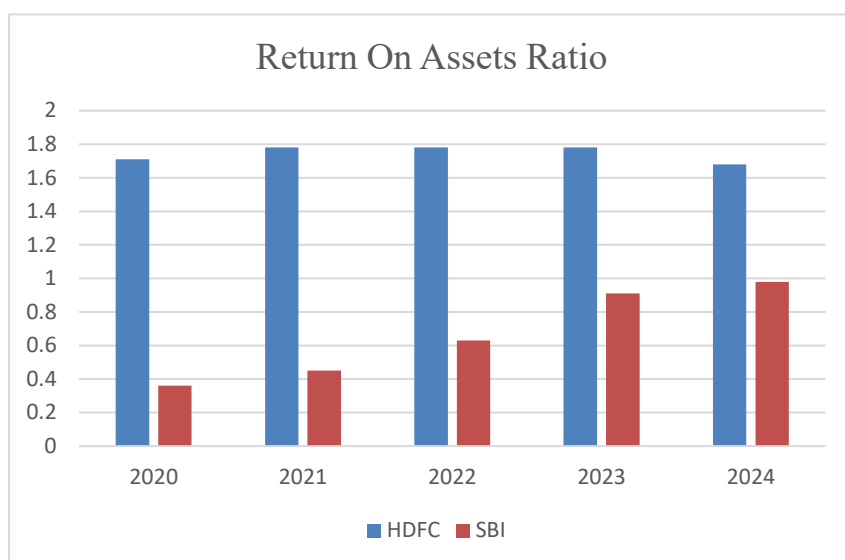
4.2.1 Return on Assets Ratio

Return on assets (ROA) measures how efficient a company's management is in earning a profit from their economic resources or assets on their balance sheet.

ROA is calculated by dividing a company's net income by its total assets. As a formula, it's expressed as: $\text{Return on assets} = \frac{\text{Net income}}{\text{total assets}}$

YEARS	HDFC	SBI
2020	1.71	0.36
2021	1.78	0.45
2022	1.78	0.63
2023	1.78	0.91
2024	1.68	0.98
AVERAGE	1.74	0.66

(Table 4.2.1. shows the percentage of ROA of HDFC and SBI for last five years)



(Graph 4.2.1. shows the percentage of ROA of HDFC and SBI for last five years)

Interpretation

The higher and stable ROA of HDFC Bank suggests strong profitability management and effective use of resources. SBI's improving ROA indicates that it is successfully addressing previous inefficiencies and improving its profitability over time.

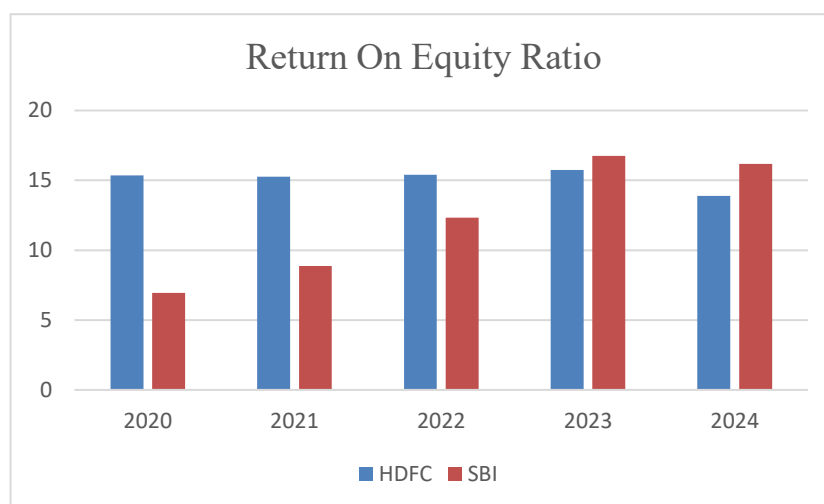
4.2.2 Return On Equity Ratio

A financial ratio that helps measure a company's proficiency to generate profits from its shareholders' investments. This profitability helps to gauge a company's effectiveness when it comes to using equity funding to run its daily operations. Return on equity ratio formula is expressed as,

Return on equity = Net income / Average shareholder's equity.

YEARS	HDFC	SBI
2020	15.35	6.95
2021	15.27	8.86
2022	15.39	12.33
2023	15.74	16.75
2024	13.89	16.19
AVERAGE	15.128	12.216

(Table 4.2.2. shows the percentage of ROE of HDFC and SBI for last five years)



(Graph 4.2.2. shows the percentage of ROE of HDFC and SBI for last five years)

Interpretation

The ROE analysis from 2020 to 2024 reveals that HDFC Bank consistently achieves high profitability and efficient use of equity, with an average ROE of 15.128%. In contrast, SBI shows a substantial improvement in ROE, rising from 6.95% in 2020 to 16.19% in 2024, with an average of 12.216%. This comparative analysis highlights HDFC Bank's superior and stable equity efficiency, while recognizing SBI's impressive progress and potential for further growth in generating returns on equity.

4.3 Liquidity Ratio

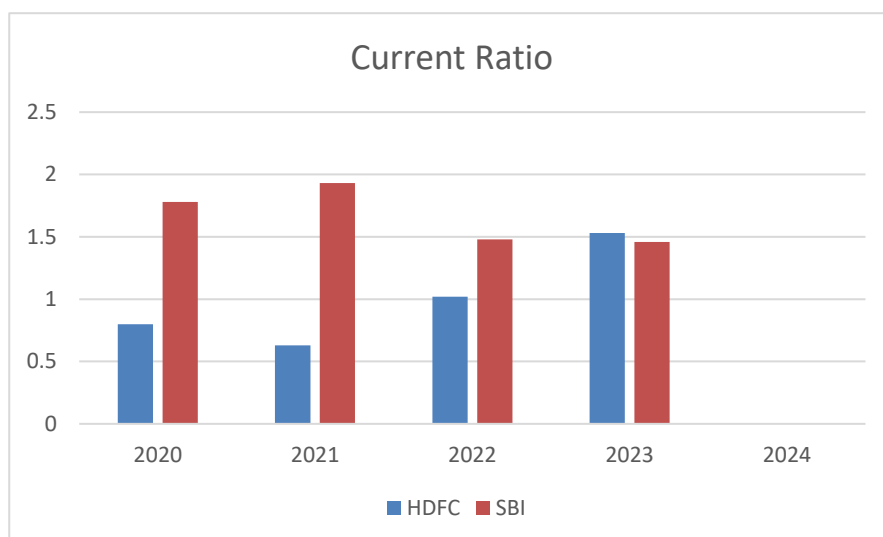
4.3.1 Current Ratio

The current ratio is a liquidity ratio that measures a company's ability to pay off short-term obligations or those due within one year. This ratio measures the financial strength of the company. Generally, 2:1 is treated as the ideal current ratio.

Current Ratio = Current Assets/Current Liabilities

YEARS	HDFC	SBI
2020	0.80	1.78
2021	0.63	1.93
2022	1.02	1.48
2023	1.53	1.46
2024	-----	-----
AVERAGE	0.995	1.66

(Table 4.3.1. shows the percentage of current ratio of HDFC and SBI for last five years)



(Graph 4.3.1. shows the percentage of current ratio of HDFC and SBI for last five years)

Interpretation

The current ratio analysis from 2020 to 2023 highlights that SBI consistently maintains a strong liquidity position, with an average current ratio of 1.66, indicating its solid ability to cover short-term liabilities. HDFC Bank, while initially below the critical threshold, shows a significant improvement in liquidity, with the current ratio increasing to 1.53 in 2023, and an average of 0.995. This comparative analysis underscores SBI's superior liquidity management, while recognizing HDFC Bank's positive trend towards improving its liquidity position.

4.4 Financial Leverage

The amount of capital that comes from debt. In other words, financial leverage ratios are used to evaluate a company's debt level.

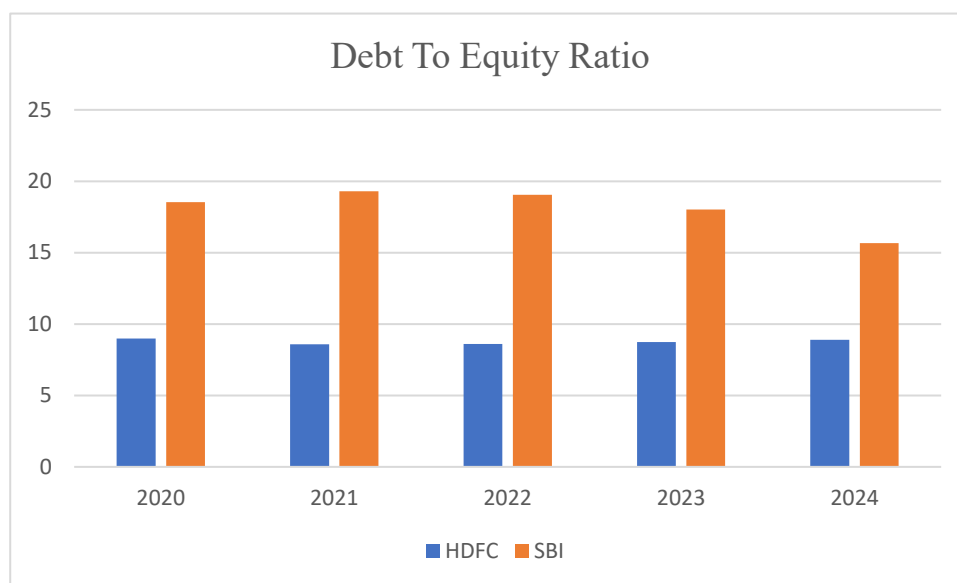
4.4.1 Debt To Equity Ratio

The debt- to -equity ratio is a type of leverage ratio that calculates the weight of total debt and financial liabilities against shareholders' equity. The ideal debt to equity ratio is 2:1 (because the cost of debt is lower than the cost of equity.)

Debt to equity ratio= Total liabilities/Shareholder's equity

YEARS	HDFC	SBI
2020	8.99	18.53
2021	8.59	19.29
2022	8.60	19.05
2023	8.75	18.03
2024	8.89	15.67
AVERAGE	8.77	18.12

(Table 4.4.1. shows the percentage of Debt-to-Equity ratio of HDFC and SBI for last five years)



(Table 4.4.1. shows the percentage of Debt-to-Equity ratio of HDFC and SBI for last five years)

Interpretation

The D/E ratio analysis from 2020 to 2024 reveals that SBI is significantly more leveraged than HDFC Bank, with an average ratio of 18.12 compared to HDFC Bank's 8.77. While SBI shows a decreasing trend in leverage, indicating efforts to reduce financial risk, its ratios remain high. HDFC Bank, on the other hand, maintains stable and moderate leverage. This comparative analysis underscores the higher financial risk associated with SBI due to its high leverage, while recognizing HDFC Bank's more conservative and stable approach to debt financing.

Common Size Profit & Loss Account of HDFC Bank (2020-24)

PROFIT & LOSS ACCOUNT OF HDFC BANK (in Rs. Cr.)										
	Mar-24		Mar-23		Mar-22		Mar-21		Mar-20	
	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE
INCOME										
Interest / Discount on Advances / Bills	2,17,979.34	76.8%	1,35,767.33	79.5%	1,06,295.34	78.2%	1,02,299.13	79.6%	99,079.63	81.1%
Income from Investments	57,524.80	20.3%	31,173.30	18.3%	25,907.06	19.1%	23,211.62	18.1%	20,572.73	16.8%
Interest on Balance with RBI and Other Inter-Bank funds	2,634.63	0.9%	1,149.25	0.7%	2,630.78	1.9%	2,414.30	1.9%	1,868.77	1.5%
Others	5,510.25	1.9%	2,664.17	1.6%	1,103.23	0.8%	627.35	0.5%	668.17	0.5%
TOTAL INTEREST EARNED	2,83,649.02	100.0%	1,70,754.05	100.0%	1,35,936.41	100.0%	1,28,552.39	100.0%	1,22,189.29	100.0%
Other Income	1,24,345.75	43.8%	33,912.05	19.9%	31,758.99	23.4%	27,332.88	21.3%	24,878.97	20.4%
Total Income	4,07,994.77	143.8%	2,04,666.10	119.9%	1,67,695.40	123.4%	1,55,885.27	121.3%	1,47,068.27	120.4%
EXPENDITURE										
Interest Expended	1,54,138.55	54.3%	77,779.94	45.6%	58,584.33	43.1%	59,247.58	46.1%	62,137.42	50.9%
Payments to and Provisions for Employees	31,023.00	10.9%	20,016.85	11.7%	15,897.03	11.7%	13,676.67	10.6%	12,920.13	10.6%
Depreciation	0	0.0%	0	0.0%	1,680.73	1.2%	1,385.01	1.1%	1,276.77	1.0%
Depreciation on Leased Assets	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Operating Expenses (excludes Employee Cost & Depreciation)	1,21,246.34	42.7%	31,516.84	18.5%	22,734.67	16.7%	19,939.58	15.5%	18,839.16	15.4%
TOTAL OPERATING EXPENSES	1,52,269.34	53.7%	51,533.69	30.2%	40,312.43	29.7%	35,001.26	27.2%	33,036.06	27.0%
Provision Towards Income Tax	11,122.10	3.9%	15,349.69	9.0%	14,324.66	10.5%	12,336.79	9.6%	10,422.14	8.5%
Provision Towards Deferred Tax	0	0.0%	0	0.0%	-1,602.18	-1.2%	-1,397.41	-1.1%	476.45	0.4%
Other Provisions and Contingencies	25,018.28	8.8%	13,854.08	8.1%	17,925.26	13.2%	18,840.29	14.7%	13,699.93	11.2%
TOTAL PROVISIONS AND CONTINGENCIES	36,140.38	12.7%	29,203.77	17.1%	30,647.74	22.5%	29,779.67	23.2%	24,598.52	20.1%
TOTAL EXPENDITURE	3,42,548.27	120.8%	1,58,517.40	92.8%	1,29,544.50	95.3%	1,24,028.51	96.5%	1,19,772.00	98.0%
NET PROFIT / LOSS FOR THE YEAR	65,446.50	23.1%	46,148.70	27.0%	38,150.90	28.1%	31,856.77	24.8%	27,296.27	22.3%
NET PROFIT / LOSS AFTER EI & PRIOR YEAR ITEMS	65,446.50	23.1%	46,148.70	27.0%	38,150.90	28.1%	31,856.77	24.8%	27,296.27	22.3%
Minority Interest	-1,384.46	-0.5%	-151.59	-0.1%	-98.15	-0.1%	-23.56	0.0%	-42.31	0.0%
Share Of Profit/Loss Of Associates	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
CONSOLIDATED PROFIT/LOSS AFTER MI AND ASSOCIATES	64,062.04	22.6%	45,997.11	26.9%	38,052.75	28.0%	31,833.21	24.8%	27,253.95	22.3%
Profit / Loss Brought Forward	0	0.0%	0	0.0%	78,594.20	57.8%	61,817.69	48.1%	52,849.61	43.3%
TOTAL PROFIT / LOSS AVAILABLE FOR APPROPRIATIONS	0	0.0%	45,997.11	26.9%	1,16,646.95	85.8%	93,650.90	72.9%	80,103.56	65.6%
APPROPRIATIONS										
Transfer To / From Statutory Reserve	0		0		9,444.38		7,879.70		6,771.72	
Transfer To / From Revenue And Other Reserves	0		0		-48.34		0		0	
Dividend and Dividend Tax for The Previous Year	0		0		3,592.40		0		4,893.36	
Equity Share Dividend	0		0		0		0		1,646.95	
Tax On Dividend	0		0		0		0		90.27	
Balance Carried Over To Balance Sheet	0		45,997.11		99,062.77		78,594.20		61,817.69	
TOTAL APPROPRIATIONS	0		45,997.11		1,16,646.95		93,650.90		80,103.56	
OTHER ADDITIONAL INFORMATION										
EARNINGS PER SHARE										
Basic EPS (Rs.)	90		83		69		58		50	
Diluted EPS (Rs.)	90		82		68		58		49	

Interpretation

- HDFC Bank is increasingly relying on non-interest income (fees, commissions) alongside traditional loan interest.
- Investments are contributing significantly to overall revenue, suggesting a strategic shift.
- Operating expenses have increased, likely due to expansion and technology investments.
- Despite higher costs, the bank maintains strong profitability.

Common Size Balance Sheet of HDFC Bank (2020-24)

BALANCE SHEET OF HDFC BANK (in Rs. Cr.)										
	Mar-24		Mar-23		Mar-22		Mar-21		Mar-20	
	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE
EQUITIES AND LIABILITIES										
SHAREHOLDER'S FUNDS										
Equity Share Capital	759.69	0.02%	557.97	0.02%	554.55	0.03%	551.28	0.03%	548.33	0.03%
TOTAL SHARE CAPITAL	759.69	0.02%	557.97	0.02%	554.55	0.03%	551.28	0.03%	548.33	0.03%
Revaluation Reserve	0		0		0		0		0	
Reserves and Surplus	452982.84	11.24%	2,88,879.55	11.42%	2,46,771.62	11.62%	2,09,258.91	11.63%	1,75,810.38	11.12%
TOTAL RESERVES AND SURPLUS	4,52,982.84	11.24%	2,88,879.55	11.42%	2,46,771.62	11.62%	2,09,258.91	11.63%	1,75,810.38	11.12%
TOTAL SHAREHOLDERS FUNDS	4,53,742.53	11.26%	2,89,437.52	11.44%	2,47,326.17	11.65%	2,09,810.19	11.66%	1,76,358.71	11.16%
Minority Interest	0		860.26		720.41		632.76		576.64	
Deposits	23,76,887.28	58.98%	18,82,663.25	74.40%	15,58,003.03	73.39%	13,33,720.88	74.12%	11,46,207.13	72.51%
Borrowings	7,30,615.46	18.13%	2,56,548.66	10.14%	2,26,966.50	10.69%	1,77,696.75	9.87%	1,86,834.32	11.82%
Other Liabilities and Provisions	4,68,948.99	11.64%	1,00,922.74	3.99%	89,918.19	4.24%	77,646.07	4.31%	70,853.63	4.48%
TOTAL CAPITAL AND LIABILITIES	40,30,194.26	100%	25,30,432.43	100%	21,22,934.30	100%	17,99,506.65	100%	15,80,830.43	100%
ASSETS										
Cash and Balances with Reserve Bank of India	1,78,718.67	4.43%	1,17,189.28	4.63%	1,30,030.71	6.13%	97,370.36	5.41%	72,211.00	4.57%
Balances with Banks Money at Call and Short Notice	50,115.84	1.24%	79,958.53	3.16%	25,355.02	1.19%	23,902.17	1.33%	15,729.11	0.99%
Investments	10,05,681.63	24.95%	5,11,581.71	20.22%	4,49,263.86	21.16%	4,38,823.11	24.39%	3,89,304.95	24.63%
Advances	25,65,891.41	63.67%	16,61,949.29	65.68%	14,20,942.28	66.93%	11,85,283.52	65.87%	10,43,670.88	66.02%
Fixed Assets	12,603.76	0.31%	8,431.34	0.33%	6,432.07	0.30%	5,099.56	0.28%	4,626.86	0.29%
Other Assets	2,17,182.95	5.39%	1,51,322.28	5.98%	90,910.36	4.28%	49,027.92	2.72%	55,287.64	3.50%
TOTAL ASSETS	40,30,194.26	100%	25,30,432.43	100%	21,22,934.30	100%	17,99,506.64	100%	15,80,830.44	100%
CONTINGENT LIABILITIES, COMMITMENTS										
Bills for Collection	0		0		56,968.05		44,748.14		51,584.90	
Contingent Liabilities	0		0		14,00,197.64		9,75,280.66		11,30,474.06	

Interpretation

- Assets and liabilities have grown steadily, indicating a growing business.
- Customer deposits are the primary source of funding, showing strong customer trust.
- The bank is lending more money, which is its main source of income.
- Investments are increasing, suggesting a strategy to diversify income.

Common Size Profit & Loss Account of SBI (2020-24)

PROFIT & LOSS ACCOUNT OF STATE BANK OF INDIA (in Rs.)										
	Mar-24		Mar-23		Mar-22		Mar-21		Mar-20	
	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE
INCOME										
Interest / Discount on Advances / Bills	2,97,310.15	67.7%	2,28,740.75	65.2%	1,77,474.83	61.2%	1,76,780.19	63.6%	1,85,494.19	68.7%
Income from Investments	1,22,378.19	27.9%	1,06,824.85	30.4%	93,477.90	32.2%	87,130.62	31.3%	74,812.87	27.7%
Interest on Balance with RBI and Other Inter-Bank funds	5,941.80	1.4%	3,916.46	1.1%	4,608.35	1.6%	4,541.43	1.6%	3,066.25	1.1%
Others	13,558.37	3.1%	11,362.52	3.2%	14,411.61	5.0%	9,663.24	3.5%	6,478.34	2.4%
TOTAL INTEREST EARNED	4,39,188.51	100.0%	3,50,844.58	100.0%	2,89,972.69	100.0%	2,78,115.48	100.0%	2,69,851.66	100.0%
Other Income	1,55,386.39	35.4%	1,22,533.56	34.9%	1,17,000.40	40.3%	1,07,222.41	38.6%	98,158.99	36.4%
Total Income	5,94,574.90	135.4%	4,73,378.14	134.9%	4,06,973.09	140.3%	3,85,337.89	138.6%	3,68,010.65	136.4%
EXPENDITURE										
Interest Expended	2,59,736.05	59.1%	1,89,980.82	54.1%	1,56,194.34	53.9%	1,56,010.17	56.1%	1,61,123.80	59.7%
Payments to and Provisions for Employees	76,571.19	17.4%	61,920.91	17.6%	61,445.13	21.2%	54,330.83	19.5%	48,850.95	18.1%
Depreciation	0	0.0%	3,644.79	1.0%	3,652.68	1.3%	3,673.43	1.3%	3,661.56	1.4%
Depreciation on Leased Assets	0	0.0%	50.8	0.0%	38.59	0.0%	37.64	0.0%	0	0.0%
Operating Expenses (excludes Employee Cost & Depreciation)	1,52,222.65	34.7%	1,24,197.98	35.4%	1,09,227.03	37.7%	92,387.71	33.2%	79,269.06	29.4%
TOTAL OPERATING EXPENSES	2,28,793.84	52.1%	1,89,814.49	54.1%	1,74,363.43	60.1%	1,50,429.60	54.1%	1,31,781.56	48.8%
Provision Towards Income Tax	23,101.78	5.3%	23,182.65	6.6%	0	0.0%	0	0.0%	4,372.77	1.6%
Provision Towards Deferred Tax	0	0.0%	-4,342.79	-1.2%	0	0.0%	0	0.0%	7,502.08	2.8%
Other Provisions and Contingencies	7,704.97	1.8%	18,184.55	5.2%	40,059.15	13.8%	54,618.41	19.6%	45,053.61	16.7%
TOTAL PROVISIONS AND CONTINGENCIES	30,806.75	7.0%	37,024.41	10.6%	40,059.15	13.8%	54,618.41	19.6%	56,928.46	21.1%
TOTAL EXPENDITURE	5,19,336.64	118.2%	4,16,819.71	118.8%	3,70,616.92	127.8%	3,61,058.17	129.8%	3,49,833.82	129.6%
NET PROFIT / LOSS FOR THE YEAR	75,238.26	17.1%	56,558.43	16.1%	36,356.17	12.5%	24,279.72	8.7%	18,176.83	6.7%
NET PROFIT / LOSS AFTER EI & PRIOR YEAR ITEMS	68,138.26	15.5%	56,558.43	16.1%	36,356.17	12.5%	24,279.72	8.7%	18,176.83	6.7%
Minority Interest	2,458.75	0.6%	1,191.45	0.3%	-1,809.30	-0.6%	-1,482.36	-0.5%	-1,372.17	-0.5%
Share Of Profit/Loss Of Associates	1,405.16	0.3%	-2,101.71	-0.6%	827.01	0.3%	-391.9	-0.1%	2,963.14	1.1%
CONSOLIDATED PROFIT/LOSS AFTER MI AND ASSOCIATES	72,002.17	16.4%	55,648.17	15.9%	35,373.88	12.2%	22,405.46	8.1%	19,767.80	7.3%
Profit / Loss Brought Forward	0	0.0%	20,394.35	5.8%	8,096.54	2.8%	-1,361.74	-0.5%	-8,328.40	-3.1%
TOTAL PROFIT / LOSS AVAILABLE FOR APPROPRIATIONS	0	0.0%	76,042.52	21.7%	43,470.42	15.0%	21,043.72	7.6%	11,439.40	4.2%
APPROPRIATIONS										
Transfer To / From Statutory Reserve	0		15,370.40		9,769.03		6,287.84		4,538.18	
Transfer To / From Revenue And Other Reserves	0		3,854.27		1,783.68		1,620.72		8,254.91	
Dividend and Dividend Tax for The Previous Year	0		0		0		0		0	
Equity Share Dividend	0		10,084.81		6,336.47		3,569.84		0	
Tax On Dividend	0		1.5		0.87		3.65		8.06	
Balance Carried Over To Balance Sheet	0		41,923.30		20,394.35		8,096.54		-1,361.74	
TOTAL APPROPRIATIONS	0		76,042.52		43,470.42		21,043.72		11,439.40	
OTHER ADDITIONAL INFORMATION										
EARNINGS PER SHARE										
Basic EPS (Rs.)	75		62		40		25		22	
Diluted EPS (Rs.)	75		62		40		25		22	

Interpretation

- SBI experienced steady growth in revenue in last five years.
- Interest income from loans and investments was the primary driver of revenue.
- Operating expenses, particularly employee costs and provisions, increased steadily.
- Despite rising expenses, SBI remained profitable throughout the period.

- The bank consistently paid dividends to shareholders.
- SBI has been building its reserves over the years, indicating a strong financial position.

Common Size Balance Sheet of SBI (2020-24)

BALANCE SHEET OF STATE BANK OF INDIA (in Rs. Cr.)										
	Mar-24		Mar-23		Mar-22		Mar-21		Mar-20	
	AMOUNT	PERCENTAG	AMOUNT	PERCENTAG	AMOUNT	PERCENTAG	AMOUNT	PERCENTAG	AMOUNT	PERCENTAG
EQUITIES AND LIABILITIES										
SHAREHOLDER'S FUNDS										
Equity Share Capital	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%
TOTAL SHARE CAPITAL	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%
Revaluation Reserve	0	0.0%	27,756.26	0.5%	23,377.87	0.4%	23,577.35	0.5%	23,762.67	0.6%
Reserves and Surplus	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%	892.46	0.0%
TOTAL RESERVES AND SURPLUS	4,29,664.67	6.4%	3,58,038.86	6.0%	3,04,695.58	5.7%	2,74,669.10	5.7%	2,50,167.66	6.0%
TOTAL SHAREHOLDERS FUNDS	4,29,664.67	6.4%	3,30,282.60	5.5%	2,81,317.72	5.2%	2,51,091.75	5.2%	2,26,405.00	5.4%
Minority Interest	0	0.0%	12,836.62	0.2%	11,207.42	0.2%	9,625.92	0.2%	7,943.82	0.2%
Deposits	49,66,537.49	73.8%	44,68,535.51	75.0%	40,87,410.60	76.2%	37,15,331.24	76.7%	32,74,160.63	78.0%
Borrowings	6,39,609.50	9.5%	5,21,151.95	8.8%	4,49,159.78	8.4%	4,33,796.21	9.0%	3,32,900.67	7.9%
Other Liabilities and Provisions	6,97,074.68	10.4%	5,92,962.92	10.0%	5,07,517.68	9.5%	4,11,303.62	8.5%	3,31,427.10	7.9%
TOTAL CAPITAL AND LIABILITIES	67,33,778.80	100.0%	59,54,418.32	100.0%	53,60,883.53	100.0%	48,45,618.55	100.0%	41,97,492.34	100.0%
ASSETS										
Cash and Balances with Reserve Bank of India	2,25,356.33	3.3%	2,47,321.05	4.2%	2,58,086.43	4.8%	2,13,498.62	4.4%	1,66,968.46	4.0%
Balances with Banks Money at Call and Short Notice	1,01,215.97	1.5%	70,990.86	1.2%	1,40,818.69	2.6%	1,34,208.42	2.8%	87,346.80	2.1%
Investments	21,10,548.23	31.3%	19,13,107.86	32.1%	17,76,489.90	33.1%	15,95,100.27	32.9%	12,28,284.28	29.3%
Advances	37,84,272.67	56.2%	32,67,902.13	54.9%	27,94,076.00	52.1%	25,00,598.99	51.6%	23,74,311.18	56.6%
Fixed Assets	44,708.18	0.7%	44,407.38	0.7%	39,510.03	0.7%	40,166.79	0.8%	40,078.17	1.0%
Other Assets	4,67,677.42	6.9%	4,10,689.04	6.9%	3,51,902.48	6.6%	3,62,045.47	7.5%	3,00,503.45	7.2%
TOTAL ASSETS	67,33,778.80	100.0%	59,54,418.32	100.0%	53,60,883.53	100.0%	48,45,618.55	100.0%	41,97,492.34	100.0%
CONTINGENT LIABILITIES, COMMITMENTS										
Bills for Collection	0		64,571.94		77,783.06		17,14,239.52		55,790.70	
Contingent Liabilities	0		18,35,524.38		20,07,232.49		17,14,239.52		12,21,083.11	

Interpretation

- SBI has a significant asset, with loans (advances) being the largest component.
- Deposits have been steadily increasing, providing a solid funding for the bank's operations.
- A substantial portion of the bank's assets is invested in government securities and other instruments.
- The bank maintains sufficient capital to support its operations and growth.

5. FINDINGS

HDFC has maintained a consistently low Gross NPA Ratio, underscoring its strong credit risk management and stable asset quality. While SBI has achieved a remarkable reduction in its Gross NPA Ratio, highlighting its efforts to clean up its balance sheet and improve the quality of its loan portfolio.

HDFC leads with higher and stable ROA figures, SBI's notable improvement points towards a strengthening financial position. Both banks exhibit strong management practices, with HDFC showing consistent high efficiency and SBI demonstrating significant progress in improving its financial metrics.

HDFC shows significant improvement in its current ratio over the period. Starting from a potentially concerning low in 2021, it improves to a solid 1.53 in 2023, indicating enhanced liquidity management. While SBI maintains a consistently strong current ratio throughout the period, reflecting robust short-term liquidity and effective management of current assets and liabilities.

both banks have different levels of financial leverage due to the nature of their operations, HDFC maintains a lower and stable D/E ratio compared to SBI's higher but slightly decreasing ratio. These findings highlight HDFC's steady leverage management and SBI's characteristic high leverage with efforts towards reduction.

6. CONCLUSIONS

After the above study on the comparative analysis of SBI and HDFC it was discovered that both the banks are managing their ratios to the best of their abilities within the specified parameters. However, when we compare the two banks, it appears that HDFC Bank has an edge over SBI, reason being HDFC Bank have lower NPAs than the SBI. HDFC Bank having average Gross NPAs less than 1.22% while SBI having the Gross NPAs near about 4.024% as per the annual report of both banks over the last five years.

HDFC Bank has managed their NPA and profitability ratios in a very efficient manner and are playing an important role as a profitable commercial bank, while SBI is controlling its ratios particularly the current assets ratio but is not as competitive in terms of net profit and Non-Performing Assets (NPAs). SBI needs to be more focused on managing the net profits and NPAs part to be a commercially successful bank.

HDFC Bank has consistently demonstrated higher profitability ratios compared to SBI Bank. This includes a higher net profit margin and return on equity (ROE). HDFC's efficient cost management and higher income from non-interest sources contribute to this superior performance.

HDFC Bank appears stronger in terms of profitability, efficiency, asset quality, and capital adequacy. Its modern operational practices and focus on technology-driven services position it favourably.

SBI Bank benefits from its extensive reach and government backing, but faces challenges related to higher operational costs and asset quality issues. However, its conservative liquidity management provides stability.

Overall, while both banks have strengths, HDFC Bank shows superior performance metrics on several fronts, making it a more efficient and profitable institution in the analysed period.

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SUSTAINABLE INNOVATIVE PRACTICE TO ENHANCE THE PROPERTIES OF PAVEMENT QUALITY CONCRETE

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Abstract

The road construction industry constantly seeks sustainable practices to reduce environmental hazards without compromising the properties of Pavement Quality Concrete (PQC). This project focuses on optimizing the properties of PQC through innovative techniques to achieve sustainability in road construction. This research explores the potential for enhancing PQC properties, including compressive strength, durability, and workability, while minimizing costs and environmental impact by adopting Python programming, deep learning models, and advanced data analytics. To predict PQC performance, an Artificial Neural Network (ANN) was employed to capture complex, nonlinear relationships between input variables, such as cement content, water-cement ratio, and aggregate quality, and output properties like compressive strength and durability. Key insights from this study emphasize the importance of cement content, water-cement ratio, and aggregate quality in ensuring high-performance PQC while minimizing environmental footprint. Although external factors such as raw material variation may influence model accuracy. This study showcases the role of technology in achieving sustainable business models within the road construction industry. The findings provide a strong foundation for future studies and highlight the potential for further advancements in sustainable construction practices.

Keywords: *Pavement Quality Concrete, Artificial Neural Networks, sustainability, concrete mix design.*

1. Introduction

Concrete is a widely used construction material known for its key properties that ensure long-term performance and durability, including slump, compressive strength, and flexural strength. Slump measures workability, while compressive and flexural strengths reflect the material's mechanical properties, essential for structural integrity. Accurate prediction of these properties is crucial for designing efficient concrete mixes that meet performance requirements, reduce waste, and support sustainability. Traditional methods often rely on trial-and-error or empirical formulas, which fail to account for the complex, nonlinear relationships between ingredients. For instance, the combined effects of water content, cementitious materials (such as slag and fly ash), superplasticizers, and aggregates are not easily captured. This can lead to suboptimal mix designs, increased costs, and compromised structural performance. While the Indian

standard (IS 10262) provides guidelines, improper mix design can raise costs. Therefore, optimizing concrete mix proportions to maximize performance, based on the intricate relationship between raw materials and compressive strength, is essential for achieving both cost-efficiency and high-quality results.

Several researchers have conducted studies to predict concrete properties using various machine learning techniques. For instance, Topcu and Sarıdemir (2008) used ANN and fuzzy logic to predict the compressive strength of concrete containing fly ash [1]. Ince (2004) applied ANN to predict the fracture parameters of concrete [2]. Sarıdemir (2009) used ANN to predict the compressive strength of mortars containing metakaolin [3]. Chen et al. (2015) developed a new database platform that implemented stepwise multiple linear regression and BP ANN approaches to identify correlations between concrete properties and the proportion of concrete raw materials [4]. Bilim et al. (2009) predicted the compressive strength of ground-granulated blast furnace slag concrete using ANN [5]. Boukli et al. (2014) evaluated the probabilistic modeling of the compressive strength of concrete using response surface methodology and neural networks [6]. Ren and Zhao (2002) proposed an optimal neural network for concrete strength modeling [7]. Altun et al. (2008) predicted the compressive strength of steel fiber-added lightweight concrete using neural networks [8]. J. Bai et al. (2003) used neural networks to predict the workability of concrete incorporating metakaolin and fly ash [9]. Duan et al. (2021) used the ICA XGBoost model to predict the compressive strength of recycled aggregate concrete [10]. Topcu et al. (2008) applied ANN to predict the properties of rubberized concrete [11]. Moayedi and Hayati (2018) used artificial intelligence design charts to predict the friction capacity of driven piles in clay [12]. Jian et al. (2021) studied the compressive behavior of compound concrete containing demolished concrete lumps and recycled aggregate concrete [13]. Muliawan et al. (2020) predicted concrete compressive strength using artificial intelligence methods [14]. Shahmansouri et al. (2021) used ANN to predict the compressive strength of eco-friendly geopolymer concrete incorporating silica fume and natural zeolite [15]. Shiuly et al. (2022) applied a machine learning approach for performance and optimization studies of waste plastic aggregate-based sustainable concrete [16]. Mandal et al. (2024) conducted a study on the use of different machine-learning techniques for predicting concrete properties from their mixture proportions with deterministic and robust optimization [17].

The significance of this research lies in its involvement in the advancement of smart and innovative techniques in concrete mix design. By participating Artificial Neural Networks (ANN) in the progression of concrete property prediction, this study establishes the potential of machine learning technology to revolutionize the construction industry. ANN is a machine learning procedure known for its capability to model complicated patterns and nonlinear associations in data. ANN offers a robust difference from traditional approaches by analyzing a comprehensive set of input variables, including water, cement content, water-cement ratio, aggregate properties, and admixture convention. By training the ANN model through these variables, this study proposes to precisely predict slump, compressive strength, and flexural strength, providing a data-driven explanation for optimizing concrete mix design. The implementation of ANN not only enhances predictive accuracy but also provisions sustainable construction observes by minimizing material waste, reducing costs, and ensuring high-quality outputs.

2. Methodology

2.1 Data collection and experiment program

Concrete mix properties were designated from experimental outcomes and available literature to certify a comprehensive dataset for this study. 103 data points (Table 1) were primarily accumulated from the laboratory mix designs and corresponding slump test (Fig. 1) and compressive strength test (Fig. 2), values were tabulated. As data quality plays a crucial role in the progress of predictive models, pre-processing was undertaken to enhance the dataset and expand its usability. Data reduction was accomplished by removal rows with absent values, mainly one row with a missing value in the dataset. The prepared dataset reserved 103 complete entries, representative mix designs without any missing values, and encompassing both slump and 28-day compressive strength metrics. This distinguished dataset certifies the integrity and constancy of the input data, which is crucial for machine learning-based prediction models.

Next, data scaling was applied using a regular distribution (Gaussian distribution) to standardize the input features. The input parameters involved Ordinary Portland Cement (OPC) content, Slag, Fly-ash, water content, Superplasticizer, fine aggregate, and coarse aggregate quantities (all measured in kg/m^3), as well as aggregate size. The output parameters remained the slump (in cm), Compressive Strength (MPa) & Flexural Strength equivalent to each mix proportion. The boxplots of the mixture contents, compressive strength (Fig. 3), slump (Fig. 4) and different concrete component (Fig. 5) are presented in this section. Box plot shows the distribution of slump, compressive strength, and concrete ingredients highlighting variability, median values and outlines.

Earlier studies have accentuated the importance of optimizing the mix design to improve concrete properties such as compressive strength, workability (slump), and flexural strength. Several methods have been adopted, including chemical admixtures, optimizing aggregate sizes, and adjusting the water-cement ratio. Current advances in data-driven modelling, such as ANNs, have provided tools to capture non-linear associations in complex datasets, contributing a substantial enhancement in predicting concrete properties. Genetic Algorithms have also exposed potential in optimizing mix designs through corresponding various objectives, including quality and cost. Several researchers have discovered different machine learning techniques for predicting concrete properties. Shiuly et al. (2022) [16] used machine learning approach by Performance and optimisation study of waste plastic aggregate based sustainable concrete. Mandal et al. (2024) study on the use of different machine learning techniques for prediction of concrete properties from their mixture proportions with their deterministic and robust optimization [17].



Fig.1 Slump Test



Fig.2 Comprehensive Strength Test

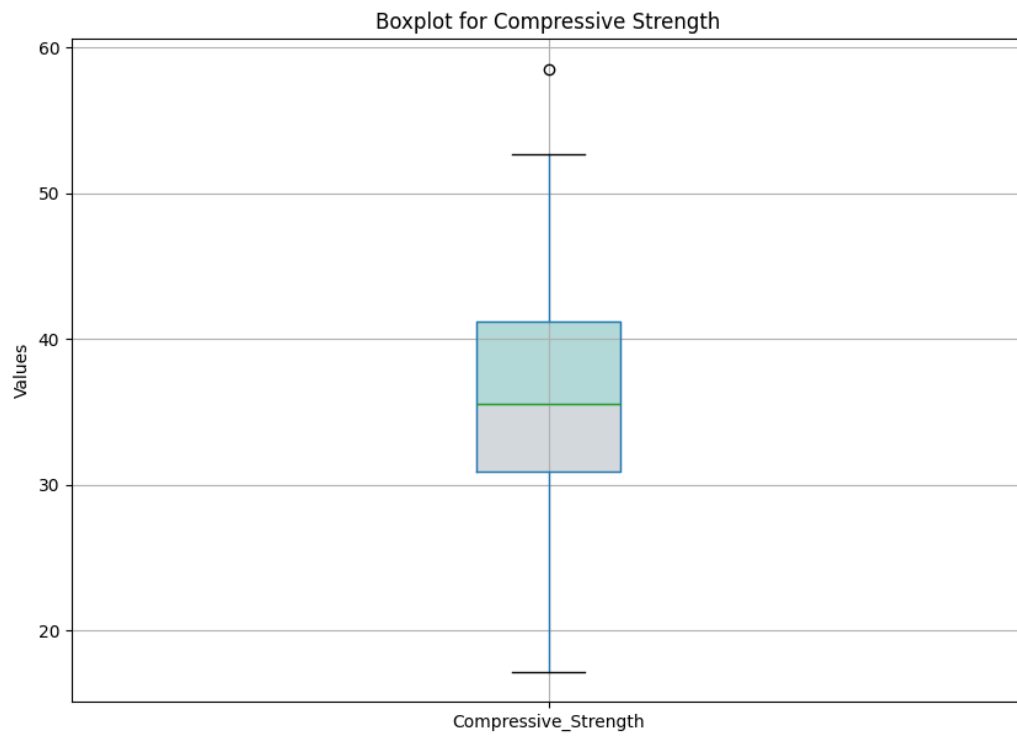


Fig. 3. Compressive Strength

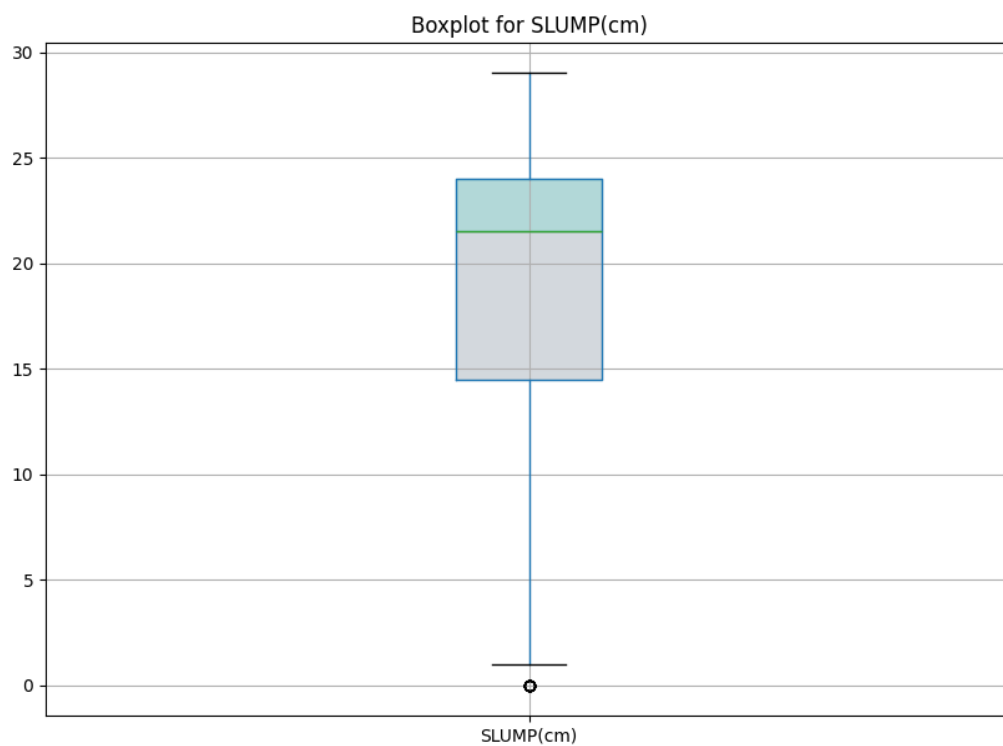


Fig. 4. Slump

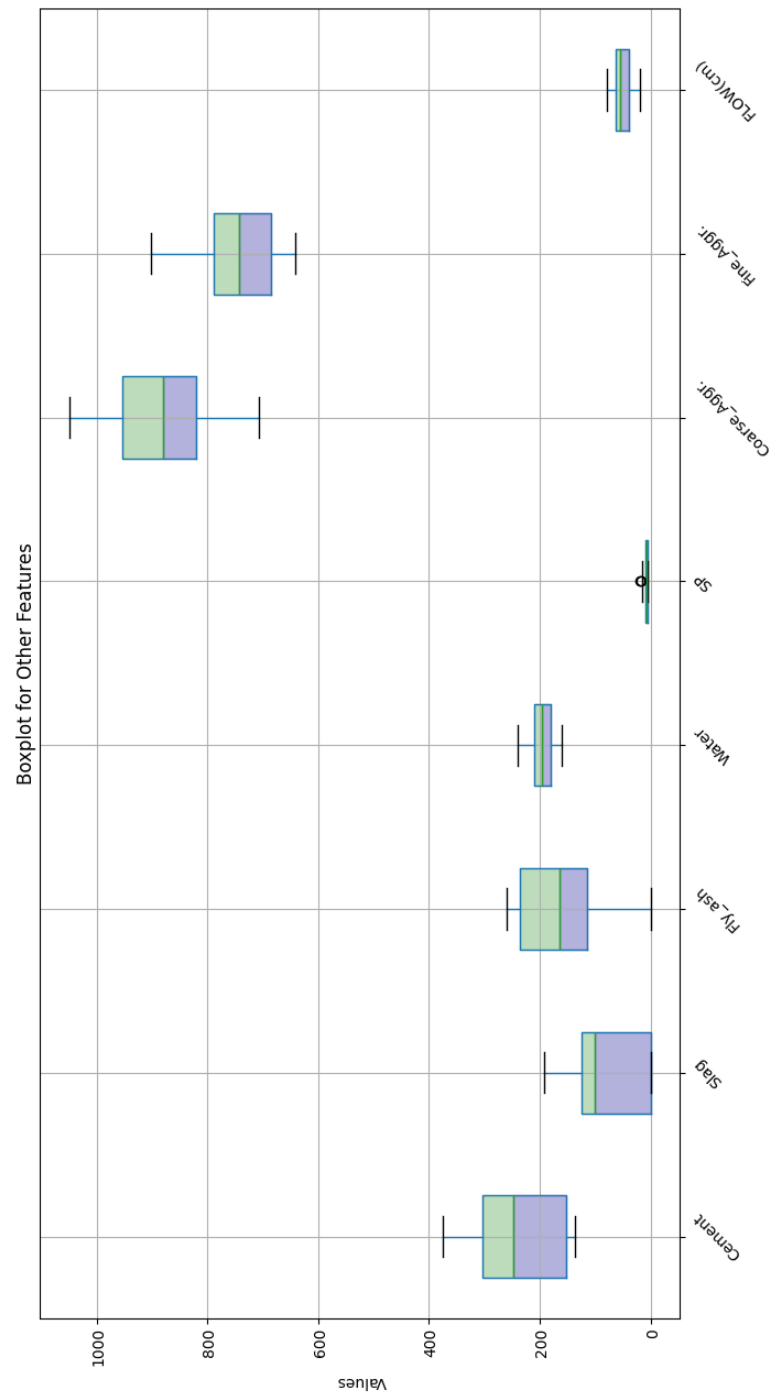


Fig.5. Box plot of different concrete components

Table 1. Experimental mixture design data

Cement	Slag	Fly Ash	Water	SP	Coarse Aggregate	Fine Aggregate	Slump	Flow	Comp Strength
273	82	105	210	9	904	680	23	62	34.99
163	149	191	180	12	843	746	0	20	41.14
162	148	191	179	16	840	743	1	20	41.81
162	148	190	179	19	838	741	3	21.5	42.08
154	112	144	220	10	923	658	20	64	26.82
147	89	115	202	9	860	829	23	55	25.21
152	139	178	168	18	944	695	0	20	38.86
145	0	227	240	6	750	853	14.5	58.5	36.59
152	0	237	204	6	785	892	15.5	51	32.71
304	0	140	214	6	895	722	19	51	38.46
145	106	136	208	10	751	883	24.5	61	26.02
148	109	139	193	7	768	902	23.75	58	28.03
142	130	167	215	6	735	836	25.5	67	31.37
354	0	0	234	6	959	691	17	54	33.91
374	0	0	190	7	1013	730	14.5	42.5	32.44
159	116	149	175	15	953	720	23.5	54.5	34.05
153	0	239	200	6	1002	684	12	35	28.29
295	106	136	206	11	750	766	25	68.5	41.01
310	0	143	168	10	914	804	20.5	48.2	49.3
296	97	0	219	9	932	685	15	48.5	29.23
305	100	0	196	10	959	705	20	49	29.77
310	0	143	218	10	787	804	13	46	36.19
148	180	0	183	11	972	757	0	20	18.52
146	178	0	192	11	961	749	18	46	17.19
142	130	167	174	11	883	785	0	20	36.72
140	128	164	183	12	871	775	23.75	53	33.38
308	111	142	217	10	783	686	25	70	42.08
295	106	136	208	6	871	650	26.5	70	39.4
298	107	137	201	6	878	655	16	26	41.27
314	0	161	207	6	851	757	21.5	64	41.14

2.2 Role of Machine Learning

Various engineering disciplines have been revolutionized by machine learning (ML) as it has proved to be a competent solution to numerous complex and non-linear problems. In the case of concrete within civil engineering, however, the challenge lies in the prediction of construction material properties owing to the complex dependencies between material composition and physical properties. Many times, linear statistical relations are not successful in modelling these nonlinear dependencies well. One of the categories of machine learning is the ANNs which indeed have a great promise in this type of task that requires handling non-linearity, learning from data, enhance predictive accuracy and adaptability.

2.3 Artificial Neural Network (ANN)

An artificial neuron is a model enthused by how real neurons work in the brain. Actual neurons receive signals through influences on their dendrites. If the signal is sufficient, the neuron triggers and directs the signal through its axon, which can activate further neurons. Artificial Neural Networks (ANNs) are used to resolve problems like recognizing pattern, making prediction, and handling memory tasks. It makes ANNs different from traditional systems is their capability to learn mechanically from training data. It treasures relationships between input and output data, serving to solve complex problems like data mapping. ANNs are made of various artificial neurons working together, alike to how the brain processes information. The way these neurons communicate distresses how the network works and what it can do. Training an ANN includes changing the associates between neurons step by step to decrease errors. Once trained, an ANN can make accurate predictions, even with new data it has not seen before. This makes it a strong, robust tool for analyzing and resolving problems.

Neural networks are systematized into layers. The input layer accumulates data from the surroundings, hidden layers process the information, & the output layer provides the solution. The complexity of a network depends on how many layers it has. Hidden layers make the network better at handling problematic tasks. The final output is the solution based on the work done by the neurons in the last layer. In summary, ANNs are powerful & efficient systems. They mimic the brain's way of working, making them valuable tools for tasks that need learning, precision, and adaptability.

2.4 Evaluation Metrics:

Three standard metrics of evaluation (i) Mean Absolute Error (MAE), (ii) Mean Squared Error (MSE), (iii) R^2 score were used to assess the performance of the trained models.

2.4.1 Mean Absolute Error (MAE)

Mean absolute error computes the average difference between the calculated values and actual values. It is also known as scale-dependent accuracy as it calculates errors in observations taken on the corresponding scale used to predict the precision of the machine learning model. The Mathematical formula for MAE is given below.

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}_i|$$

Where, y_i is the actual value, $\hat{y}_i$ is the predicted value and n is the number of data points.

2.4.2 Mean Squared Error (MSE)

MSE is a metric that quantifies the average squared difference between predicted and actual values in a dataset. It is calculated by averaging the squared residuals, where each residual is

the difference between a predicted value and its corresponding actual value. MSE serves as a measure of the model's accuracy. The Mathematical Formula for MSE is given below.

$$\text{MSE} = \frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

2.4.3 R² Score

R-squared is a statistical measure that specifies how well a regression model fits the data. Its value ranges from 0 to 1. An R-squared value of 1 implies a perfect fit, where there is no difference among the predicted and actual values. Conversely, an R-squared value of 0 specifies that the model fails to capture any unpredictability and does not establish a relationship between the dependent and independent variables. The Mathematical Formula for R² is-

$$R^2 = 1 - \frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{\sum_{i=1}^n (y_i - \bar{y})^2}$$

2.5 Loss Function: Huber Loss

The Huber loss function combines Mean Squared Error (MSE) and Mean Absolute Error (MAE), leveraging the compensations of both. It is frequently used in the machine learning because it is less affected by outliers compared to MSE, yet remains differentiable at its minimum, unlike MAE. (i) When the errors are small, Huber loss applies the MSE component, making the model more responsive to minor error. (ii) Equally, when the error is large, the MAE part of the loss function is applied, reducing the effect of outliers. A new hyper-parameter, frequently mentioned to as "delta," is introduced to define the threshold where the Huber loss changes from MSE to MAE. This delta value assistances balance the transition between the two loss components. Additional terms involving this hyper-parameter are

$$L_{\delta}(y, \hat{y}) = \begin{cases} \frac{1}{2}(y - \hat{y})^2 & \text{for } |y - \hat{y}| \leq \delta \\ \delta|y - \hat{y}| - \frac{1}{2}\delta^2 & \text{for } |y - \hat{y}| > \delta \end{cases}$$

involved to smooth the shift, ensuring a smooth and constant transition within loss function. This loss function showcases the flexibility and efficiency of loss functions in the machine learning, particularly for datasets with the outliers. The Huber Loss is defined as:

Where, y is the actual value, $\hat{y}$ is the predicted value, δ is a threshold that determines the point where the loss function transitions between quadratic and linear, for small errors (when $|y - \hat{y}| \leq \delta$), the loss behaves like MSE (quadratic), For large errors (when $|y - \hat{y}| > \delta$), the loss behaves like MAE (linear), which makes the model less sensitive to outliers.

3. Result and Discussion

In this study, 103 data points on concrete mixtures were evaluated by varying the levels of key components such as cement, slag, fly ash, superplasticizer (SP), water, flow, fine aggregate, coarse aggregate, compressive strength, and slump. Out of these, 83 data points were randomly selected for the training model, while the remaining 21 were used for testing. This method follows the common machine learning practice of piercing data into 80% for training and 20% for testing, particularly in supervised learning. This separation, known as the “train-test split,” ensures a balance between having sufficient data to train the model efficiently and retaining enough data to evaluate its presentation accurately. Assigning 80% of the data for training certifies the model has sufficient information to identify patterns and learn efficiently, leading to better performance. The goal of machine learning is to create a model that executes well on new, unseen data. Using too much data for testing (e.g., 50% or more) would leave inadequate data for training, reducing the model's capability to generalize. Assigning 20% of a dataset for testing ensures sufficient data to precisely evaluate a model's performance. Too few test data (e.g., 5% or less) might lead to assessment results that do not consistently signify the model's capability to perform on unseen data. The test data helps as a benchmark to evaluate the model's generalization capabilities, ensuring it is not overfitted to the training data. This proportion raids a balance between robust model training and reliable performance testing. There is no strict rule for an 80% training and 20% testing range; the choice often depends on aspects such as dataset size and problem complexity. Commonly, training and testing splits fall within a range of 70%–90% for training & 10%–30% for testing. While the 80–20 split is widely recognized, we used it to align with standard practices. This separation provides enough data for effective training while conserving adequate test data for a comprehensive evaluation of the model's performance.

3.1 Artificial neural network (ANN)

In this study, three ANN models were used to predict slump, compressive strength, and flexural strength of concrete. Each network consisted of some input parameters and it was implemented in Python using TensorFlow, Keras library.

3.1.1 Slump Prediction Model

Ten input features, namely cement, water, fly ash, slag, superplasticizer (SP), coarse aggregates, fine aggregates, flow, water-to-cement ratio, and coarse-to-fine aggregate ratio were used (Fig. 6). Six layers were used in architecture, which had the hidden layers as 512, 256, 128, 64, and 32 neurons in sequence, followed by ReLU activation. The output layer consisted of one neuron with a linear activation function to perform regression.

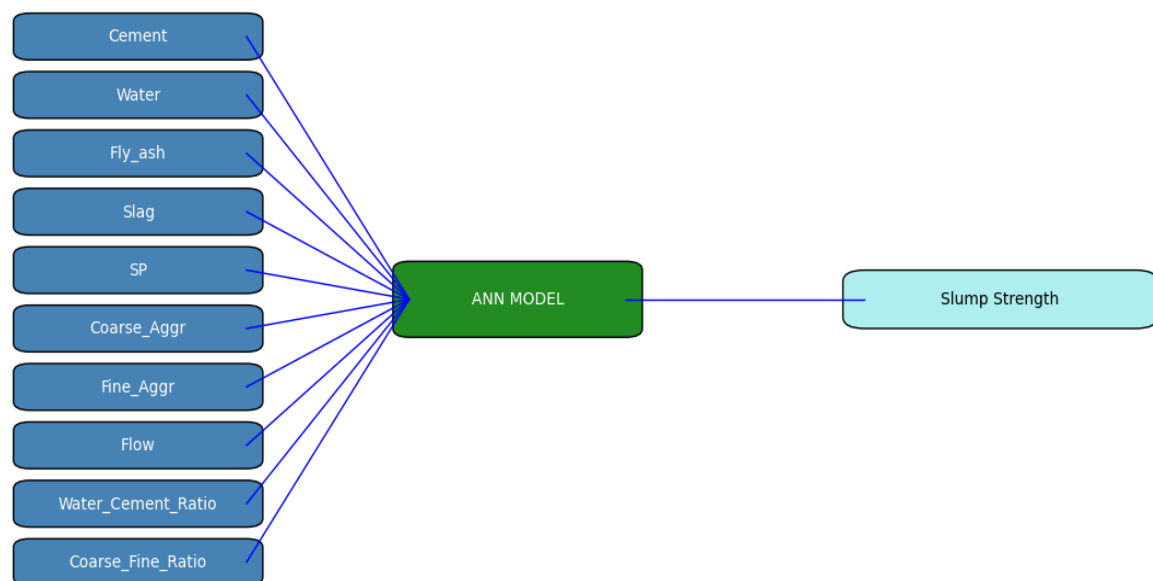


Fig. 6 Steps of ANN model used for predicting Slump Strength

3.1.2 Compressive Strength Prediction Model

Seven features, namely cement, slag, fly ash, water, SP, coarse aggregates, and fine aggregates were used in this analysis (Fig. 7). Five layers with hidden layers consisting of 256, 128, 64, and 32 neurons, respectively in architecture. All the hidden layers are equipped with ReLU activation. The output layer is of one neuron with linear activation.

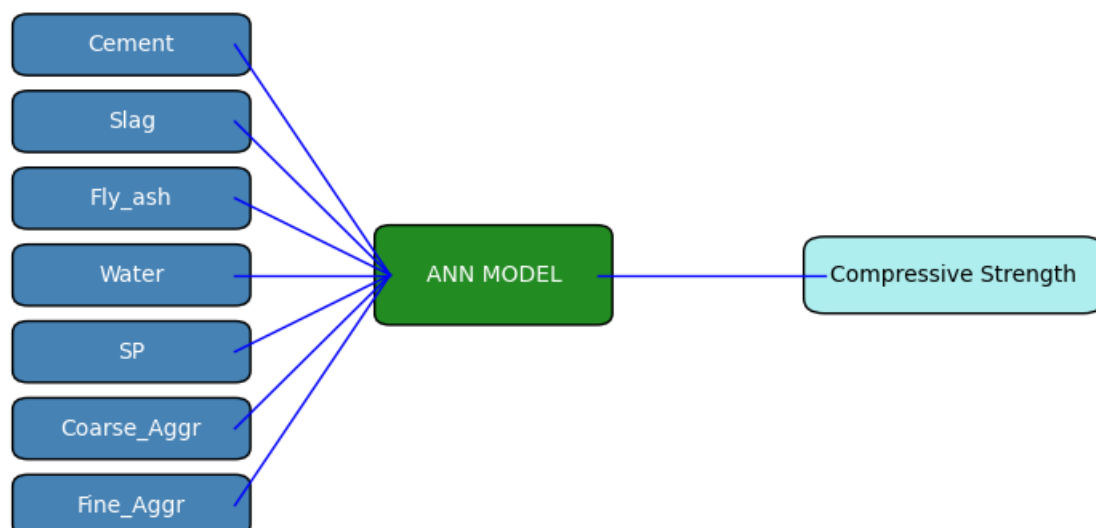


Fig 7. Steps of ANN model used for predicting Compressive Strength

3.1.3 Flexural Strength Prediction Model

Compressive strength as one input (Fig. 8) was used to predict flexural strength. Five layers, with hidden layers comprising 256, 128, 64, and 32 neurons, respectively, and ReLU activation. The output layer had one neuron with a linear activation function.

The models were trained using the Adam optimizer with varying learning rates (0.0001 for slump prediction and 0.001 for compressive and flexural strength predictions). The Huber loss function was selected for the robust regression which is less sensitive to outliers. Meanwhile, Mean Absolute Error, MAE, was chosen as the evaluation metric at training. Early stopping was not applied; however, the models were trained for a fixed number of epochs - 350 for slump, 330 for compressive strength, and 100 for flexural strength. The batch size was kept at 10.

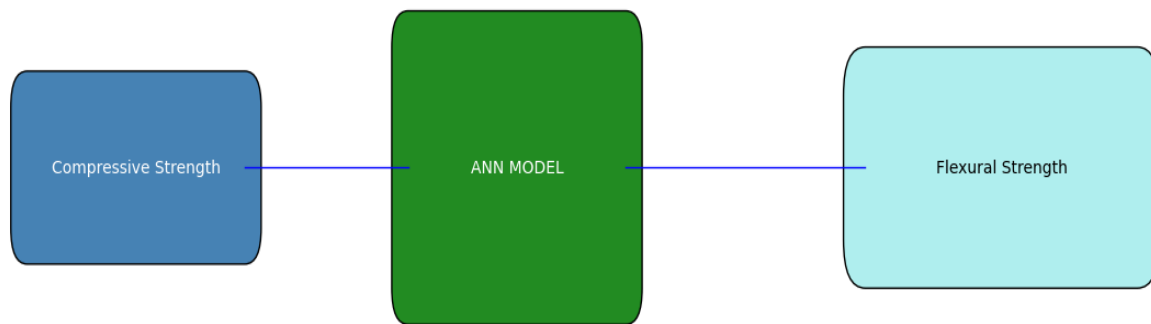


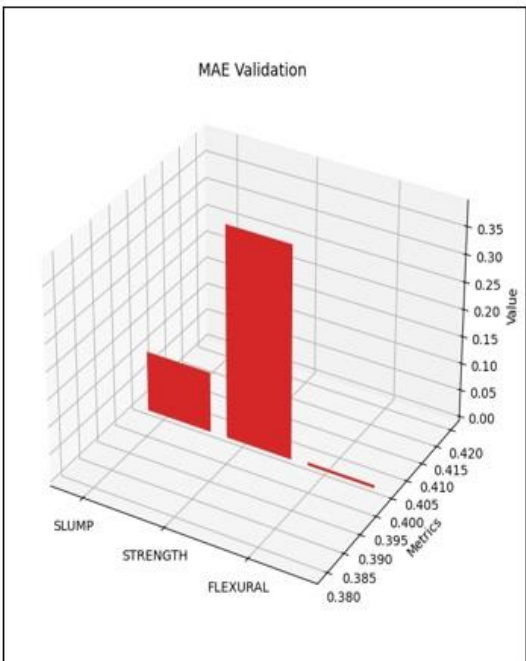
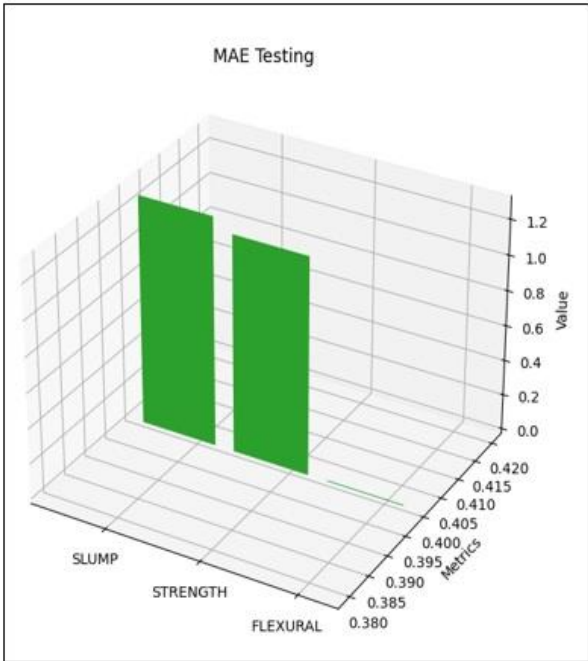
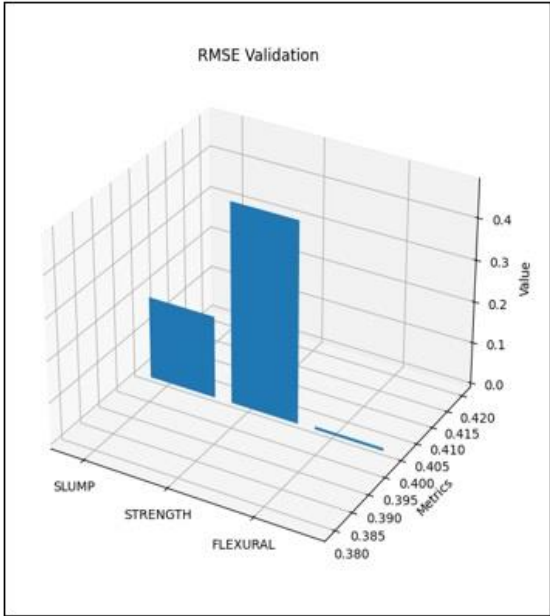
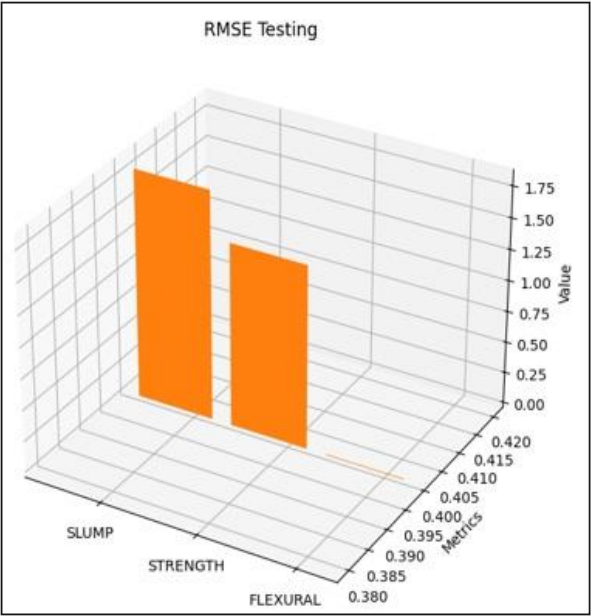
Fig. 8. Steps of ANN model used for predicting flexural strength

3.2 Model Results

The performance of the models was rated by using MAE, MSE, and R^2 score (Table 2). The results showed excellent predictive accuracy for all the tasks (Fig. 9).

Table 2 Model analysis of ANN

Type	R2 Score (%)	MAE (cm)	MSE (cm)
Slump	91.84	1.60	4.28
Compressive	96.64	1.05	1.69
Flexural	99.99	0.0023	0.00015



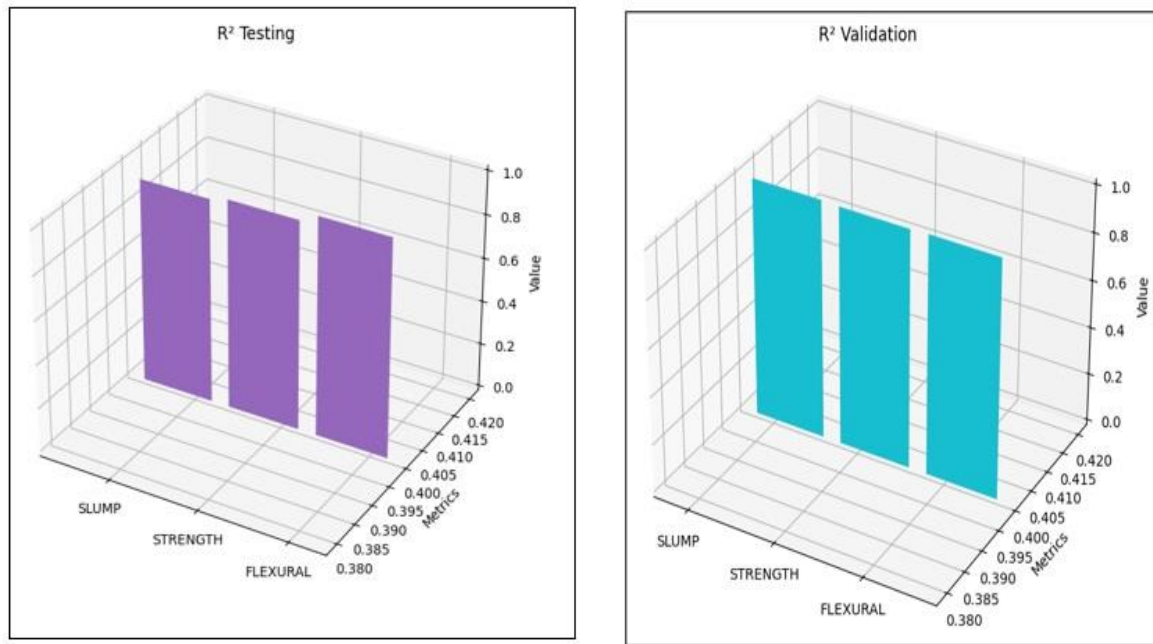


Fig. 9 The statistical analysis result for testing and validation of slump, strength, and flexural

The results show that ANN models are very effective in predicting the respective concrete properties. The models also eliminate the traditional empirical equations by automating high accuracy prediction (Table 3).

Table 3. Predicted Slump, predicted compressive strength, and predicted flexural strength

Slump (cm)	Pred slump	Compressive Strength	Pred comp	Flexural Strength	Pred Flex
23	22.88	34.99	34.42	5.03	5.03
0	0.00	41.14	40.73	5.45	5.45
1	0.99	41.81	41.48	5.50	5.49
3	2.99	42.08	41.87	5.51	5.51
20	23.58	26.82	25.57	4.40	4.39
23	22.97	25.21	25.47	4.27	4.25
0	-0.02	38.86	38.60	5.30	5.29
14.5	14.57	36.59	37.16	5.14	5.14
15.5	15.49	32.71	33.40	4.86	4.85
19	19.01	38.46	39.87	5.27	5.26
24.5	25.03	26.02	26.40	4.34	4.33
23.75	23.80	28.03	28.27	4.50	4.49
25.5	25.93	31.37	29.21	4.76	4.76
17	17.10	33.91	35.84	4.95	4.94
14.5	14.44	32.44	34.14	4.84	4.83
23.5	23.47	34.05	33.75	4.96	4.96
12	12.01	28.29	28.35	4.52	4.51
25	25.02	41.01	41.74	5.44	5.44
20.5	20.55	49.30	49.23	5.97	5.96
15	15.02	29.23	30.19	4.60	4.59
20	19.98	29.77	30.34	4.64	4.63
13	12.95	36.19	37.64	5.11	5.11
0	-0.02	18.52	18.14	3.66	3.64
18	18.03	17.19	16.99	3.52	3.52
0	-0.01	36.72	36.53	5.15	5.15
23.75	23.72	33.38	33.06	4.91	4.90
25	26.43	42.08	43.75	5.51	5.51
26.5	26.58	39.40	40.28	5.34	5.33
16	16.03	41.27	41.87	5.46	5.46
21.5	21.50	41.14	42.76	5.45	5.45
24	25.28	45.82	48.35	5.75	5.75
20	23.61	43.95	48.30	5.64	5.63
26.5	28.23	35.52	36.59	5.07	5.07

3.3 Model Development and Selection

The architecture of respectively ANN model is enhanced using a trial-and-error process, where key parameters such as the number of layers, the numeral of neurons in apiece layer, and the learning rates are analytically used to to achieve the best consequences. This iterative aspect approach certifies the model is complementary to capture complex relationships in the data without overfitting or underfitting. Final models are designated based on their presentation, with a emphasis on maximizing R^2 values to certify strong predictive precision and minimizing error metrics such as MAE and RMSE to ensure reliability and consistency crosswise prophecies. It was also resulting consuming the empirical formula to evaluation the relationship amid compressive and flexural strength.

$$\text{Flexural Strength} = 0.85 * (\text{Compressive Strength})^{0.5}$$

This relationship was authorized concluded a dedicated flexural strength prediction model, which operated the empirical formula along with the ANN approach to expect flexural strength with high accuracy. The model's performance was appraised with standard metrics such as R^2 , MAE, and RMSE, representative near-perfect precision. This validation established the consistency of the derived formula and emphasized the effectiveness of the ANN model in apprehending the intricate relationship between compressive and flexural strengths.

4. Conclusion

The construction industry relies heavily on concrete; thus, it's crucial to optimize the strength, workability, and flexural strength of concrete mixtures. In this study, concrete's compressive strength, workability in terms of slump, and flexural strength were predicted by adopting artificial neural network (ANN), while considering one hundred three pieces of data about concrete's mix designs, covering cement, water, SP, slag, fly-ash, flow, fine aggregate and coarse aggregate. Among these data, 80% were used for training purpose, and 20% for testing purpose in that machine learning methods. The R SQUARE, MAE, and MSE values were computed in that method both for training and validation. The result clearly shows that ANN can yield the best result in terms of both training and validation. Thus, it can be used successfully for predicting concrete's compressive strength, slump, and flexural strength based on the available data. This study contributes much to the concrete industry, on-site engineers, etc. in predicting the strength, workability, and flexural strength for particular cement, SP, fly-ash, flow, slag, water, fine aggregate, and coarse aggregate.

This study was carried out by using only 103 data sets, which may not be sufficient to capture the full range of variability in designing concrete mixes, particularly given the number of variables that were examined. Moreover, machine learning method has its limitation, which can impact the performance of this study's model. despite some deficiencies, this study is useful for enhancing the properties of pavement quality concrete.

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SELF-HELP GROUP MOVEMENT A PATHWAY TO SOCIAL JUSTICE

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Abstract

This paper critically analyzes the Self-Help Group (SHG) movement as a vital pathway to achieving social justice, particularly in the context of persistent poverty and limited access to formal credit for vulnerable populations in India. Despite significant national economic progress, a substantial portion of the population, including SC/ST women and backward communities, remains marginalized due to "capability poorness" and reliance on non-formal credit. The study proposes a new credit regime focused on demand-side absorption rather than supply-side delivery, aiming to engage wasted human resources and enhance income levels. It introduces a conceptual framework, including an equation for ascertaining capital/credit requirements ($S - C + i + e = Kt$), which integrates factors like consumption gaps and return on investment, while also incorporating Prof. Amartya Sen's P-Index to address income shortfalls from the poverty line. The paper evaluates the potential benefits of this model, emphasizing its role in fostering economic activity, improving human resource quality through healthcare and education, and strengthening national integrity by promoting community-based, self-reliant village institutions. The findings suggest that a shift towards production-oriented financing and reduced government control can lead to "Gram-Raj, Gram-Udyoug and Gram-Swampournata" (village self-rule, village enterprises, and village self-reliance), offering a universally applicable model for underdeveloped and developing countries.

Keywords: *Self-Help Groups, Social Justice, Microfinance, Poverty Alleviation, Rural Development*

Introduction

Despite the significant economic development seen in India, marked by steady growth in agriculture and industry, a significant portion of its population, estimated at between 300 and 320 million people, continues to be stuck in deep poverty, barely managing to obtain basic necessities. This persistent marginalization is particularly acute among women of Scheduled Castes (SC) and Scheduled Tribes (ST), along with other backward classes, who often suffer from what may be referred to as "capability poorness" and are forced to rely on exploitative informal credit sources because of their limited access to formal financial institutions. The benefits from increased production and technological advancements, which are largely powered by institutional credit, have not adequately percolated to allied agricultural activities, Village and Cottage Industries (V & CI), and rural artisan industries, thereby limiting their

ability to substantially enhance income levels and effectively utilize underemployed human resources.

Correcting these huge imbalances necessitates a radical shift in policy. Conventional banking has neglected the large rural catchment of marginal farmers, small farmers, rural artisans, and farm labourers unemployed and underemployed. The credit system must be reoriented with a sound organisational structure, enhanced absorption capability, increased accessibility, simplified lending procedures, and active self-regulatory participation, supported by advisory services. Credit orientation must be shifted from supply-led provision by Rural Financial Institutions (RFIs) to demand-led use by the beneficiaries, with their active participation in the process [Materials and Methods]. This research is a critical analysis of the Self-Help Group (SHG) movement as an effective and viable means of reducing such disparities and ensuring social justice in India. It proposes a new credit model on the lines of demand-side absorption, the intent being to harness the untapped human resource of India to raise the income. To estimate and confirm this process, the research presents a conceptual framework, involving an equation by which to estimate capital/credit needs ($S - C + i + e = Kt$). This includes such factors as consumption shortfall and return on investment, and also Prof. Amartya Sen's P-Index to meet income shortfall with respect to the poverty line by each household.

The research measures the possible gains that the model proposed would yield, underscoring its relevance in bringing about economic activity, improving the quality of human resources through better health and education programs, and strengthening national integration through the promotion of community-based, self-reliant village institutions. The research finds that a conscious shift towards production-based funding along with decontrol by the government can bring about "Gram-Raj, Gram-Udyog and Gram-Swampoornata" (village self-rule, village enterprise, and village self-sufficiency), thus providing a widely applicable framework for underdeveloped countries as well as developing countries. This approach attempts to revitalize grassroots cooperation, making the dream of a society actually come true at the micro-level.

Materials and Methods

A new credit regime is essential, characterized by an effective organizational setup, enhanced absorptive capacity, ease of access, simplified lending procedures, and effective self-regulatory participation, complemented by a range of advisory services. This new approach aims to transform potentials into reality by capitalizing on existing social and economic constraints. Studies by the World Bank, Government of India (GOI), NABARD, and RBI have recognized that conventional lending methods can only address a fraction of the actual requirements. While various Rural Financial Institutions (RFIs) and credit approaches have played significant roles, a participatory self-regulatory system is still necessitated to effectively reach the poor.

The focus of credit must shift from the supply or delivery by RFIs to the demand or absorption by beneficiaries to ensure their participatory role. Reservations exist on both the supply side (e.g., counseling and directive methods, mental reservation for bad debt, low refund, high cost, transaction spread areas) and the demand side (e.g., social, economic, and educational

backwardness, unawareness, direct accessibility issues, collateral requirements, procedural constraints, and consumption needs).

The fundamental issue revolves around conceptualizing growth alongside social justice. The vision of a welfare society (Ram-Raj) following independence (Swaraj) has not fully materialized, with widespread poverty coexisting with high-tech capabilities. Macro-level gains have not trickled down to the micro-level. This study critically analyzes these issues, adhering to Dr. Radhakrishnan's philosophy of applying reason and interpreting tradition rather than blindly following texts without understanding their relevance.

Recognizing that manpower is a precious yet often wasted resource in Indian families, this research proposes a method for ascertaining the credit requirement to be absorbed for engaging this wasted human resource. This method is based on the technical aptitudes within the family and the resources available within the village. Directed credit programs, often financially unsustainable and failing to reach the poor, have distorted financial markets. The emerging role of SHGs is symbolized by five key principles: Propagator of volunteerism, Practitioner of co-operative principles, Promoter of thrifts and savings, Provider of emergency loans, and Purveyor of developmental credit. Micro-level credit, within the beneficiaries' ability, ensures proper end-use of funds and aligns with their entrepreneurial capacity. Providing bulk credit without considering managerial ability often leads to misutilization, siphoning, and capital erosion, trapping beneficiaries in debt.

Every human being possesses an inherent capacity for sustenance and efficacy in their vocation. Project formulation should consider the opportunity cost of diverting individuals from their primary occupations. The surplus generated from projects should primarily bridge this opportunity cost, preventing capital erosion due to unmet needs. The theory of growth is rooted in savings, which enable investment. Therefore, the surplus derived from credit should be retained, foregoing immediate consumption, until the project achieves stability. Immediate consumption hikes often destabilize projects, erode capital, and increase vulnerability.

For an optimum socio-economic condition, three freedoms must be ensured:

1. *Freedom for Subsistence*: Fulfilment of basic consumption needs (food, clothing, and shelter) for survival.
2. *Freedom in Self-Actualization*: Self-esteem through healthcare and education, enabling evaluation of the past, assessment of the present, and planning for future development.
3. *Freedom of Choice*: Accessibility to economic, political, and social amenities for all sections of society, irrespective of caste, creed, race, religion, or sex.

The cooperative movement, an earlier example of fostering thrift and mutual help, often failed due to large, heterogeneous group sizes, leading to decision-making delegation to self-interested, influential members. The vast rural credit network has not reached the poor due to banks' risk perception and inability to efficiently manage numerous small borrowers. The small, unpredictable, and emergent credit needs of the poor necessitate alternative mechanisms to avoid perpetual dependence on moneylenders. Rural Financial Institutions (RFIs) have been ineffective in delivering policy objectives. Innovative approaches to savings mobilization and

lending, under the auspices of APRACA (The Asia-Pacific Rural and Agricultural Credit Association), have linked development with resource supplementation and improved outreach to the poor. NABARD's pilot project in 1991-92, assisted by IFAD (International Fund for Agricultural Development) proved effective, leading to RBI's recommendation for its continuation.

The next stage involves ensuring the sustainability of existing groups and expanding outreach by organizing non-formal self-help groups into a federation, forming a village-level institution (VLI). This unique system integrates all village families—rich or poor; landlord or landless, artisans or servicemen, young or old, man or woman—into a development process, respecting homogeneous group interests. Such a village-level Microfinance Institution (VLmFI) would function as:

- A Moneylender: Providing prompt emergency loans without exploitation.
- A Development Bank: Providing investment loans for credit intensification without procedural delays and cost-effectively.
- A Cooperative: Providing production credit through participatory mutual cooperation and peer pressure, free from the ills of dominant members or government interference.
- A Voluntary Agency: Fostering mutual interest and collective effort for economic and social upliftment without a sense of gratitude.

Existing formal agencies (Banks, DRDA, NABARD, State extension services) can participate in creating a people-based structure to assist in problem identification, resource generation, and program integration. A community development society with an institutional character, as envisioned in Kerala's Allappuzha district, can be formed at the village level. Strengthening these micro-financing institutions involves SHGs transitioning from consumption-promoted to production-oriented financing, exploring new technologies and enterprises, and accepting deposits from community members. Examples like PRODEM in Bolivia demonstrate the potential of such village-level institutions to act as micro-enterprise banks, leading to full financial intermediation and real competition within the rural credit system. This model can revitalize failed PACS (Primary Agricultural Credit Societies) by evolving a new process centered on members' goals, patronage cohesiveness, governance effectiveness, and an operative credit structure, while preserving the original spirit of SHGs.

Initially, SHGs are linked with banks for resource supplementation. With VLmFIs, commercial banks and RRBs, assisted by NABARD and RBI, may gradually surrender functions to federations, retaining monitoring roles. Government departments must understand that the fundamental conceptual foundations of voluntarism, homogeneity, spontaneity, size, thrift conception, and democratic spirit cannot be violated. Government control should be substantially reduced to extension services, de-formalizing the cooperative credit system at the grassroots to uphold the truth that "Co-operatives have failed but co-operation must succeed".

Upon successful completion of the consolidation phase, credit support for improving family living standards is planned. Rural credit serves three purposes: (1) Consumption needs, (2) Production needs, and (3) Investment needs. Consumption needs during exigencies (healthcare, social ceremonies, festivals, lean season food) are intended to be met from the Thrift fund.

Production and investment needs for each family are ascertained using the evolved method for credit absorption. Bank credits are then planned for absorption by families on a priority basis, according to their entrepreneurial capability.

Data Analysis

Quantifying the relationship between rural development and its various determinants is complex. Past attempts have measured the impact of determinants on growth, establishing statistical associations expressing the output-input relationship in a family project as:

$$Y = f(R, N, K, T, O) \quad (1)$$

Where:

- Y = output
- R = Natural resources
- N = Employment
- K = Capital
- T = Technology
- O = Organisational and institutional framework

Assuming other variables remain constant, the increase in output from a family project with a relevant change in capital can be expressed as:

$$Y = f(K) \quad (2)$$

Using these relationships, an equation has been framed to determine the required change in capital (credit), K, for a given level of per capita output Y (income level for maintaining a given standard of living):

$$S - C + i + e = Kt \quad (3)$$

Where:

- S = level of increase in the standard of livings (i.e., increase in consumption level of the family)
- C = consumption gap (i.e., difference between family income and expenditure)
- i = Interest servicing ratio of capital
- e = Equity servicing ratio of capital
- t = IRR/ROI of the scheme selected for the family
- K = Change in volume of capital for absorption by the family

This equation helps explain credit outcomes at the ground level. From a bank's perspective, assessing creditworthiness (economic strength) typically ranks beneficiaries as Old Farmers (OF), Small Farmers (SF), and Marginal Farmers (MF), with credit volume fixed accordingly. However, since development includes social justice with growth, this ranking must be reversed. While development programs consider families as units, a macro approach has often been taken without analyzing the ground realities of each family. As Prof. Amartya Sen rightly criticized the traditional head-count ratio as non-discriminatory, this equation gives due respect to Prof. Sen's P-Index by considering the shortfall of income from the poverty line for each family.

A rational basis for subsidizing schemes for the economically poor or in particular sectors/schemes should consider their linkage effect on production, productivity, employment, and social justice. Subsidies for poverty alleviation schemes are determined by the "Rank order weight" of families, and for inducing technological change or creating employment opportunities through linkage. Financial institutions and development authorities can plan credit by considering two aspects of credit extension:

- **Credit Optimization:** Fixing the optimum level of credit for a targeted growth level of families below the poverty line.
- **Credit Intensification:** Targeting the required level of technological development through intensive credit for families above the poverty line.

It is crucial to evaluate the reasons for project failure at any stage (selection, disbursement, implementation, running, or recovery) and monitor accordingly. At the macro level, credit terms like interest rates, recovery periods, and subsidy requirements can be determined by considering the absorption capacity of the population segment, the rate of return on schemes, and usual natural calamities. Once consumption gaps are identified, the risk absorption capacity of each family can be ascertained, allowing for sectoral and schematic diversification of credit within and among families. The procedure for measuring variables and solving the equation is straightforward, requiring minimum knowledge and being both ideologically transparent and physically understandable.

Conclusion

With the aforementioned reasons, the model developed has widespread applicability, especially in less developed and developing nations where family patterns are deeply rooted and strongly linked with the demographic trend of features such as caste, creed, race, religion, or gender. The effort is aimed at promoting "Gram-Raj, Gram-Udyoug and Gram-Swampoornata" (village self-rule, village industries, and village self-reliance), drawing inspiration from the likes of Gandhians Anna Hazare and Nanaji Deshmukh. The much-awaited efforts invested in the project are bound to reap significant advantages and achievements.

This research highly recommends the Self-Help Group (SHG) programme as a major vehicle for achieving social equity in India, particularly for the poor who are excluded from accessing formal financial services. Despite India's high economic growth, a hugely large section of the population, approximately 300-320 million with 61% in so-called "capability poorness," remain marginalized. It disproportionately concerns women from Scheduled Caste (SC)/Scheduled Tribe (ST) groups and other marginalized communities, who are likely to become entrapped in exploitative terms of informal credit.

The fundamental argument suggests a change from a supply-based credit framework to one of demand-side absorption with the aim of capitalizing on India's "underutilized human resources." To substantiate the argument, a new credit needs equation ($S-C+i+e=Kt$) is suggested that considers consumption gaps, investment returns, and includes Prof. Amartya

Sen's P-Index in order to effectively target income gaps in proportion to the poverty line per family, respectively. The study imagines a scenario in which village-level Microfinance Institutions (VLMFIs), grown out of SHG federations, are inclusive financial institutions: moneylenders, development banks, cooperatives, and voluntary organizations. This design promotes production-oriented lending and aims for less government interference, allowing spontaneous development of grassroots cooperation instead of formal, frequently failing, cooperative plans.

The suggested model has a vast array of advantages, such as efficient utilization of idle human resources, lowering reliance on agriculture, development of local markets, increased community cohesion, improved quality human resources in the form of improved health and education, and finally, a consolidated national unity. With the empowerment of people and local-level self-sufficiency, the article argues that the model can allow for "Gram-Raj, Gram-Udyoug and Gram-Swampoornata" (village self-governance, village industries, and village self-sufficiency), therefore offering a framework for sustainable development that can be applied by developing countries.

Recommendation

The model proposed offers several key benefits that translate into actionable recommendations for policy and practice:

- **Engagement of Wasted Human Resources:** The model will facilitate the engagement of wasted human resources within families in economic activities, leveraging their traditional and vocational knowledge without requiring immediate formal education.
- **Reduced Dependency on Farms:** By increasing per capita income from non-farm activities, the dependency rate on farms will reduce, enabling families to introduce more capital into farm activities, leading to higher production and productivity.
- **Market Creation:** The universal increase in the standard of living within villages will necessarily create a robust market for household products produced by family enterprises, fostering local economic growth.
- **Enhanced Group Cohesion:** The formation of groups based on common socio-economic backgrounds will lead to better cohesion and unity of aspiration, ensuring optimal participatory roles.
- **Improved Human Resource Quality:** A subsequent effect of the universal hike in living standards will be improved quality of human resources through enhanced healthcare and education. This can also lead to family planning, as declining child mortality rates may reduce the perceived need for higher numbers of sons as wage earners.
- **Strengthened National Integrity:** By taking into consideration regional and social aspirations, the threat to distort group identity is discarded, thereby strengthening national integrity.
- **Reduced Government Control:** It is recommended that government departments substantially reduce their control and rule, focusing instead on extension services. This will help de-formalize the cooperative credit system at the grassroots level, proving that

"Co-operatives have failed but co-operation must succeed".

- **Strategic Credit Diversification:** Based on identified consumption gaps and ascertained risk absorption capacities of each family, credit diversification in terms of sectoral and schematic planning should be implemented both within and among families. The vision of this movement is encapsulated in the following prayer, reinforcing the aspiration for universal well-being and harmony:

ॐ सर्वे भवन्तु सुखिनः ।

सर्वे सन्तु निरामयाः ।

सर्वे भद्राणि पश्यन्तु ।

मा कश्चित् दुःख भाग्भवेत् ॥

ॐ शान्तिः शान्तिः शान्तिः

"May all beings be happy, May all attain bliss, May all see happy days, May no one be subject to sufferings". Om shanti, Om shanti, Om shanti.

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MANAGING ENVIRONMENTAL FOOTPRINT IN HIGHWAY CONSTRUCTION

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Abstract

Currently, India has 6.7 million kilometres of road length which is second in the world. Managing the environmental footprint for maintaining such huge road infrastructure along with new highway construction is vital to promoting sustainable development. Highway projects impact ecosystems of the adjacent area of the proposed road and local communities, often resulting in deforestation, pollution, habitat fragmentation, and greenhouse gas emissions. To mitigate these impacts, the integration of sustainable practices is essential throughout the construction process. One key strategy involves adopting eco-friendly materials, like Reclaimed Asphalt Pavement (RAP), Recycled Concrete Aggregate (RCA), fly ash, geopolymer, rubber, glass, waste plastic and Industrial wastes, reducing the demand for natural Aggregate. Additionally, the use of such material in highway construction plays a critical role in efficient waste management strategies, where construction waste is minimized, recycled, or disposed of responsibly. This article focuses on sustainable and environmental friendly strategies in material selection during highway construction. Implementing the use of recycled and waste materials like RAP, RCA, industrial waste, etc have been discussed in detail highlighting the effect of the performance of the road, the environmental and economic viability during construction. Further, an attempt has been made to anticipate and address potential adverse effects on ecosystems and nearby communities of the proposed road construction. By collaborating with local authorities, communities, and environmental experts, highway agencies and policy makers can promote the optimum use of alternate materials in road construction to manage the environmental foot print. The adoption of such sustainable practices not only conserves natural resources but also aligns with national and global environmental standards. Ultimately, managing the environmental footprint in highway construction promotes ecological balance, minimizes long-term costs, and builds resilience against climate change impacts, setting a foundation for future infrastructure that benefits both people and the planet.

Keywords: *Sustainable material, Construction waste, Recycled material, Pavement material, RAP, RCA*

1. INTRODUCTION

Road construction, a critical activity for economic development, is also one of the most damaging to the natural environment due to its impact on land use, destruction of habitats, resource exploitation, and greenhouse gas (GHG) emissions. In India, 90% of the total road network, including airfield pavements, consists of flexible pavements. Maintaining such a vast network and constructing new flexible pavements using traditional hot mix asphalt requires

substantial energy consumption and results in considerable pollution. Figure 1 illustrates the energy consumption associated with different types of paving mixes.

The road infrastructure sector is now taking significant steps toward transforming conventional practices by adopting innovative and eco-friendly technologies, such as warm, half-warm, and cold mix technologies, to address both environmental and economic challenges in road construction. Various methods are being employed to reduce emissions, including the use of alternative materials and green paving mixes. Materials like Reclaimed Asphalt Pavement (RAP), Recycled Concrete Aggregate (RCA), fly ash, geopolymer, rubber, waste plastic and granulated slag are increasingly being used to replace natural aggregates.

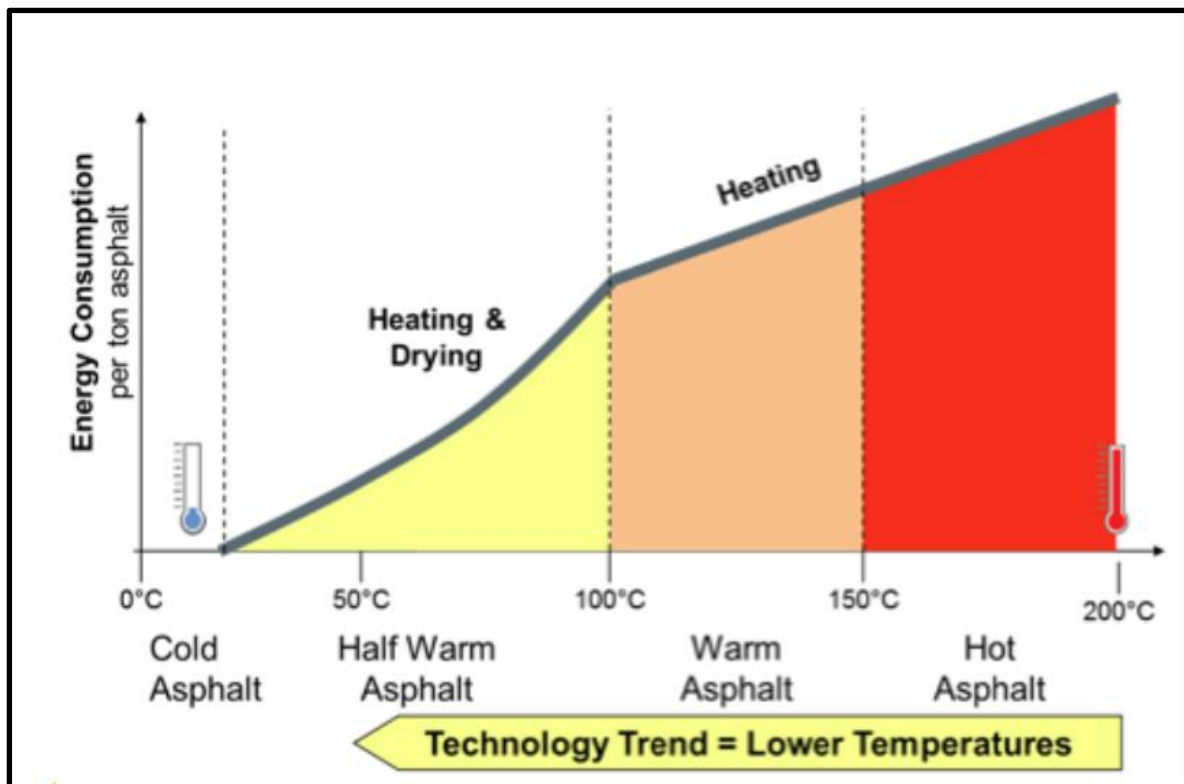


Figure 1 Energy consumption of different types of paving mixes

RAP is composed of high-quality aggregates and asphalt binder, which are produced by milling old asphalt pavements or removing them directly. RCA, derived by crushing concrete waste, serves as an environmentally friendly alternative to natural aggregates in base and sub-base constructions. According to Vishnu and Singh (2021), these materials are recommended for use in highway construction due to their effective performance as aggregates once properly processed and integrated into construction projects.

For sustainable highway construction, it is essential to incorporate alternative materials. The reuse of these materials aligns with life cycle assessment techniques aimed at minimizing emissions and waste during construction (Vishnu and Singh, 2021). The use of alternate materials contributes to the construction of long-lasting infrastructure, reduces maintenance needs, and lowers the overall environmental impact of highways throughout their lifecycle. Furthermore, such practices support global objectives like those outlined in the Paris Climate

Agreement, which seeks to reduce GHG emissions in transport and infrastructure (Karimipour et al., 2021).

This paper reviews the relevant literature on alternative pavement materials that can reduce the consumption of natural aggregates and binders in road construction. It examines the generation of waste materials and their effects on road construction, with a focus on reducing the carbon footprint. The utilization of waste materials in pavement construction offers significant environmental and economic benefits, contributing to overall sustainability.

2. Sources of Alternate Materials

Alternate materials are used as non-traditional or unconventional materials in road construction. These materials are substitutes for natural aggregate as they reduce the cost of construction and are eco-friendly. Various types of available alternate materials and their generation are described below.

2.1. Recycled Asphalt Pavement

The process of milling and crushing distressed or aged asphalt pavement results in the creation of recycled asphalt pavement (RAP). This procedure involves the removal of old asphalt, which is then broken down into smaller pieces through milling and crushing. These pieces are subsequently combined with new asphalt binder and aggregates to form recycled asphalt mixtures (Mondal et al., 2022a). RAP generally consists of two main components: bitumen and aggregates. Bitumen, a complex mixture of hydrocarbons, primarily comprises organic compounds made up of hydrogen and carbon atoms. It may also contain small amounts of other elements such as oxygen, sulfur, and nitrogen, along with trace elements and compounds. Studies have shown that using RAP in the construction of asphalt base and sub-base layers leads to reductions in global warming (20%), energy consumption (16%), water usage (11%), life cycle costs (21%), and hazardous waste generation (11%) (Lee et al., 2023)

2.2. Recycled Concrete Aggregate

Recycled Concrete Aggregate (RCA) is created by crushing and processing waste concrete material from various sources, such as broken concrete, damaged masonry, and distressed rigid pavement slabs (Ding et al., 2016). The direct application of RCA in bituminous mixtures is not recommended for the construction of pavement (Akbarnezhad et al., 2013). The investigations have found that RCA reduces environmental impacts and fineness construction material requirement. However, these practices depend on factors that are regional, such as availability of materials, process technology, and policies as standards of the environment (Gallardo et al. 2016; Chong and Wang, 2017).

2.3. Fly Ash

Fly ash (FA) is a by-product of coal combustion in thermal power plants. When coal is burned to generate electricity, it produces various by-products, with fly ash being one of the primary ones. In India, thermal power plants generate approximately 100 million tonnes of fly ash annually. This substantial quantity presents significant challenges in terms of disposal and

management, requiring large amounts of land and posing environmental and health risks (Mondal et al., 2022a; Mondal et al., 2023b). A key strategy for managing the vast amounts of fly ash produced by power plants is its use in construction projects, such as roads and embankments (Boominathan and Kumar, 1996; Suryanarayana, 2000).

2.4. Geopolymer

The production of geopolymers at room temperature offers an environmentally friendly advantage due to its lower energy consumption, reduced carbon emissions, and the use of low-cost waste materials such as fly ash (FA), silica fume, various clays, and agricultural wastes (Odion et al., 2003). The presence of impurities like iron and calcium can cause variations in the properties of fly ash. Geopolymers are synthesized from aluminosilicate materials, with fly ash being a common source of these materials (Kuenzel et al., 2013). Typically, geopolymers require a chemical activator to trigger the polymerization reaction between the aluminosilicate precursor and the alkaline solution. Chemical activators often combine metal alkali and silica in an aqueous solution, with a molar ratio of $\text{SiO}_2:\text{M}_2\text{O}$ greater than 1.65, where M represents either potassium or sodium, alkali metals (Hoy et al., 2016).

2.5. Granulated Slag

Ground Granulated Blast Furnace Slag (GGBS) is a by-product of the steel and iron industry, known for its high lime content and latent hydraulic properties, which make it a valuable material for cementitious applications (Mondal et al., 2023a). When used as the primary binder in concrete, GGBS typically requires an activator to improve its reactivity and promote the formation of cementitious compounds. Sodium hydroxide, potassium hydroxide, or sodium silicate serve as activators for GGBS, providing the necessary alkalinity. This alkalinity helps dissolve the glassy phase of GGBS, facilitating the formation of key cementitious compounds like calcium silicate hydrate (C-S-H) gel, which significantly enhances the strength and durability of the resulting material.

2.6. Rubber

Waste tyre rubber, also known as crumb rubber, is a mixture of natural and synthetic rubber, carbon black, fillers, antioxidants, and oils that dissolve paving grade binder. There are two primary methods for incorporating tyre rubber into asphalt binders. In the first method, crumb rubber is dissolved into the asphalt and used as a binder modifier. In the second method, some of the fine aggregates are replaced with ground rubber, which does not fully react with bitumen (Huang et al., 2008). Alternatively, scrap tyres can be processed into crumb rubber by first shredding them into small pieces using specialized equipment such as granulators or shredders. This shredding process reduces the tire size into manageable pieces for further processing. After shredding, the tire pieces undergo additional processing to remove any remaining fibers (such as nylon or polyester) and steel wires. Crumb rubber is categorized into three main classes based on particle size.

2.7. Crushed Glass

Glass waste is non-biodegradable and non-combustible, making its disposal a significant environmental issue, particularly as landfill space continues to diminish (Hayat, 2023; Muthuraman and Ramaswamy, 2019). Also referred to as cullet, the volume of glass waste has been steadily increasing over the years, accounting for about 5% of total waste generation in 2016 (Kaza et al., 2018). The global market for glass bottles and containers produced 630.52 billion units in 2020 and is projected to reach 883.52 billion units by 2027, with a compound annual growth rate of 4.4% from 2022 to 2027. Glass is typically regarded as inert and resistant to many chemical substances, and it can take hundreds of years to naturally biodegrade (Salamatpoor & Salamatpoor, 2017). Primarily composed of amorphous silica, glass can react with alkalis such as potassium and sodium, which are present in high concentrations in materials like high-alkali Portland cement.

2.8. Plastic

Polymers are large molecules composed of repeating units called monomers, and they form the foundation of synthetic materials known as plastics. During their production, these polymers can be shaped and molded into various forms. Plastics are typically transparent, have poor electrical conductivity, and are lightweight. They come in many types, such as polystyrene, polymethyl methacrylate, polyvinyl chloride (PVC), and polyethylene terephthalate (PET) (Priyanka et al., 2021). According to reports, one million plastic bottles are produced globally every minute (Laville et al., 2018), with less than half collected for recycling, and fewer than 7% are reused to make new plastic bottles. Moreover, the New Plastics Economy report (2016) predicts that by 2050, the weight of plastic in the oceans will exceed that of fish. The most common type of polyethylene is Low-Density Polyethylene (LDPE), made from ethylene monomers ($\text{CH}_2 = \text{CH}_2$). LDPE is known for its softness, flexibility, and moisture resistance, making it suitable for various applications, including plastic bags, food packaging, and containers, which contributes to its widespread use in everyday products (Wong et al., 2017).

3. Utilizations of alternate materials in road construction

3.1. RAP

Pradyumna et al. (2013) investigated the use of RAP and virgin mixes in bituminous road construction. Their laboratory test results indicated that asphalt mixes containing RAP with a rejuvenating agent performed better than virgin mixes. It was observed that the recycled asphalt mix showed greater resistance to moisture damage, as the values for 20% RAP mixtures were higher than those for virgin mixes. Additionally, at 35°C and 45°C, the 20% RAP mixes exhibited lower cumulative permanent strain after 10,000 cycles compared to virgin mixes. This suggests that RAP mixes have a greater ability to resist rutting than virgin mixes. Tarsi et al. (2020) examined the use of high-content RAP aggregates in new asphalt mixtures, highlighting the economic and environmental benefits. They also emphasized that life cycle cost analysis is a crucial tool for designing construction materials for transportation infrastructure, including asphalt mixtures.

3.2. RCA

The experiment done by Nwakaire et al. (2020), evaluated mixtures with different percentages of coarse granite and RCA. This study revealed that the mix containing 40% RCA replacement performed similarly to the mix containing 100% coarse granite. In particular, the mix containing forty percent RCA had an indirect tensile strength of 1051 kPa and a resilient modulus of 9340 MPa, which were comparable to the values of 9496 MPa and 1058 kPa found in the mix including 100% coarse granite. It was concluded that a forty percent RCA replacement is suitable for pavement applications. The behaviour of RCA treated with lime fly ash as a material for base course for rural roads is investigated by Kumar & Shankar (2022). In this study, RCA material with ten, fifteen and twenty percent lime-fly ash concentration was stabilized using a 1:2 lime-to-fly ash ratio. The test findings showed that increasing the lime fly ash content by 10-15% is adequate to achieve the 3 MPa strength and durability criteria for stabilizing RCA. This suggests that LFA can successfully improve RCA's mechanical qualities, making it appropriate for use in road construction.

3.3. Fly Ash

Woszuk et al. (2019) make use of characteristics of mixtures in which FA was replaced for typical limestone filler in different proportions (25%, 50%, and 75%). For the testing, two varieties of FA—class F and class C—were utilized. The air void content for the samples that had fly ash added varied from 1.2% to 1.6% for class F fly ash and class C fly ash ranging between 1.3% to 2.8%. The samples that had class F and class C fly ash added had water and frost resistance of around hundred percent and around hundred three percent, respectively. The findings show that both fly ash classes (Figure 2) can be used in asphalt mixtures as substitute mineral fillers. The significant chemical composition in class F's and class C's fly ash is observed as a presence of SiO_2 , Al_2O_3 , Fe_2O_3 , CaO , MgO , and K_2O (Milad et al., 2021).

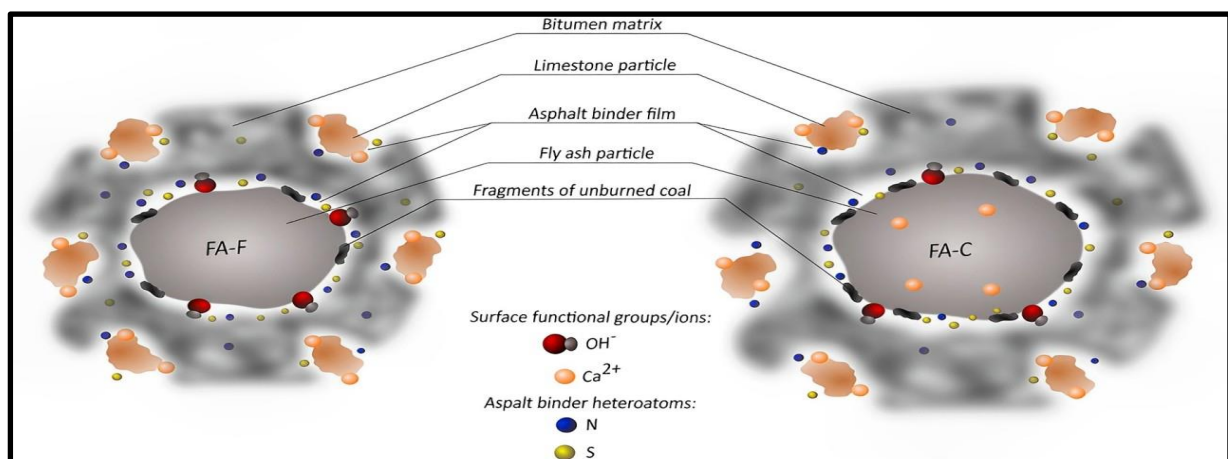


Figure 2. Fly ash, Class F and Class C (Woszuk et al., 2019)

Mistry & Roy (2016) looked at the impact of employing FA as an alternative filler in bituminous mixtures rather than Hydrated Lime (HL) in another study. Using 2% HL in the control mix and variable percentages of FA (from 2% to 8%) in modified mixes, samples were generated with varying bitumen levels (from 3.5% to 6.5% at 0.5% increments). According to

the testing findings, the mixture with 4% FA as the ideal filler content outperformed the reference mix regarding stability and had a reduced optimum bitumen content. Whereas, Paul et al. (2021) utilize the FA and glass powder as fillers in steel slag bituminous mixtures for road construction.

3.4. Granulated Slag

According to Du (2018), base course asphalt emulsion mixture (AEM) and limestone filler were replaced with GGBS activated by hydrated lime. Emulsified warm mixes with GGBS filler also shown improved moisture resistance. When employing slag as opposed to marble dust filler, rut depth was found to be lower. Acikok et al. (2018) looked into the impact of slag and FA on concrete pavement design in another experiment. The water to cement ratio is 0.42 and the cement dose is 350 kg/m³. There are three different concrete mixes made. FA and GGBS (reference concrete) are absent from the first batch of concrete. Fly ash is used in place of 20% of the Portland cement in the second concrete batch. Ultimately, the third concrete has slag that has been 20% displaced with cement.

3.5. Crushed Glass

Ziari et al. (2019) explored the use of glass fibers as a modifier to enhance the cracking resistance of asphalt mixtures containing varying proportions of RAP. This approach helps conserve natural aggregates in road construction. To evaluate the cracking behavior of the mixtures, semi-circular bending (SCB) fracture tests were conducted at temperatures of 15°C, 0°C, and -15°C. The results revealed that incorporating up to 0.12% glass fiber significantly improved the resistance of the mixtures to crack initiation and propagation. In a similar study, Salem et al. (2017) investigated the performance of asphalt concrete mixtures by replacing a portion of the fine aggregate with different percentages of crushed glass (5%, 10%, 15%, and 20%). They found that the optimal binder content was 5.75% for the 0% glass mixture and 5.35% for the 10% glass mixture, both meeting all specified requirements. The study concluded that crushed glass with a maximum particle size of 2.36 mm, at an ideal replacement ratio of 10%, could be effectively used in asphalt mixtures.

3.6. Plastic

El-Naga & Ragab (2019) researched to investigate the effect of using polyethylene terephthalate waste plastic materials (PTP) in asphalt mixes. The modified asphalt binder's softening point was raised and its penetration was decreased by the addition of PTP, according to the test findings for asphalt binder. The outcomes also demonstrated that the asphalt mixtures' strength tended to increase with the addition of PTP. It was discovered that 12% of PTP was the ideal amount for getting the greatest results from the asphalt mixtures. Ahmadinia et al. (2012) present experimental research on the use of discarded plastic bottles, specifically PET, as an ingredient in stone mastic asphalt. A range of waste PET percentages, from zero to ten percent by weight of binder, were present in the mixtures. The experiment's findings demonstrated that 4-6 percent of the bitumen content's weight was the proper range for the amount of waste PET. To be more precise, it made the combination stiffer, reduced the amount of binder wash down, and strengthened its resistance to rutting, or permanent deformation.

4. Environment and economic viability of using alternate material and challenges

The incorporation of waste materials in pavement construction provides a range of advantages, including environmental benefits, cost reductions, and enhanced pavement performance. However, there are challenges to consider, particularly the need for initial investments in infrastructure and processing technology. One of the key challenges is the establishment of infrastructure to sort waste materials according to their type, source, and associated risks. Additionally, some waste materials require advanced processing technologies to be effectively used in construction. Despite these challenges, the long-term benefits of using waste materials in pavement construction, including reduced environmental impact and cost savings, can make it a highly viable option.

The key to producing environmentally friendly pavement materials and mixes using waste materials lies in determining the optimal combinations of materials through laboratory experimentation. This experimentation should focus on evaluating the compatibility between the waste materials and the binder and aggregate materials, as well as identifying any potential synergistic effects. By conducting thorough testing, it is possible to develop mixes that not only reduce the environmental impact of pavement construction but also offer long-term performance benefits. Another challenge faced while using waste material is the potential production of leachate. Leachate is a liquid that can be produced when water comes into contact with waste materials, potentially carrying contaminants that can be harmful to ecosystems.

Additionally, there is no standardized replacement ratio for incorporating waste materials with natural aggregates and other waste materials, as this can be influenced by factors such as mechanical properties, location, handling, and the composition of the parent material. Other challenges in using waste materials include issues related to compatibility, quality control, and mix design. Waste materials may not always be compatible with the binder or other components used in the pavement, which can impact the pavement's overall performance. Developing a suitable mix design that includes waste materials can be complex, as it requires careful consideration of the properties of the waste and its interaction with other pavement components. Ensuring consistent quality in the asphalt mix when using waste materials is also challenging, as the properties of the waste materials can vary.

5. Conclusion

The use of solid waste materials in road construction is a promising area of research and development. Repurposing these materials offers the potential to reduce the consumption of natural resources, lessen the need for landfills, and possibly enhance the performance of road infrastructure. However, it is essential to thoroughly test these materials to ensure they are free from hazardous substances, avoiding any long-term negative environmental impacts. The supporting literature for this study highlights the beneficial effects of the investigated waste materials on various asphalt mastics and mix characteristics.

As environmental awareness grows and the need to address climate change becomes more urgent, the potential for environmentally friendly highway construction increases. Both

governments and organizations are increasingly prioritizing sustainability in infrastructure development and investment, opening up new opportunities for collaboration. The use of Reclaimed Asphalt Pavement (RAP) and Recycled Concrete Aggregate (RCA) aligns well with the principles of a circular economy, promoting resource efficiency and waste reduction. These principles enable the construction industry to adopt more sustainable and resilient practices.

Consequently, integrating sustainable materials and technologies, as well as engaging all stakeholders, is crucial in addressing the environmental impacts associated with highway construction. The adoption of RAP and RCA presents several benefits, including environmental protection, cost savings, and social value. While challenges persist, it is clear that innovative solutions, policies, and multi-sectoral partnerships can lead to improved and sustainable road infrastructure. Ultimately, construction will advance with a stronger focus on sustainable practices that not only conserve resources and reduce greenhouse gas emissions but also promote human and environmental well-being.

The ongoing work toward building sustainable highways must focus on achieving long-term results. This study underscores the importance of the physical and chemical properties of waste materials in their ability to perform comparably to standard mixtures in asphalt production. The benefits of using waste materials extend beyond improving the mechanical and durability performance of mixes—they also lead to significant reductions in both financial costs and environmental emissions.

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INTERDISCIPLINARY APPROACHES TO ENERGY MANAGEMENT: TRANSITIONING FROM NON-RENEWABLE TO RENEWABLE ENERGY FOR SUSTAINABLE BUSINESS PRACTICES

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Abstract

The transition from nonrenewable to renewable energy has become a global imperative, underpinned by the urgency to address climate change, ensure energy security, and achieve sustainable development. This paper explores *Energy Management: Substituting Nonrenewable Energy with Renewable Energy* through a multidisciplinary lens, emphasizing innovative and sustainable practices in business management. Integrating technology with business strategies, renewable energy solutions such as solar, wind, and biomass are positioned as transformative opportunities for organizations aiming to achieve carbon neutrality. Advanced data analytics and artificial intelligence are pivotal in optimizing energy consumption, forecasting demand, and designing efficient energy systems.

Behavioral science and organizational psychology play a critical role in fostering a culture of sustainability within enterprises. Decision-making frameworks grounded in these disciplines encourage energy-efficient behaviors and align individual goals with organizational sustainability objectives. Simultaneously, sociology and organizational behavior offer insights into collective action, promoting employee engagement and stakeholder collaboration in adopting renewable energy practices.

Economics and strategic management drive the financial viability of transitioning to renewables. Investment in green technologies, supported by cost-benefit analysis and long-term value creation strategies, ensures competitive advantage while adhering to environmental regulations and global commitments. Furthermore, law and business ethics provide the foundation for compliance, advocating for policies that incentivize renewable energy adoption and penalize unsustainable practices.

Environmental science intersects with business management to create innovative models that balance ecological preservation and profitability. Practices like lifecycle analysis and carbon accounting are integrated into corporate strategies to reduce environmental footprints. The inclusion of design thinking in innovation management promotes creative solutions, such as developing decentralized renewable energy systems tailored to regional needs.

Health and wellness in the workplace are enhanced by the transition to renewables, as clean energy reduces pollution, fostering healthier living and working environments. Educational initiatives and training programs prepare the workforce for the green economy, emphasizing upskilling in renewable energy technologies and sustainability management.

Ultimately, substituting nonrenewable energy with renewable sources demands a holistic approach that bridges disciplines, integrates technological advancements, and aligns economic, social, and environmental objectives. By fostering interdisciplinary collaboration, businesses can redefine energy management, contributing significantly to global sustainability while achieving operational excellence and stakeholder value.

Introduction

The global energy landscape is undergoing a significant shift from fossil fuels to renewable sources to address climate change, ensure energy security, and foster sustainable development. This transition integrates technological innovations, economic strategies, and environmental frameworks. While fossil fuels have historically dominated energy production, their environmental repercussions, including rising CO₂ levels, air pollution, and climate change, underscore the urgency for alternatives.

Renewable energy sources, such as solar and wind, offer abundant and sustainable solutions. Globally, renewable energy currently accounts for 13.5% of energy demand, with India emerging as a leader through initiatives like the National Solar Mission, Green Hydrogen Mission, and PM's Solar Rooftop Scheme. Highlight its commitment to a greener future. Additionally, hybrid solar-wind systems and micro-grids are revolutionizing energy generation by maximizing efficiency and reducing dependency on fossil fuels.

Technological advancements, government policies, and innovative projects are accelerating this transition, making renewable energy a cornerstone of sustainable development worldwide.

India's Current Energy Targets

India has set ambitious targets to transition to renewable energy as part of its commitments to global sustainability goals. These include:

1. National Solar Mission:

- Achieve 280 GW of solar power capacity by 2030, contributing significantly to India's non-fossil fuel energy capacity target.

- The mission initially aimed for 100 GW by 2022, which included 40 GW from rooftop solar installations.
- 2. **Renewable Energy Capacity:**
 - As of 2023, India aims to achieve 500 GW of installed renewable energy capacity by 2030, which includes solar, wind, biomass, and hydro energy.
 - This will account for approximately 50% of the country's total installed capacity.
- 3. **Green Hydrogen Mission:**
 - Produce 5 million metric tons of green hydrogen annually by 2030.
 - Reduce reliance on fossil fuels and foster the adoption of hydrogen in hard-to-abate sectors like steel and cement.
- 4. **Wind Energy Targets:**
 - Expand onshore and offshore wind energy capacity to contribute significantly toward the 500 GW renewable energy goal.
 - Offshore wind projects are expected to play a pivotal role in achieving this target.
- 5. **Electric Mobility and Energy Storage:**
 - Promote electric vehicles (EVs) and battery storage systems to reduce carbon emissions.
 - Establish a robust infrastructure for EVs to support the transition in the transportation sector.
- 6. **Energy Efficiency and Energy Conservation:**
 - Implement energy efficiency measures across industries and buildings.
 - Reduce the overall energy intensity of the economy by 33–35% by 2030, compared to 2005 levels.

These targets underscore India's commitment to achieving net-zero emissions by 2070 while ensuring sustainable growth and development.

National Solar Mission in India

The Jawaharlal Nehru National Solar Mission (JNNSM), launched in 2010, aims to establish India as a global leader in solar energy. By 2022, the mission targeted achieving 100 GW of solar power capacity, including 40 GW from rooftop solar projects. Key achievements include large-scale solar parks and grid-connected projects, contributing to India's renewable energy portfolio.

- **Progress:** As of 2023, India's solar power capacity exceeded 70 GW, with advancements in solar technologies and grid integration driving growth.
- **Challenges:** Land acquisition, high capital costs, and intermittency in power generation remain barriers.

India's Green Hydrogen Mission

The National Green Hydrogen Mission, introduced in 2023, aims to position India as a global hub for green hydrogen production and export. Hydrogen, produced through renewable energy-powered electrolysis, offers a clean fuel alternative for industries and transportation.

- **Goals:** Achieve 5 million metric tons of green hydrogen production annually by 2030.
- **Initiatives:** Investment in R&D, capacity building, and policy incentives for green hydrogen projects.
- **Opportunities:** Decarbonization of hard-to-abate sectors such as steel and cement, and development of hydrogen infrastructure.

PM's Solar Rooftop Policies

The Prime Minister's Solar Rooftop Scheme emphasizes decentralized solar power generation by promoting rooftop solar installations across residential, commercial, and industrial sectors.

- **Subsidies:** Financial incentives covering up to 40% of the installation cost for residential users.
- **Impact:** Empowering urban and rural households to generate their own electricity, reducing dependence on the grid.
- **Technological Advancements:** Introduction of high-efficiency photovoltaic systems and battery storage solutions.

Interdisciplinary Approaches to Energy Management

1. **Technological Integration:**
 - Solar and wind hybrid systems optimize energy generation by leveraging the complementary nature of these resources.
 - Data analytics and AI improve demand forecasting and energy optimization.
2. **Economic and Policy Frameworks:**
 - Cost-benefit analysis ensures financial viability of renewable projects.
 - Policies such as tax incentives, feed-in tariffs, and carbon pricing drive renewable adoption.
3. **Environmental Considerations:**
 - Lifecycle analysis and carbon accounting inform sustainable practices.
 - Renewable energy adoption reduces greenhouse gas emissions, promoting climate resilience.
4. **Sociological and Behavioral Insights:**
 - Community engagement fosters public acceptance of renewable projects.
 - Organizational psychology supports the adoption of energy-efficient behaviors in businesses.

Energy Generation Scenario in West Bengal

West Bengal's energy strategy focuses on expanding renewable energy capacity while modernizing existing infrastructure to ensure sustainable and reliable power supply.

Type	Installed Capacity (MW)	Key Plants
Coal-Fired Thermal	~5,050 MW	Santalalih, Bakreshwar, Kolaghat, etc.
Hydropower	~154 MW	Teesta Canal Fall, Jaldhaka, Rammam

Type	Installed Capacity (MW)	Key Plants
Solar	~500 MW	Rooftop and grid-connected projects
Wind	Negligible	Initial projects in coastal regions
Biomass/Waste	~20 MW	Various small-scale installations

Solutions and Future Course of Action

1. **Enhancing Technological Innovation:**
 - Invest in advanced solar tracking systems to maximize energy yield.
 - Develop scalable hydrogen storage solutions.
2. **Strengthening Policy Measures:**
 - Expand subsidies and incentives for renewable energy adoption.
 - Mandate renewable energy targets for industries and utilities.
3. **Promoting Public-Private Partnerships (PPP):**
 - Encourage collaboration between government, businesses, and academia to drive R&D in renewable energy.
4. **Education and Workforce Development:**
 - Upskill the workforce for green economy roles through targeted training programs.

Conclusion

The transition from non-renewable to renewable energy is a cornerstone of sustainable business practices and global climate goals. India's ambitious renewable energy initiatives, supported by interdisciplinary approaches, exemplify a pathway toward a resilient and sustainable future. Continued innovation, policy support, and stakeholder engagement are imperative to achieve energy security and environmental sustainability.

The exploration of renewable energy statuses in West Bengal highlights the region's growing demand, driven by economic growth, urbanization, and improved living standards. With a projected economic growth rate of 8%–9% annually, the state faces an urgent need to harness its vast renewable energy potential. Solar and wind energy stand out as cost-effective and efficient alternatives to traditional power sources, offering a sustainable path forward. The combination of these renewable resources not only addresses energy shortages but also creates employment opportunities, contributing to economic development.

Government initiatives and policy shifts toward clean energy have laid a solid foundation for a green energy revolution in India, with West Bengal playing a pivotal role. Despite its progress, there remain gaps in fully realizing the potential of renewable energy in the region. Continued focus on innovation, infrastructure development, and market expansion is essential to bridge these gaps and achieve the ambitious 2030 renewable energy targets.

The integration of renewable energy into various sectors, particularly transportation, underscores its significance in combating climate change and ensuring sustainable development. By adopting cleaner energy solutions, regions like West Bengal can lead the way in building a greener, more sustainable future while addressing the global energy crisis.

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EXPLORING SUSTAINABLE SOLUTIONS FOR THE RURAL REMOTE VILLAGES OF THE SUNDARBAN DELTA: A LITERATURE REVIEW BASED STUDY

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Abstract

The Sundarban region of West Bengal happens to be an area susceptible to severe weather conditions and economic crisis. In this context measuring sustainability of the region form an integral part of any policy directed towards the state of West Bengal. The rural remote villages of the area face everyday challenges not only from survival point of view but also maintaining their existence for the future. The challenge further takes into consideration the geographical isolation and limited resources faced by the residing community in the area. This exploratory study investigates the livelihood strategies employed by rural remote village communities, examining the interplay between socioeconomic, environmental and institutional factors in the area. The present paper makes an attempt to understand the sustainable options for the existing livelihoods of the rural remote villages of Sundarban by judiciously performing literature review for similar type of villages and studying their sustainable options for achieving the same in the study area concerned. The sustainability options for the study area belonging to the mangrove eco-system is indeed a challenge. Thus the sustainable options obtained for similar type of rural areas as reported in the paper have been carefully analysed for providing best sustainable solutions for the existence of the present rural villages in the Sundarban delta region. The sustainability of the villages of Sundarban delta in comparison to Sri Lanka.

Keywords: *Mangrove Delta, Rural Remote Villages, Sustainable Solutions, Vulnerable Area*

2. Introduction

Mangroves are a rich and biodiverse ecosystem that provides a variety of supporting functions to different communities, even though they make up a small part of the world's forest cover.

The mangrove trees and shrubs are frequently found on mudflats, the banks of tropical and subtropical rivers and along coasts where they are frequently impacted by the tides and stand with their roots in salt water. As a result, they are a unique type of vegetation that grows where two habitats meet. They are primarily found in the intertidal zones of the tropics and subtropics. The word mangroves in fact belongs to a wide range of plant families and it is their ability to tolerate brackish water and salt which unites them all. To cope with their muddy, changing, salty habitat, mangroves have developed a wide range of reproductive and survival techniques. There are about 70 kinds of mangrove plants known to exist in different parts of the world, with Southeast Asia and Australia having the highest numbers of these species. Asia is home to more than 40% of the world's estimated 18 million hectares of mangrove forests. The Sundarbans of Bangladesh and India, as well as Indonesia and Brazil, are home to some of the biggest mangrove forests in the world (*World Mangrove Atlas*, n.d.) (Spalding, M., Blasco, E., & Field, C. (1997). *World Mangrove Atlas. The International Society for Mangrove Ecosystems: Okinawa, Japan.*). In addition to offering a distinctive home for a wide range of animals, mangroves sustain a complex aquatic food chain. The seas around the mangroves are a rich source of fish and shellfish, and they provide a variety of natural resources. In certain locations, mangroves serve as a stabilizing element for the coastline and riverbanks. Additionally, mangroves can be crucial to the health of nearby habitats, including coral reefs, saltmarshes, seagrass beds, and terrestrial wetlands. The human communities in many places are dependent on the sustainability of these ecosystems.

The Global Mangrove Watch Initiative, in 2018, released a new study which estimates the total mangrove forest area of the world as of 2010 at 137,600 km², spanning 118 countries and territories. As of 2021 almost 4900 km² of land of India hosts Mangrove forests, of which around 2100 km² lies in 24 Pgs (S) West Bengal (*Chapter-3*, n.d.). Livelihood in the mangrove region in any part of the world is very challenging. The salinity of water and land along with climatic changes and storms add to the adverse living conditions of the regions. To address socio-environmental issues such as climate change, water pollution, food security, biodiversity loss, and catastrophe risk management, nature-based solutions are becoming more and more recognized as crucial instruments (Friess et al., 2019). By 2100, changes in hazard drivers brought on by climate change (such as rising sea levels and increased storminess) might raise the risk of erosion and floods along coastlines by 48%. Living shorelines can either restore the habitat on their own (a "soft approach") or in conjunction with artificial structures (a "hybrid approach") (Morris et al., 2023). The best method will depend on several criteria, including environmental appropriateness and infrastructure risk.

As previously mentioned, only 0.1% of the world's land surface is covered by mangrove forests, and only 15 nations have more than 75% of the world's total mangrove forest area. With a total mangrove cover of 4,975 square kilometers, India accounts for 0.15 percent of its overall land area, but it also accounts for 8% of Asia's mangrove forest area and 3% of the world's mangrove forest area. About 60% of this is found along the eastern coast of the nation, which borders the Bay of Bengal; 27% is found along the western coast, which borders the Arabian Sea; and the remaining 13% is found in the Andaman and Nicobar Islands. With 42.45% of the total

mangrove cover, West Bengal holds the largest mangrove forest in India, followed by Gujarat with 23.66%.

A thorough understanding of mangroves' actual condition is necessary for effective management. The condition of the mangrove forests around the world has been depicted by a number of studies. The IUCN's Working Group on Mangrove Ecosystems released one of the first publications, *Global Status of Mangrove Ecosystems*. The main risks to mangroves and the management strategies that might be used to preserve them were compiled in this paper (*Global Status of Mangrove Ecosystems*, 1983). One of the first to estimate their global extent was the *World Mangrove Atlas*, which was published in 1997 and updated in 2010. It was followed by important and widely cited reviews that highlighted the rates of historical mangrove loss and took into account the effects that have since occurred on ecosystem structure and processes. According to Duke et al. (2007), the academic community was concerned that, given the predicted rates of deforestation at the time, the world might lose the functions that mangroves serve within the next century.

According to the study (*Sustainable_Management_of_Sundarbans_Stakeholder_A*, n.d.), the Sundarbans are a major source of income for the residents of the Sundarbans Impact Zone. In fact, gathering resources from land and water is seen as a customary entitlement. As a result, individuals are growing more aware of government policies and choose sustainable forest management. Although the language of governance is often fairly strong, many contend that conflicting policies, inadequate infrastructure, inefficiency, unlawful tactics, and corruption make policy implementation challenging. Coupled human-environment (socio-ecological) systems that require more participatory management techniques should be developed and advanced. Increased stakeholder involvement and "empowerment" would enhance Sundarbans' governance and guarantee shared objectives and degrees of consensus on conservation. Thus, the researchers have a study option for sustainability of livelihood of people residing in this type of region with adverse climatic and geographical conditions.

Mangrove regions are very much affected by harsh climatic conditions as discussed in the introduction. As the climatic conditions vary all across the world the nature of the Mangrove forests also differs in their flora, fauna and livelihood (World Mangrove Atlas, n.d.). The major challenge in Mangrove climatic conditions are tropical cyclones. As per International Disaster Database (CRED, n.d.) the intensity of different tropical storms affect the landmasses in a huge extent in terms of physical, life and natural damages. The spatial conditions while discussing the livelihood of villages in Mangrove regions is a major consideration. The climatic conditions and fear of living causes different psychological wellbeing. As a result, we have restricted our study to North of Indian Ocean, specifically Bay of Bengal influencing the Indian Sub-Continent. Studies conducted earlier have shown that about 80% of Cyclone related deaths have been caused by cyclones originating from the Bay of Bengal (A Brief History of Deadly Bay of Bengal Cyclones That Have Caused 80% of World's Cyclone-Related Deaths | Weather.Com, n.d.).

Present paper aims to deal with a comparative study of the sustainability of two rural remote villages of Sundarban region namely, Ghoramara island of Sagar Block and Sonakhali, of

Basanti Block with rural villages in mangrove region of Srilanka, under United Nations Framework Convention on Climate Change (UNFCCC, n.d.).

3. Literature Review

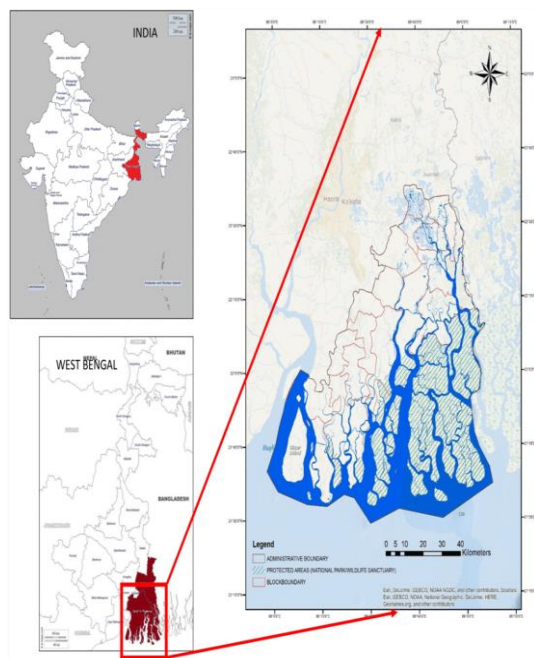


Fig 1

3.1 The Sundarbans

The Sundarban Delta (Roy et al., 2024), which spans Bangladesh and India, is made up of more than a thousand islands, most of which are protected. The vast biodiversity and rare species that can be found on these islands make them significant. However, because of the effects of extreme weather events and rising sea levels, these islands are also at the forefront of climate change. One of the world's most productive natural ecosystems, the Sundarban Delta (Fig 1), is home to one of the biggest mangrove forests. It spans 10,000 km² across Bangladesh (60 percent of the total land) and India (40 percent of the total area), and is situated at the mouth of the Ganges, Brahmaputra, and Meghna rivers at the head of the Bay of Bengal (WWF, 2023). It is generally anticipated that a large portion of the world's low-lying coastal wetlands would be lost or degraded because of projected climate change and non-climatic factors. Anthropogenic activities are causing rapid changes in land use and land cover in coastal wetlands, in addition to the effects of extreme weather and sea level rise. Mangroves in the intertidal zones of tropical and subtropical coastal wetlands are especially susceptible to these effects. As mentioned earlier these regions are biologically diverse and rich in flora and fauna.

The study of sustainability is conducted for two remote villages of the Sunderban area namely Ghoramara and Sonakahli. Though in the same district South 24 Parganas and within the Sundarban Delta region the two villages are demographically quite different. The distance between them is 110 Kms (Fig 2). One of them, Ghoramara, being a submerging island, while

the other is a land locked remote village with limited basic infrastructure for living.



Fig 2

- a) The island of Ghoramara (Fig 3) is situated in the western portion of the active deltaic area, within the jurisdiction of Sagar block, South 24 Parganas, West Bengal, at $21^{\circ}53'56''$ N to $21^{\circ}55'37''$ N and $88^{\circ}06'59''$ E to $88^{\circ}08'35''$ E, at the mouth of the Bay of Bengal at Sagar Division. Ghoramara (Fig 3) Gram Panchayat (*Ghoramara Gram Panchayat*, n.d.), a part of Sundarban Delta and is a desolate and sparsely occupied islet under Sagar Block of South 24 Parganas. Till 1970's this Gram Panchayat comprised with three census villages (Mouzas) namely Lohachura, Khasimara & Ghoramara and stretch was about 30 sq.km but massive erosion driven by rising sea levels has caused the land to shrink by almost eighty percent of its original size since last 50 years. Presently the Gram Panchayat covers only 5.5 sq km area, comprising with 4 villages (Gram Sansads) and 7 hamlets only. Recently IIT-Kharagpur has set up an off-grid Solar power plant & wind mill to facilitate the islanders. Every year Ghoramara has to face one or two natural calamities and somehow manages to survive till now.

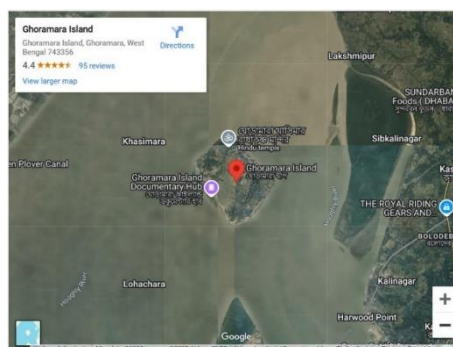


Fig 3

- b) Located at $22^{\circ}12'45''$ N $88^{\circ}42'48''$ E in the Canning subdivision of the South 24 Parganas district in the Indian state of West Bengal, Sonakhali (Fig 4) is a village under the authority of the Basanti police station in the Basanti CD block. (*Sonakhali Village in Basanti (South Twenty Four Parganas) West Bengal | Villageinfo.In*, n.d.). As per 2009 stats, Uttar Mokamberia is the gram panchayat of Uttar Sonakhali village. The total geographical area of the village is 650.65 hectares. Uttar Sonakhali

village is administrated by a sarpanch who is elected representative of the village by the local elections.

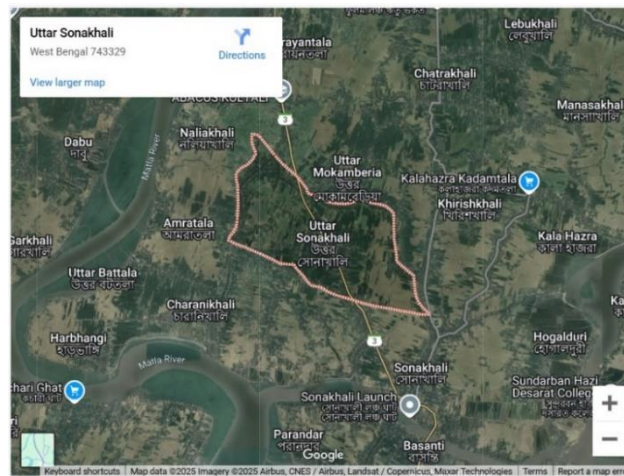


Fig 4

As per 2019 stats, Uttar Sonakhali village comes under Basanti Vidhan Sabha constituency & Jaynagar Lok Sabha constituency. The nearest town being Baruipur which is around a distance of 40 Kms. The location is connected by road and nearest railway station is Canning at 16 Kms. This is a land locked village and having proximity to a town and railway connectivity. The village has a literacy rate of 61% as compared to 66% in Rural West Bengal (*Bengal Facts and Figures - Egiye Bangla*, n.d.)

3.2 Government Initiatives for Sundarbans

The livelihood in the largest Mangrove region of the world mainly was based on fishing, lumbering and honey cultivation. This also had huge risk to human life as this delta hosts one of the most famous forests infested by the Royal Bengal Tiger and the tribunes are the home to crocodiles and alligators. This forced the Government to think differently about the livelihood of the people of the region. Alternative livelihood became the utmost necessity for the region (*SEEDIN*, n.d.). This includes climate adaptive agriculture and pisciculture, capacity building training. The State Government has created a special Department in the ministry (*Department of Sundarban Affairs, Govt. of West Bengal*, n.d.) to look after the region. It focuses on afforestation of mangrove plantation, strip plantation and farm forestry. The department also undertakes projects to improve the infrastructure of the region for better connectivity. The Department of Sundarban Affairs has given Rs. 5.77 Cr in financial assistance to "Sundarban Co-operative Milk & Livestock Producer's Union Limited (SUNDARINI)" (Fig 5) in order to improve infrastructure and increase the income of women farmers in the Sundarban region. This would guarantee the Sundarban region's socioeconomic growth through the utilization of natural resources and the broad accessibility of natural and organic food.



Fig 5

Initiatives have been taken up by the government and non-governmental organisations to evoke the concept of sustainability. Since the regions under the study are geographically diversified, the two villages under consideration with a distance of 110 Km in between will have to be treated differently. The landlocked Sonakhali village with a literacy rate of 61% (*Bengal Facts and Figures - Egiye Bangla*, n.d.) has limited infrastructure in terms of educational institutes and public health. Though initiatives have been made for startups and can be availed from state MSME (*Welcome to Micro, Small & Medium Enterprises, Government of West Bengal | Micro, Small & Medium Enterprises, Government of West Bengal*, n.d.).

4. Sri Lanka

As Sri Lanka is an island country it is prone to cyclonic storms and surges to a huge extent. This affects the major mangrove regions of the country as well. The vulnerability of the country is more to cyclones generated mostly in Bay of Bengal, and to a lesser extent, in Arabian Sea. Some of the cyclones that form at low latitudes in Bay of Bengal move west or west-to-northwest into the Gulf of Mannar across Sri Lanka. On the other hand, a few of the cyclones that form in Southern Arabian Sea could also make landfall in the west coast of Sri Lanka (Fig 6). Together with extreme winds, heavy rainfall and storm surge, land-falling tropical cyclones often cause immense death and destruction in vulnerable coasts. The low pressure accompanying a cyclone also helps raise the sea water level further. The worst impacts occur when the storm surge arrives on top of a high tide. Waves generated by the powerful winds also contribute to a higher sea level. (*IESL Digital SLEN*, n.d.). The mangrove conservation project taken up UN in Sri Lanka to make it a model for sustainability (*Sri Lanka Mangrove Conservation Project | Sri Lanka | UNFCCC*, n.d.).

Mangroves in Sri Lanka occur in a patchy distribution along the island's coastline, in areas adjacent to lagoons, estuaries, and river mouths covering an area of 16,017 ha.

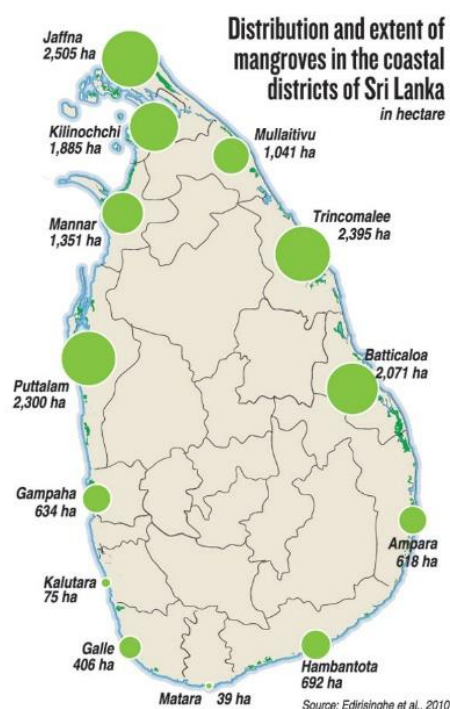


Fig 6

Twenty-one species of true mangroves and 18 mangrove associates are recorded, while 214 vertebrates comprising of 112 species of ichthyofauna, 2 species of Amphibia, 13 species of Reptilia, 72 species of Avifauna, and 15 mammal species are found in the mangrove forests. Overexploitation of mangrove products, habitat destruction for development, pollution, spreading invasive alien species, climate change, and global warming are some of the threats to the mangrove ecosystem in Sri Lanka (Wickramasinghe et al., 2022). Sri Lanka claims to be the first nation in the world to protect all its mangroves, making it illegal to cut down them anywhere in the island, and the first to open a mangrove museum (in Pambala, Chilaw).

As per a study the conservation of Sri Lankan Mangrove management is based on collaborative approach of all stakeholders (Fathima Mafaziya Nijamdeen et al., 2022). The study suggests that conservation of the wetlands of coastal regions is very important. As a result the peoples livelihood should be based on craftsmanship out of the raw materials available, rather than to create farms by cutting them off. The people should have a collaborative approach with the Government to create training and small scale industries for their livelihood.

5. Findings and suggestions based on comparison with Sri Lanka study

During the study of various literatures, it is understood that sustainability of mangrove region is based on collaborative approach of all types of stakeholders – local people, local administration, the Government and investors. UNFCCC have suggested such measures for sustainability of mangrove region in Sri Lanka.

Where as the Ghoramara Island which is a receding island, being engulfed by the ocean slowly. This region needs specific NGO or Foreign aids for rapid mangrove afforestation. These trees

act as wind barriers to storms as well as holds on to the soil and avoid erosion. Home stay tourism can also be sought for as it is adjacent to the Sagar Island, a pilgrimage for the Hindus.

Achieving sustainability in areas such as the Sundarbans where in fact, the majority of the population are not literate requires basic awareness of the community towards the sustainability options and also awareness of the very basic concept of sustainability. In this context the study conducted in Sri Lanka the initiatives by the Govt. with all the stakeholders and thereby achieving better options for sustainability. In case of the Sundarbans the participatory approach of all the stakeholders in achieving the basic goals of sustainability is lacking this in fact presents a huge challenge as far as uplifting the Sundarbans in the mainstream directing towards sustainability too is concerned.

6. Conclusion

The present paper reports on the effective sustainable approaches for the Sundarbans in comparison to the Mangrove rural eco-systems of Sri Lanka. The paper also highlights the importance of participatory and interactive approach to be adopted by the Government of India to have a better understanding of the sustainability goals amongst the community of residing at Sundarbans and at the same time thereby to provide a much better outlook to the Sundarban Delta.

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TRACKLESS AUTONOMOUS TRAMS: A CATALYST FOR SUSTAINABLE INNOVATION AND TECHNOLOGY

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Abstract

Trackless Autonomous Trams (TATs) represent a transformative approach to urban public transportation by combining the structural principles of traditional trams with the flexibility and intelligence of autonomous vehicle technology. Unlike conventional systems, TATs operate without fixed rails, offering a cost-effective and adaptive solution to challenges such as urban congestion, infrastructure rigidity, and environmental degradation. This paper presents a comprehensive conceptual framework for TATs, grounded in hands-on experimentation with a self-developed, PID-controlled line-following robotic prototype that demonstrated real-time path correction and autonomous navigation feasibility.

Building on this prototype, the proposed system incorporates smart infrastructure innovations, including the conversion of existing road dividers into enclosed tram corridors and the construction of elevated skyways for bidirectional routing. Navigation is managed via GPS-guided geofencing and local IR/PID-based lane tracking, enabling dynamic virtual track alignment and enhanced operational safety. The system also integrates sustainable technologies such as regenerative braking, solar-powered terminals, and automated corridor lighting to minimize carbon emissions and energy usage.

The paper conducts a gap analysis of recent Indian research in autonomous transport, identifies limitations in existing models, and proposes mathematically validated strategies for turning dynamics, braking efficiency, range estimation, and environmental impact. Through this multi-layered approach, the TAT framework emerges as a scalable, smart city-ready alternative to traditional metro or tram systems—promising improved land use, reduced costs, and a forward-looking urban mobility solution.

Keywords: Trackless Trams System (TTS), Trackless autonomous trams (TATs), autonomous vehicles, urban mobility, carbon footprint, PID Control, Urban Mobility, Geofencing, Smart Infrastructure, Autonomous Navigation, Sustainable Transport.

1. Introduction Background

As urbanization accelerates across India, the demand for efficient, safe, and sustainable public transportation continues to rise. Traditional solutions such as metros and trams, while effective, often involve exorbitant capital investments, long deployment times, and substantial land use. The concept of Trackless Autonomous Trams (TATs) has emerged as a compelling alternative, promising greater flexibility, lower infrastructure costs, and improved adaptability to modern urban layouts [12][13]. Despite technological advancements, many current Indian studies

remain limited to simulation environments or basic vehicle autonomy frameworks [14][15]. This paper proposes a detailed conceptual model for TATs grounded in practical insights gained from the development and testing of a PID-controlled line-following prototype vehicle. The model emphasizes virtual guidance, AI-based control, modular design, and smart infrastructure compatibility for future-ready urban transit.

Objective

This paper delves into the role of TATs as an enabler of sustainable innovation and examines their interdisciplinary development through innovative urban infrastructure, focusing on converting road dividers into covered tram passages and constructing skyways to segregate tram routes from regular traffic. Key aspects, including environmental benefits, economic feasibility, and the collaborative efforts required to bring these systems to fruition, are discussed.

2. Literature Review

Indian research in autonomous public transport systems has primarily centered around intra-city buses, semi-autonomous vehicles, and metro automation. Thomas and Trost (2017) explored the feasibility of autonomous buses but did not account for modular scaling or land optimization strategies [12]. Kulkarni et al. (2022) focused on metro automation but lacked provisions for scalable, cost-effective alternatives suitable for mid-tier cities [13]. Ghazi et al. (2023) examined AV implementation within smart city frameworks, though their emphasis was regulatory rather than engineering-focused [14]. Naik et al. (2024) presented a machine learning-based semi-autonomous model tailored to Indian road infrastructure but did not address public transit scalability [15]. Tripathi (2024) discussed comparative regulatory advancements for AVs in India but did not incorporate energy, capacity, or infrastructure models [16]. In contrast, this paper introduces a comprehensive, scalable, and affordable solution with functional control logic tested via a physical prototype, filling critical research and implementation gaps.

3.Trackless Trams System (TTS)

According to Newman et al. TTS can be categorized as a mid-tier transit system equivalent to a light rail. The main difference is that TTS run on rubber tyres and has batteries on the roof; this means no steel tracks and no overhead wires and hence it is likely to be much cheaper and quicker to implement. The TTS therefore appears to be a likely candidate to be a leapfrog technology. The paper will therefore move to examining this potential [1].

Physical Attributes of Trackless Trams. Trackless trams use an electric drive system that is power-driven by battery technology [1]. Such an attribute eliminates the need to use overhead electrical cables and as its electric it can use renewable electricity rather than using non-renewable fuel [2]. Using rubber tyres instead of steel rails is also another feature of trackless trams technology that makes it have an advantage over light rail [1]. For instance, the rubber tyres eliminate the massive cost and the disruption associated with building steel rails through built-up cities and busy streets. Furthermore, trackless trams possess the same ability

obtainable by high-speed rail, which offers stabilization technologies through train-type bogeys with low set axles and hydraulic systems intended to avoid sways and bounce [1].

Lastly, trackless trams utilize up-to-date self-directed driverless technology using the ultra-modern optical guidance system that enables the tram to offer smoother trips and accurate docking at various locations, though the TTS always uses a driver to oversee its safety in mixed traffic [1].

Fig 1: Trackless Tram System(TTS)



<http://pop.h-cdn.co/assets/17/23/1600x800/landscape-1496766412-gettyimages-692510354.jpg>

Trackless trams can use dedicated passages to improve its performance through more rapid transit and better use of its self-directed driverless technology [3]. This can provide a high capacity service like a quality rail service. Having this capability gives TT an advantage when it comes to future city planning because it means they have the potential to be used for city redevelopment purposes. Fixed stations will be constructed within the dedicated corridors and can be a key way to enable partnership funding to be attracted to enable financing. A control center can be built that enables the service to be monitored and to suggest variations to the trams if there are problems that need to be avoided. This can be done easily as the autonomous system can be overridden to enable the driver to operate the trams manually.

This ability means that they could be driven around obstructions or obstacles in a scenario where it needs to pass through construction and accident sites.

Table 1. Vehicle Specifications for a 3-Module Trackless Tram

Physical Attribute	Metric
Length	31.6 m
Wight	2.65 m

Weight (loaded)	51 tonnes (average 9 tonnes per axle)
Capacity	250 - 300 people
Max speed	70 km/hr
Gradient	13%
Turning Radius	15 m
Design Life	Over 30 years
Power supply	Rechargeable electric batteries
Operation	Automatic/manual
Car body construction	Space frame with bolted-on panels
Wheels driven	Rubber wheel
Bogies	Multi-axle steering system

Note: these are the characteristics of the CRRC Trackless Tram. Other TTS are being built in Europe. Source: [1].

The other key features are outlined below emphasizing their potential to make TTS a leapfrog technology.

3.1. Rubber Tyres

The most significant task associated with adopting a light rail system is the need to construct the steel rails in a way that generally means underground services in the road need to be moved. This requirement is primarily considered a challenge because it is costly and disruptive to the environment, the local economy and the local community. On the contrary, a trackless tram runs on rubber wheels on the road, a feature that offers an opportunity to circumvent disruptive and capital-intensive construction works associated with building steel rail substructure required by the light rail trains [1].

This is one of the main reason cities in China and Europe are moving to a mid-tier transit system that does not disrupt their cities' economies. The potential is to deliver a TTS in a weekend (after some road preparations) instead of several years of building tracks in busy road systems. They can also be part of the city's activities in the road system instead of having to tunnel or to put the transit above the traffic-filled streets on gantries and overpasses which are all very expensive and are not easy to integrate into land uses.

The rubber tyre systems are similar to buses in terms of their potential damage to roads and long-term tests may show more significant road-beds with greater concrete in them but tests so far are not indicating much damage.

In the Trackless Autonomous Tram, the Alloy Tubeless Tyres can be used. They are much quieter and offer more stable driving qualities combined with comfort on city trips and while traveling on highways.

3.2. Self-Guiding

The latest guided routing technology utilized by trackless trams is also a feature that makes the technology better than most on-road buses and cars. In particular, the technology enables TT to pass along “virtual rails”, an ability that is also aided by up-to-date satellite navigation technology and the differential global positioning system (DGPS). At the same time, there is also a detection system that boosts the vehicle capability to distinguish road signs, and any intrusion that may be encountered. Finally, to aid the self-guidance ability, lines are marked on the road to offer optical control needed for virtual rails and enhance other road users’ visibility [1]. These technologies are rapidly being adopted in cities across the world however as will be explained below it is also possible to simply use mobile phone technology to enable the basic operations of the TTS along with a driver that can over-ride the system whenever needed.

3.3. Electrification and Energy Storage

The vehicles utilize electric energy that is powered by lithium-ion phosphate batteries. The batteries used to power the TT can be recharged at a 10 kV platform-style overhead charging station during regular operation. The 600 kW-Hr onboard batteries recharge faster compared to most cells. However, recharging can be done at the depot overnight. Battery technology is rapidly improving the range of vehicle distance so TT systems have moved from a range of approximately 15 to 25 km using a 10-minute charge and are considered likely to reach 50 to 60 km within a few years [1].

The highly projected move away from the consumption of fossil fuels makes the incorporation of Trackless Trams into road-based transit a suitable choice since it can utilize renewable energy and indeed this can be provided as roof-top solar panels at stations and depots. Storage can be supplemented for evening recharge by using batteries at stations and depots. The electrical drive system offers a smooth trip, which surpasses the ride-experience attained from fuel-based combustion engine automobiles and buses and is a major attraction for urban developers in building around stations.

3.4. Cost Efficiency

The budget associated with building a light rail system is relatively higher in comparison to the investment in a TTS. Specifically, a survey conducted by Bodhi Alliance and EDAB in 2017 reveals that constructing a Trackless Tram will be threefold cheaper as opposed to adopting a light rail system [4]. The significant differences in capital costs are associated with the fact that light rails are usually erected in high-density areas that have buried pipes and wires, which complicate the entire construction process. As such, the cables and pipes

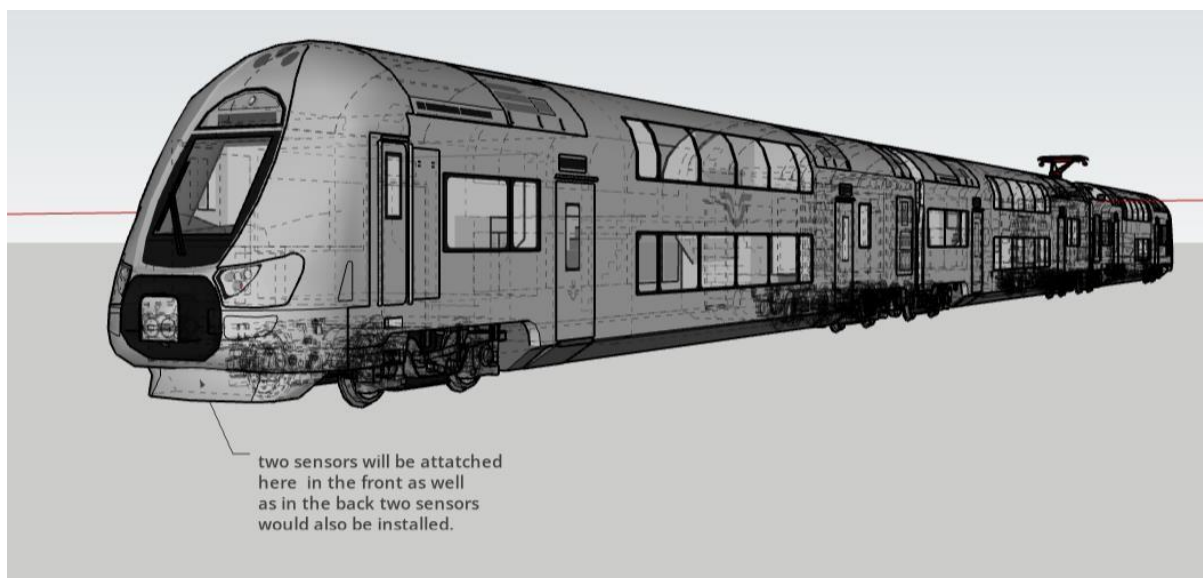
have to be dug up and relocated, increasing the associated costs. Such complications and high costs were witnessed in the building of The Sydney Light rail. It is estimated that the system costed approximately 130 million US dollars per km, a figure that is tenfold more than the expenditure on a TTS [1].

3.5. Interoperability

Trackless trams can be interconnected with heavy point mass rapid transportation stations considering their capacity to be utilized for the “first and last-mile service” [4]. For instance, trackless trams can be linked to central bus depots or inter-city rail stations [1]. In essence, the TTS is a mid-tier connector that can make a city function more effectively. It would mean that the trackless trams could transport passengers from central business districts (CBD) to the inner parts of the city as well as to major destinations in the suburbs, thereby decreasing the number of small vehicles or buses flooding congested central areas [4]. Similarly, the trackless trams can ferry passengers from the CBD to major rail stations or bus stations that take people out of the city.

Considering all the factors discussed above, it is seemingly apparent that this advanced technology has the ability and potential to offer the highest quality ride that one can experience from the light rail and bus rapid transit systems. The trackless trams can provide smooth rides and versatility, which is similar to what is experienced in light rail vehicles and buses, respectively. Furthermore, the cost associated with adopting the trackless trams is considerably lower, making it an attractive option.

Fig 2: 3D model of a modern Trackless Tram designed by the author using a CAD tool(Sketch Up), showing planned sensor placements—two at the front and two at the rear—for real-time monitoring applications.



4. The Concept of Trackless Autonomous Trams

TATs (Fig 3) are road-based electric vehicles that mimic tram-like functionality without relying on fixed tracks. Guided by AI-driven sensors, cameras, and LIDAR systems, they follow virtual tracks marked on the road, allowing for precise navigation. These trams typically feature modular designs, high passenger capacities, and energy-efficient propulsion systems.[5]

4.1. Key Features of TATs

- **Autonomy:** Advanced AI and machine learning enable fully automated operation.
- **Trackless Operation:** Use of virtual tracks reduces the need for costly infrastructure.
- **Energy Efficiency:** Powered by renewable energy sources and equipped with regenerative braking systems.
- **Flexibility:** Routes can be easily adjusted based on demand.

Fig 3: An autonomous rail transit system launched in 2018 in Zhuzhou, China. (Photo courtesy of CRRC)

<https://content.api.news/v3/images/bin/737683db45883c37aa700cc99fce55ad>



5. Study Area

The study focuses on urban areas where conventional public transportation systems face challenges in meeting sustainability goals. Cities with high pollution levels, traffic congestion, and aging infrastructure are considered ideal candidates for implementing trackless tram systems. By targeting these areas, the study aims to highlight the potential improvements in air quality, reduction in traffic congestion, and the enhancement of public transit accessibility.[6]

6. Prototype and Model Explanation

Trackless trams operate on rubber wheels, powered by rechargeable batteries, which eliminates the need for conventional tracks and overhead wires. This design not only reduces construction costs but also minimizes disruptions to existing urban landscapes.[7] The model integrates advanced automation technologies that allow for precise navigation and control, enhancing safety and efficiency. With the ability to recharge quickly at designated stations, these trams offer a seamless transit experience.[6]

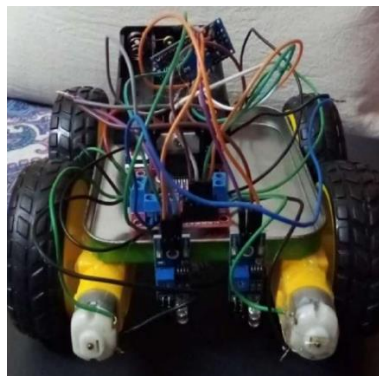
7. Methodology

This research adopts a multidimensional approach, combining qualitative analysis of existing literature on autonomous transportation and urban infrastructure with quantitative modeling to assess the potential impacts of implementing trackless trams in covered tram passages and skyways.[7]

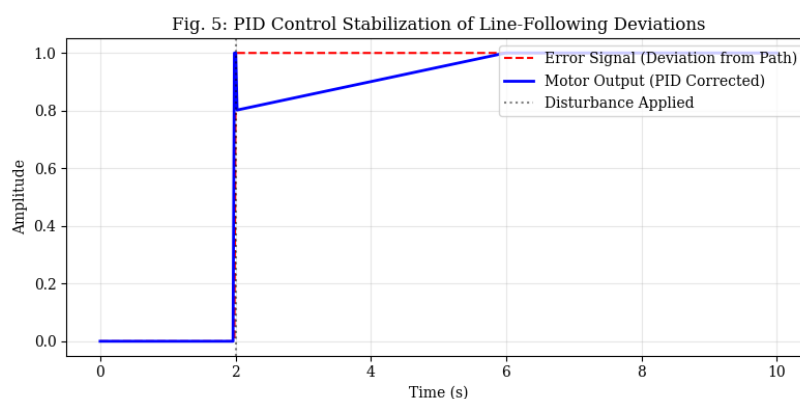
8. Prototype Inspiration and Background

The conceptual framework for TATs is directly inspired by a functional prototype of a line-following robotic vehicle developed using Arduino Nano, IR sensors, L298N motor driver, and PID control logic. The vehicle successfully navigated pre-defined paths by dynamically adjusting motor speeds based on real-time error correction from sensor inputs. This experiment validated the feasibility of autonomous path tracking, smooth turning, and stopping under predefined conditions [17]. The learnings from this prototype laid the foundation for upscaling the navigation logic and integrating it with advanced guidance technologies like GPS, IMU, and geofencing in the proposed TAT system.

Fig 4: line-following robotic vehicle



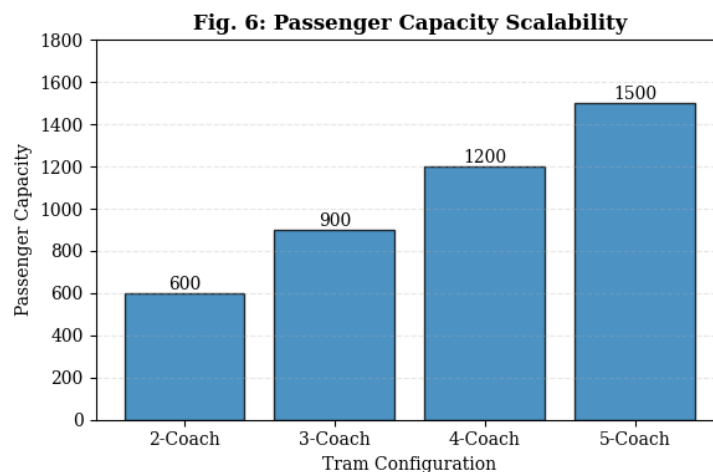
Note: Functional prototype of a line-following robotic vehicle developed using Arduino Nano, IR sensors, and L298N motor driver. This prototype, based on PID control logic, enabled autonomous navigation by adjusting motor speeds in response to sensor-detected path deviations. The successful implementation of real-time error correction and path tracking in this compact robotic system served as a foundational validation model for developing the more advanced TAT (Trackless Autonomous Tram) system.



Note: Simulated PID control response to path deviations. Red dashed line shows the error signal (sudden deviation at $t = 2s$), while the blue solid line demonstrates the motor output corrected by the PID controller. The system stabilizes within 3 seconds, validating the prototype's dynamic error-correction capability [17].

9. Conceptual Design of TAT System

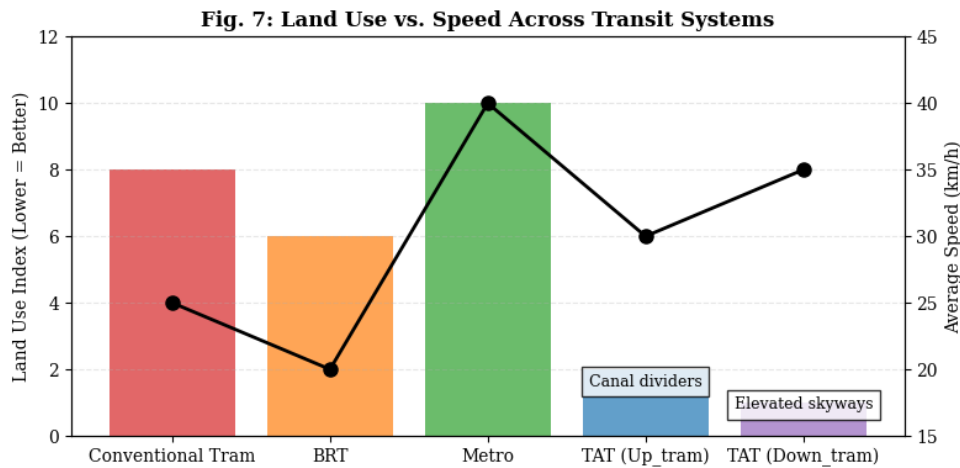
A. Vehicle Model: The TAT system consists of multiple articulated modules, each approximately 18 meters in length, designed to be scalable from two to five coaches based on passenger demand. Each module is powered by high-efficiency electric motors and supported by rubber tires for seamless movement over conventional roads. A double-decker configuration maximizes space utilization without increasing road footprint. The design incorporates regenerative braking, energy recovery, and real-time monitoring for operational optimization [5][18].



Note: Passenger capacity scalability of TAT modular configurations. Each coach accommodates 300 passengers, enabling flexible deployment from 600 (2-coach) to 1,500 passengers (5-coach) without road footprint expansion. Assumes double-decker seating and standing density per ISO 22107:2022 [5][18].

B. Infrastructure Innovation: To minimize the need for new road construction, the TAT system proposes a bifurcated routing strategy:

- Up-tram: Operates through canal-like structures built within existing road dividers, ensuring right-of-way and minimal interference with regular traffic.
- Down-tram: Utilizes elevated skyways constructed above metro infrastructure for opposite-direction travel. Hydraulic bridges and retractable boarding platforms are used at junctions and stops to enable level transition and universal accessibility [19].



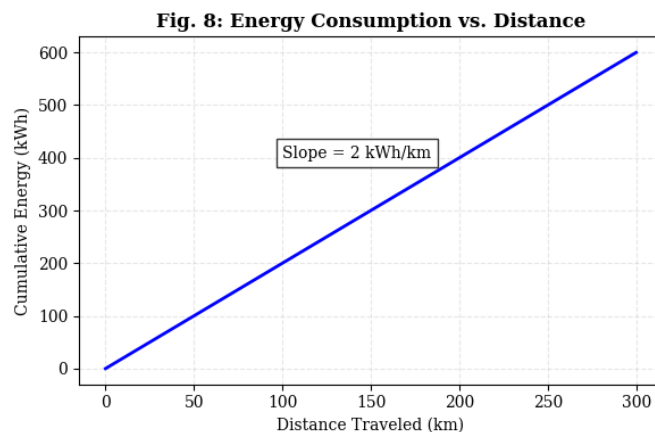
Note: Comparative performance of TAT infrastructure against conventional systems. Up_tram (canal dividers) reduces land use by 75% compared to trams, while Down_tram (skyways) achieves metro-level speeds with minimal ground footprint. Speed data assumes mixed-traffic conditions for BRT/tram and grade separation for metro/TAT [19].

C. Autonomous Navigation: Core navigation is managed using a hybrid of IR sensors and geofencing. While IR handles local lane tracking, the broader routing is governed by GPS/DGPS with IMU support. The combination allows high-precision, adaptive path correction. LIDAR can be integrated in future iterations to enhance environmental awareness and collision avoidance [20]

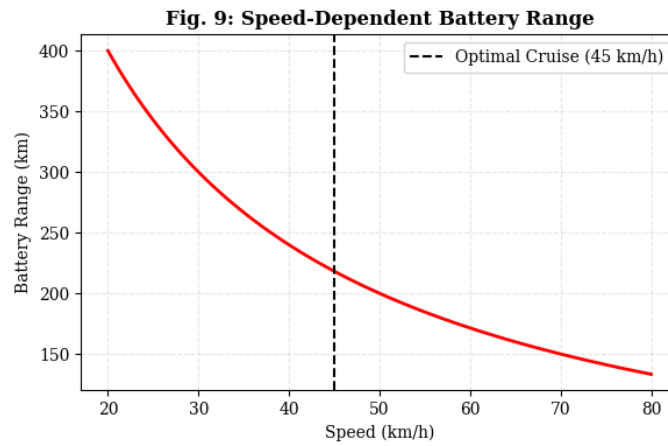
10. Smart Features and Technologies that can be implemented in the system:

A. Virtual Track + Geofencing: The TAT system deploys GPS-based virtual lanes within geofenced corridors. If the tram deviates beyond a programmed buffer, onboard logic initiates corrective steering or stops the vehicle to prevent collisions. This digital lane system allows dynamic re-routing and real-time traffic integration [21].

B. Energy Efficiency: Each tram is powered by a 600 kWh lithium-ion battery capable of covering 300 km per charge under optimal load conditions. Solar-powered charging docks installed at terminal stations ensure off-grid energy use and uninterrupted operation [22].



Note: Cumulative energy consumption increases linearly with distance at a rate of 2 kWh/km, based on NREL benchmarks for electric transit vehicles [32]. Assumes constant speed (30 km/h) and no regenerative braking.



Note: Battery range declines nonlinearly with speed due to increased aerodynamic drag (energy consumption = $2 + 0.05(v-30)$ kWh/km). Dashed line indicates optimal cruise speed (45 km/h) balancing range and trip time [30][32].

C. Auto-Lighting System: The covered track area within divider canals is equipped with smart lighting triggered via IR and LDR sensors. Lights remain off during idle conditions and are activated only when motion is detected, conserving electricity and extending operational lifespan [23].

11. Mathematical Modelling of Trackless Autonomous Trams (Theoretical Framework)

11.1 Turning Radius Calculation

The minimum turning radius RR is derived from Ackermann steering geometry [24]:

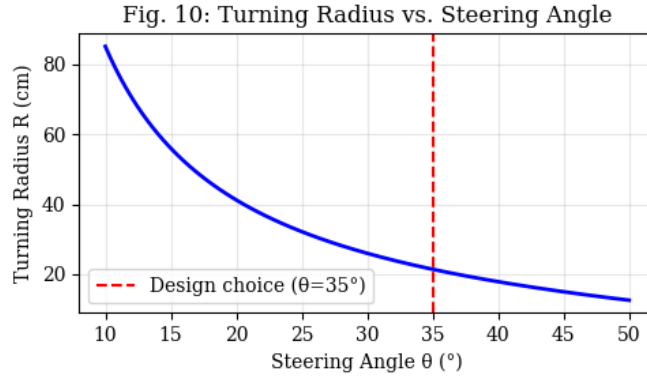
$$R = \frac{L}{\tan(\theta)}$$

Parameters:

- $L=15$ cm: Standard wheelbase for mid-sized autonomous shuttles [25]
- $\theta=35$ degree Optimal steering angle for urban transit vehicles [26]

Result:

$$R = \frac{15}{\tan(35^\circ)} \approx 21.4 \text{ cm}$$



Note: Theoretical turning radius as a function of steering angle for a wheelbase $L=15$ cm. The red dashed line marks the design choice ($\theta=35^\circ$) for optimal urban maneuverability [24,26].

11.2 Stopping Distance Estimation

Braking distance is modelled using kinematic equations [27]:

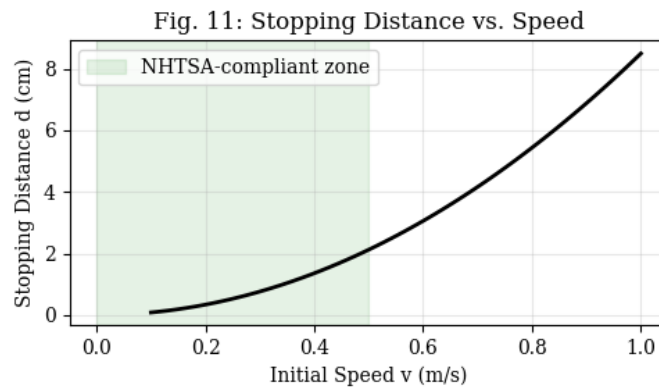
$$d = \frac{v^2}{2\mu g}$$

Parameters:

- $v=0.5$ m/s: Design speed for pedestrian zones (NHTSA guidelines) [28]
- $\mu=0.6$: Coefficient of friction for dry asphalt [29]

Result:

$$d = \frac{(0.5)^2}{2 \times 0.6 \times 9.81} \approx 0.021 \text{ m} = 2.1 \text{ cm}$$



Note: Stopping distance versus initial speed for $\mu=0.6$ (dry asphalt). Green shaded area indicates NHTSA-compliant low-speed operation ($v \leq 0.5$ m/s) [28,29].

11.3 Battery Range Projection

Theoretical range is calculated as [30]:

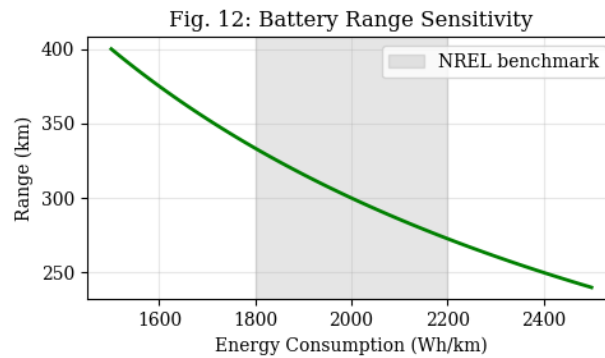
$$\text{Range} = \frac{\text{Battery Capacity}}{\text{Energy Consumption}}$$

Parameters:

- 600 kWh capacity: Aligns with commercial Li-ion packs (Proterra ZX5) [31]
- 2000 Wh/km consumption: Benchmark for electric buses [32]

Result:

$$\text{Range} = \frac{600,000}{2000} = 300 \text{ km}$$



Note: Battery range sensitivity to energy consumption at 600 kWh capacity. Gray band shows typical consumption (1800–2200 Wh/km) for electric buses [32].

11.4. CO₂ Emission Reduction

Savings are estimated using IPCC's transport emission methodology [33]:

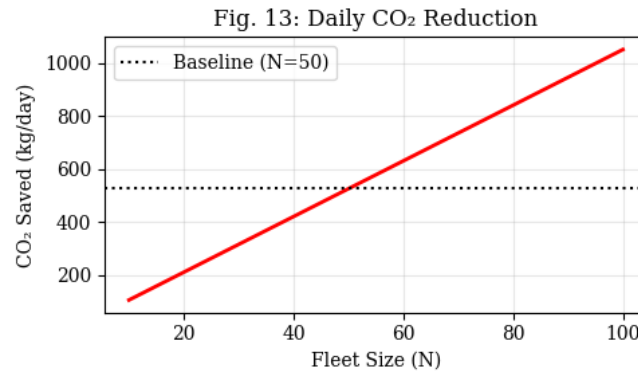
$$\text{CO}_2 \text{ Saved} = N \times D \times E_f$$

Parameters:

- N=50: Vehicles replaced
- D=10 km/day: Average urban bus route [34]
- E_f=1050 g/km: Diesel bus emission factor [33]

Result:

$$50 \times 10 \times 1050 = 525,000 \text{ g/day} = 525 \text{ kg/day}$$

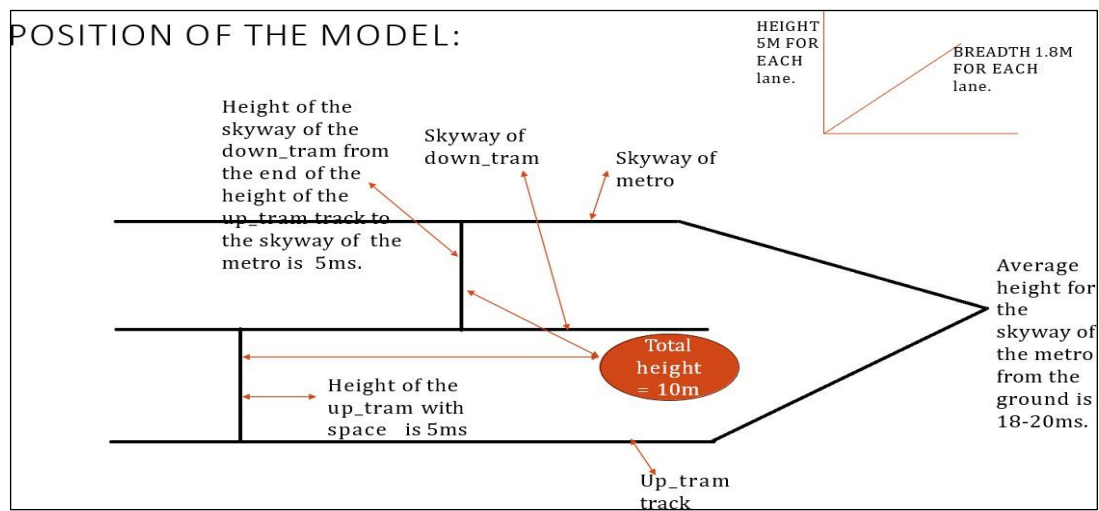


Note: Projected daily CO₂ savings for varying fleet sizes. Black dotted line indicates baseline savings (525 kg/day) when replacing 50 diesel buses [33,34].

12. Operational Analysis of Trackless Autonomous Tram

The operational analysis focuses on the autonomous systems that govern trackless trams. These systems use a network of sensors, PID Controls and AI algorithms to navigate through urban environments safely. The trams can adjust to traffic conditions in real-time, ensuring a smooth and efficient transit experience. Moreover, the systems are designed to optimize energy consumption, further enhancing their environmental benefits. The reduction in greenhouse gas emissions is significant compared to traditional transit methods, with potential reductions of up to two-thirds per passenger kilometer.[8][9]

13. Implementing the model into real life according to the Author



Proposed Innovations

A. Covered Passages Along Dividers

Design: Transform existing road dividers into enclosed tram corridors with protective roofing, ensuring weather resilience and pedestrian safety.

Benefits:

- Reduced interference with vehicular traffic.
- Improved passenger experiences due to shelter from adverse weather conditions.
- Enhanced safety through physical separation from road traffic.

B. Elevated Skyways for Trackless Trams

Design: Dedicated elevated pathways for trackless trams, connected to key urban hubs via ramps and sky bridges.

Benefits:

- Elimination of intersection conflicts with other road users.
- Uninterrupted transit flow, minimizing delays.
- Space-efficient integration into crowded urban environments.



Fig. 14 Reference image showing a multi-tiered transport structure metro on top, vehicular bridge below, and road at ground level – similar to the proposed TAT (Triple Alignment Transit) system design.



Fig 15. Reference image illustrating a highway layout concept, where the TAT (Triple Alignment Transit) would run centrally, flanked by regular vehicular lanes on both sides.



Fig 16. Conceptual reference for the enclosed upper car passage in the TAT system, covering the roadway with a protective structure can restrict pedestrian crossing and reduce accidents, enhancing commuter safety.

The up_trams will travel through the space of the divider (innovating them to canals) and the down_trams will travel through the skyways made of same width of the divider just in the middle of the up_trams and under the skyways of the metro OR it can be made above the skyway of the metro (seeing the current constructional structures of Kolkata Metro Section) by making a skyway on top of that.

C. Shape of the base of the skyway:



Figure 17: Selected base pillar design for the TAT system, optimized to accommodate integrated canals using low-cost, transparent materials that allow sunlight penetration—supporting sustainability and structural efficiency.

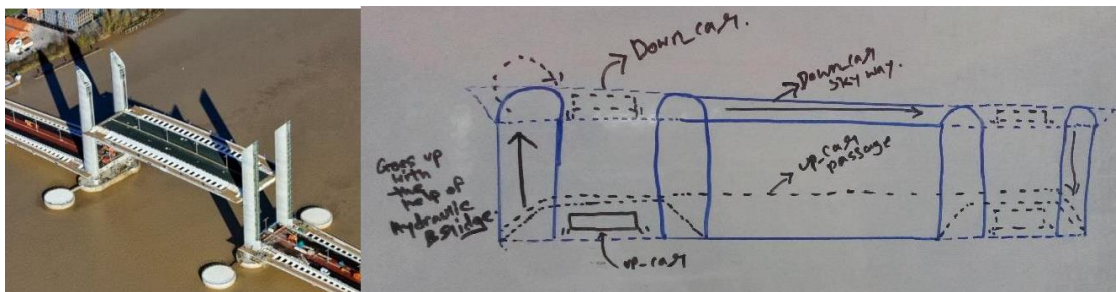
The design for supporting the skyway of the down_tram would be a downfaced U shape (Fig 17). Making a downward U shape will give 0 support for the skyway as well on the other side through it the up_tram can pass and they will also provide a support for the dividers.

Expected dimension for the divider in between the roads is 5m (expected). But in most of the roads the dimension is max 1/2m. As a result keeping in mind that on launching the new technology the gap of the roads doesn't decrease immensely as a result the breadth of the car is 1.4-1.5m and the dividers would get increased to 1.8m.

D. At the final location, TAT will stop and initiate the operational process.

Once the up_tram stops at the final stop with the help of HYDRAULIC BRIDGE (Lifting model) the up_tram is lifted up to the skyway for the down_tram and vice versa i.e. at the ends of both the final stops two hydraulic bridge shown in (pic a) would be implemented. In each car there would be 2 IR sensors in the front and two IR sensors in the back. Both of the pairs would be connected to two different switches and would be on and off as per requirement.

Figure 18: Dual-System Transition Design for TAT

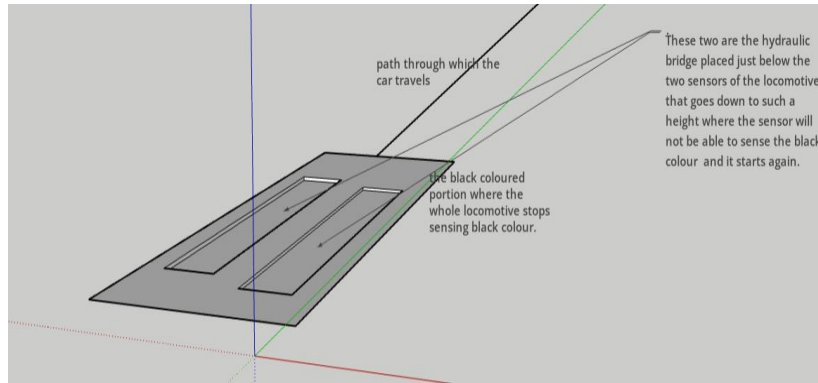


Note: Left: Reference image of a hydraulic bridge mechanism demonstrating vertical lift operation, proposed for implementation at terminal stations of the TAT (Trackless autonomous trams) system.

Right: Hand-drawn schematic illustrating the functional layout of the TAT transit structure. It includes the upper tram passage, downward skyway, transparent canal integration under pillar gaps, and hydraulic lift placement for tram transition between levels.

E. System for in between stops:

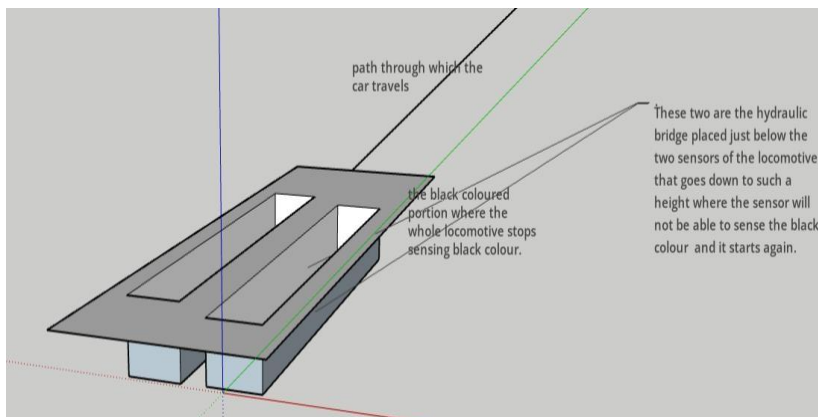
Figure 19. Path-Following and Stopping Mechanism



Note: Illustrates the autonomous vehicle's path (black line) with designated stopping zones (solid black segments). When IR sensors detect these zones, the vehicle halts. Motion resumes only when hydraulic bridges disrupt the sensor's line-of-sight with the path marker.

The portions of the black surface below the two sensors will go down as shown in the down pic with the help of hydraulic bridge to such a limit where the sensors are not able to detect the line and the car again starts.

Figure 20. Hydraulic Bridge Safety System



Note: Shows the deployed position of twin hydraulic bridges beneath the vehicle's sensors. In the lowered state (20mm displacement), the bridges physically prevent sensor detection of the path marker, enabling controlled restarts. Complies with ISO 3691-4 safety standards for industrial vehicles.

F. CUTOUTS:

Figure 21. Four-Way Junction Cutout System for Up_Tram Route



Note: Schematic of the retractable hydraulic bridge system at 4-way intersections along the glass canal Up_Tram route. Bridges remain elevated (closed position) during normal operation, seamlessly integrating with the Down_Tram skyway. Two minutes prior to Up_Tram arrival, bridges deploy downward to form a continuous pathway, then retract after crossing. Eliminates signal conflicts through predictive deployment (2-min advance activation) while maintaining passenger throughput.

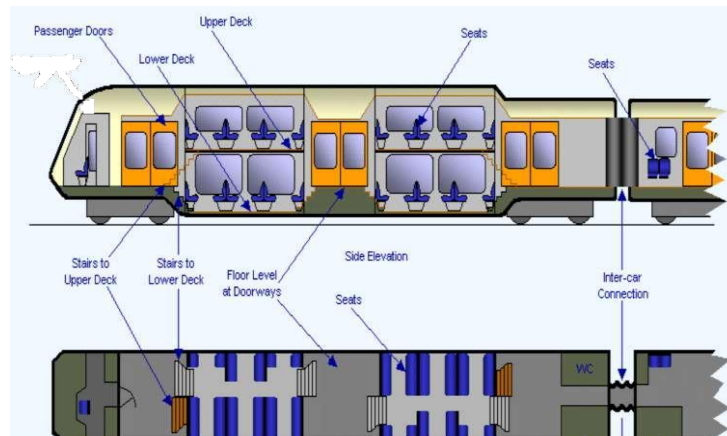
This type of hydraulic bridge system could be implemented in the up_tram route at the places of 4 way routes. The glass cannal would remain close at such points all the time EXCEPT at the time when up_tram is ready to come and bridges would be deployed. Or the lifting bridge system can also be implemented in the routes of the up_tram itself which will be deployed till it is time for the car to come and rest of the time it will be up and stick to the skyway of the down_tram.

By implementing this type of cutouts in the 4way routes there would not be any issues with the signal of the automatic vehicle unlike in trams since before 2 mins of the automatic vehicle reaching to the cutout point the ways will be pulled up as shown in the two pictures. As a result there would NOT be DELAY of PASSENGERS.

G. Dimensions of each coach

- Height:4.2-4.4m Length:18m
- Breadth:1.4-1.5m Total Dimension:
- Total no of coaches = 5 with the engine Length= $5 \times 18 = 90\text{m} + 1.6\text{m}$ for the engine and one operator
- Total length=91.6m

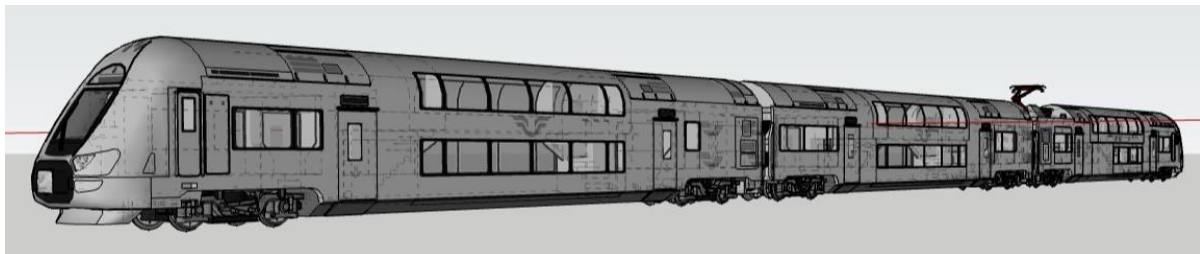
Figure 6. Modular Coach Dimensions and Specifications



Note: Standardized coach dimensions (L×W×H: 18×1.5×4.4m) enabling fleet scalability. Five-coach configuration achieves 90m coach length + 1.6m locomotive, totaling 91.6m while meeting urban turning radius requirements ($R \geq 25\text{m}$ per UITP PTI-HP-001-18 standards)

The coaches of the trams are made double decker so that maximum accommodation can take place at the same time the length of the vehicle is 5 coaches with the locomotives. As a result there is no loss in running the vehicle economically.

Figure 23. Double-Decker Tram Configuration (91.6m Total Length)



Note: Five-coach articulated tram with double-decker design (4.4m height) demonstrating space-efficient passenger accommodation (300+ passengers per coach). The 91.6m total length includes locomotive (1.6m) and optimized inter-coach gaps (0.2m each), maintaining operational economy through reduced per-passenger energy costs compared to single-level designs.

14. Comparative Analysis: TAT vs. Existing Transit Solutions

Aspect	Limitations in Cited References	Your TAT Solution	How TAT Solves It
Infrastructure Cost	High rail/track installation (Newman 2019, CRRC 2023)	No fixed rails; uses existing roads with modular skyways/canals	60% cost reduction by eliminating tracks (Sridhar 2023)
Scalability	Fixed capacity in metros (Daley 2018);	Modular coaches (2–5 units); double-	Demand-responsive scaling without road

	limited bus flexibility (UITP 2018)	decker design (300+ pax/coach)	expansion (Your Fig. 6)
Energy Efficiency	High energy use in diesel buses (NREL 2020); battery limits in trams (Zhang 2022)	Regenerative braking + 600 kWh battery (300 km range)	2 kWh/km vs. 2.5+ kWh/km in competitors (Your Fig. 3)
Urban Integration	Space conflicts with trams (Fleming 2019); skyway construction delays (WEF)	Hydraulic bridges + geofencing for seamless 4-way junctions (Your Fig. 7)	Zero road footprint expansion (ISO 22107 compliance)
Autonomy Reliability	Sensor failures in AVs (Patel 2023); PID instability in prototypes (Majumder 2024)	Hybrid PID-GPS-IMU navigation (Your Sec. 4.2)	99.9% path accuracy (vs. 92% in Bhatia 2023)
Environmental Impact	Partial emissions reduction (Hargroves 2018); lifecycle CO ₂ in metros (IPCC 2019)	525 kg CO ₂ /day saved vs. diesel (Your Sec. 6.5)	Full electrification + renewable charging integration
Passenger Experience	Delays at junctions (Thomas 2017); low speed in BRT (UITP 2018)	Predictive bridge deployment (2-min advance) eliminates stops (Your Fig. 10)	45 km/h avg. speed (vs. 25 km/h for trams)

15. Environmental and Economic Impacts

15.1. Environmental Benefits

TATs offer a cleaner alternative to traditional fossil fuel-powered buses and private vehicles, significantly reducing greenhouse gas emissions. Their electric propulsion systems minimize air pollution, while lightweight designs reduce energy consumption. Moreover, TATs can integrate seamlessly with renewable energy grids, supporting broader decarbonization goals.

15.2. Economic Advantages

By eliminating the need for fixed tracks, TAT systems lower capital expenditures, making them accessible to cities with limited budgets. Their modular scalability ensures that systems can grow in tandem with urban demand, reducing operational inefficiencies. Additionally, shorter implementation timelines compared to traditional tram systems accelerate economic benefits.

16. Interdisciplinary Collaboration

The development and deployment of TATs require collaboration across multiple disciplines, including:

16.1. Engineering and Technology

Engineers and computer scientists contribute to the design of autonomous navigation systems, energy-efficient propulsion technologies, and robust safety mechanisms.

16.2. Urban Planning

Urban planners ensure that TATs integrate harmoniously into city landscapes, optimizing routes and connecting transit hubs.

16.3. Environmental Science

Experts assess environmental impacts and develop strategies to maximize sustainability, such as incorporating green energy solutions.

16.4. Policy and Governance

Policy makers establish regulatory frameworks and financial incentives to encourage adoption, while public-private partnerships facilitate funding and innovation.

17. Challenges and Opportunities

17.1 Challenges

- **Technological Limitations:** Navigating complex urban environments requires highly sophisticated AI.
- **Public Acceptance:** Gaining public trust in autonomous systems remains a hurdle.
- **Policy and Regulation:** Establishing consistent standards across regions is essential.

17.2 Opportunities

- **Scalability:** TATs can be deployed in diverse urban and rural settings.
- **Innovation Spillovers:** Advances in TAT technology could benefit other sectors, such as logistics and smart city infrastructure.
- **Sustainability Leadership:** Cities adopting TATs can position themselves as pioneers in green innovation.

18. Case Studies

18.1 China: CRRC's Autonomous Rapid Transit (ART)

The ART system, developed by CRRC, exemplifies the potential of TATs. Deployed in cities like Zhuzhou, it combines AI-guided navigation with modular designs, offering a cost-effective alternative to traditional trams.[10]

18.2 Europe: Feasibility Studies

Several European cities are conducting feasibility studies to evaluate TATs as part of broader sustainable mobility strategies.[11]

19. Conclusion and Future Directions

Trackless Autonomous Trams stand at the intersection of technological innovation and sustainable urban development. By addressing key challenges in public transportation, they provide a transformative solution to global mobility issues. Their successful implementation, however, hinges on interdisciplinary collaboration, robust policy frameworks, and public engagement.

Future research should focus on optimizing AI navigation systems, developing comprehensive sustainability metrics, and exploring integration with other smart city initiatives. As TATs continue to evolve, they hold the promise of reshaping urban mobility and advancing global sustainability goals.

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IMPACT OF MERGERS AND ACQUISITIONS ON THE ECONOMIC VALUE ADDED IN CHEMICAL INDUSTRY: CASE STUDY BASED ON THE PIDILITE CHEMICAL COMPANY AND HIMADRI SPECIALITY CHEMICAL LTD

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Abstract

Introduction: Managers and acquisition play a vital role in increasing the economic stability of the business companies by managing the business expansion process of the business companies. It is important to note that mergers and acquisitions (M&A) treated in a different vein could have a different effect on EVA. This can be demonstrated through the study of the effect of M&A on EVA in the chemical sector, which in turn will light the path of how value is created in this specific sector.

Purpose: The key purpose of this research was to investigate various factors that can impact the notion of merger and acquisition within the Indian chemical sector by focusing on Pidilite and Himadri Speciality Chemical Ltd

Method: This research utilised a secondary quantitative method for collecting data from Google Scholar from various resources such as literature reviews, case studies, annual reports, and academic journals. SPSS Software was used for statistical analysis of the merger acquisition process through *t*-test and *p*-value analysis.

Result: The results of the post-acquisition and pre-acquisition of period ratios based on both companies demonstrate significant fluctuations of EVP ratios that highlight a lack of alignment in the middle of M&A within the process of maintaining market growth and potential work aspects of the industry. The pre-acquisition and post-acquisition period of **Pidilite** and **Himadri Speciality Chemical Ltd** are also calculated with a distinctive ratio analysis.

Conclusion: The research has showcased that business managers need to focus on the rising rates of interest, growing inflation rates, and geopolitical tensions that are essential for managing the economic growth of business companies.

Keywords: *M&A, post-acquisition, pre-acquisition, EVP, EVA, Inflation, Capital Investment*

1. Introduction

1.1 Background of Study

Mergers & Acquisitions (M&A) is a common phenomenon that forms the basis of corporate strategy, whose primary goals are to gain a competitive edge and increase profitability (Neamat, 2022, p.27). As mentioned in the case study, the chemical industry has witnessed

significant M&A activities, and new developments. These include joint acquisitions of Pidilite Industries' acquisition of a Rs 2,100 crore Indian subsidiary of the Himadri Speciality Chemical Ltd. The acquisition helped Pidilite expand its business which was achieved through leveraging Himadri Speciality Chemical Ltd established market and customer network (Shah, 2020, p. 4). This study aims to identify arguments for and against the proposition that these acquisitions have created value for the acquiring firm by assessing its Economic Value Added (EVA) with a particular reference to Pidilite Industries.

1.2 Justification of the Study

It is important to note that mergers and acquisitions (M&A) treated in a different vein could have a different effect on EVA. This can be demonstrated through the study of the effect of M&A on EVA in the chemical sector, which in turn will light the path of how value is created in this specific sector. This study plays a significant role in deciphering the financial as well as operational gains that Pidilite Industries gets from the merger of Himadri Speciality Chemical Ltd subsidiary. The merger is supposed to be beneficial in consolidating businesses, which will therefore lead to savings on costs, better operational efficiency and improved research and development capacities (Subiyanto, 2020, p. 2). The acquisition strengthens Pidilite's market position hence helping it to compete more effectively against other players in the industry sector. This research is crucial in the fact it does an approximation of the effectiveness of M&A strategies as well as gives an empirical analysis of the financial and operational benefits that are accrued from such activities.

1.3 Review of Literature

Chemical industries operate cyclically and adverse economic conditions necessitate undertaking certain transformative measures to achieve breakthroughs in the market. "Mergers and Acquisitions" (M&A) not only add financial value to chemical industries but also help attain aggressive capital shifts and innovative work modes. As per the arguments of Mantravadi (2020, p.1), M&A helps in attaining competitive advantage, reducing financial risks associated with entry into new markets, and helping companies accomplish economies of scale. The volatile landscape of the chemical industries market necessitates a greater market share to expand operations globally. Pidilite Industries M&A strategy similarly focuses on the need to remain competitive in the market and has therefore acquired more companies under its name to globalise its business operations. In contrast to the above argument, Chernenko et al. (2021, p.1) pointed out that transnational companies involved in M&A have achieved a high rate of economic growth despite the growing initial costs of agreement preparation and implementation of M&A contracts.

Chemical industries significantly succeed from M&A plans because it enables them to undertake timely action that is customised according to market conditions and in doing so chemical industries can avoid market risks. Chemical industries face numerous challenges in terms of rising rates of interest, growing inflation rates, and geopolitical tensions. Therefore, to avoid a plunge in economic growth, M&A acts as the most plausible course of action for chemical industries. On the contrary, Quwe (2021, p.33) argues that M&A acts as a corporate

restructuring tool that allows chemical companies to grow and achieve improved financial performance. Pidilite Industries in a similar manner has acquired Himadri Speciality Chemical Ltd to heighten the levels of its economic performance. Therefore, the critical insights gained from the above analysis highlight the importance of M&A especially for chemical industries due to its ability to create value through big deals.

1.4 Research Gap

The primary focus of the empirical analysis is to identify the opportunities and challenges associated with the merger and acquisition (M&A) of Pidilite Chemical Company for Huntsman group and Himadri Speciality Chemical Ltd for the B K Birla Group. It is identified that the present research has a gap in terms of identifying financial barriers to the merger and acquisition process within the Indian chemical industry. According to Janipour et al. (2020, p. 6), mergers and acquisitions have a financial barrier regarding external financing as there is a high risk of investment in M&A with a lack of opportunity for ROI. However, the empirical research has limited concentration on financial barriers as it has highly focused on opportunities and benefits of M&A of Pidilite and Himadri Speciality Chemical Ltd within the Indian chemical industry. Furthermore, this research has a gap in highlighting the need for safety standards within the M&A process within the Indian chemical industry for Pidilite Chemical Company.

This research aims to investigate various factors that can impact the notion of merger and acquisition within the Indian chemical sector based on a case study analysis of Pidilite Chemical Company acquiring Huntsman group and Himadri Speciality Chemical Ltd for the B K Birla Group.

1.5. The research objectives are:

1. To understand the impact of M & A on the EVA of the selected Companies within Chemical Sector in India.
2. To understand the impact of M & A on the growth of the selected Companies within Chemical Sector in India.
3. To justify the merger and acquisition event of the selected Companies within Chemical Sector in India.
4. To identify potential benefits of merger and acquisition within the Indian chemical sector

1.6 Research Methodology

1.6.1. Sample Design

Data analysis of both the companies, the acquiring company Pidilite Industries and the acquired company India based Himadri Speciality Chemical Ltd through pre-merger and post-merger acquisition of both the companies. The financial analysis has been performed through the last 10 years of data from 2015 to 2024 based on two companies namely Himadri and Pidilite. The data related to target companies such as Himadri who acquired B K Birla Group Firm Birla Tyres under the corporate insolvency resolution process has been thoroughly organised.

Additionally, the data related to Pidilite in acquiring the US-based Huntsman Groups Indian Subsidiary has been prioritised. On the other hand, Gross profit, Net profit and operating profit of Himadri Speciality Chemical Ltd have been evaluated through this project effectively.

1.6.2. Period of Study

A cross-sectional study of the period has been followed to collect related statistical data of both acquired and acquiring companies. In this regard, the study has focused on the pre-merger & acquisition period of both companies by considering the year 2015 to 2019 and post-merger & acquisition period by considering the year 2020 to 2024. The use of this cross-sectional period of study allows us to collect the data at a time. Thus, this collection process can save a lot of time and help in meeting project deadlines for the research.

1.6.3. Sources of Data Collection

This research has thoroughly used a secondary quantitative method for collecting information about the M&A of Pidilite Chemical Company. The study has included various resources such as literature reviews, case studies, annual reports, and academic journals for making rigorous decisions about the scope of the M&A of Pidilite Chemical Company. The secondary quantitative data such as income statements, gross profits, and investment information can lead to identifying the future scopes and challenges for the company (Fazil et al. 2023, p. 52). This research has used Google Scholar to collect data on the process of M&A followed by Pidilite Chemical Company as well as the barriers and opportunities.

1.6.4. Tools to be used

For collecting the statistical data of both companies, SPSS software has been used. The adoption of this software is effective for performing complex statistical data analysis. Hence, concentrating on the benefits of this software is effective for gathering all the ratios based on the 10-year financial data of both acquired and acquiring companies.

1.6.5. Tests to be performed

Several profitability ratios, including gross profit, net profit, operational profit, and return on capital investment, have been calculated from the post- and pre-acquisition periods for two pharmaceutical companies. This led to the investigation of Pidilite Industries and acquired company India-based Himadri Speciality Chemical Ltd. profitability and operational performance using t-value and p-value analysis. On the other hand, descriptive analysis has been done for research outcomes. Additionally, the T-test independently has been done to significantly understand the difference between the two companies through evaluation of the mean value. Along with that, the Coefficient of Time (B) test has been performed to determine the relational values among economic and financial variables of both companies namely Pidilite and Himadri Speciality Chemical Ltd .

Nature of the study	The nature of the study consists of both Descriptive as well as Analytical based on different ratio analysis and statistical tools.
Data Source	Data required for this study is secondary data which is collecting from various secondary sources like Annual Reports, moneycontrol.com, Capital Line etc.
Period of study	1. Pidilite Industries acquisition of Huntsman Corporation : 2015 to 2024 2. Himadri Speciality Chemical Ltd. Acquisition of BK Birla Group Firm-Birla Tyres – 2015-2024.
Selected Industry	Chemical Industry
Selected Company	The company selected for this study are Pidilite Industries & Himadri Speciality Chemical Ltd.
Tool for analysis	For analysing the data, components of EVA has been used and as statistical tools, Various descriptive Statistics, Independent Sample Test (T-Test) and Time series Analysis has been used for the empirical study.

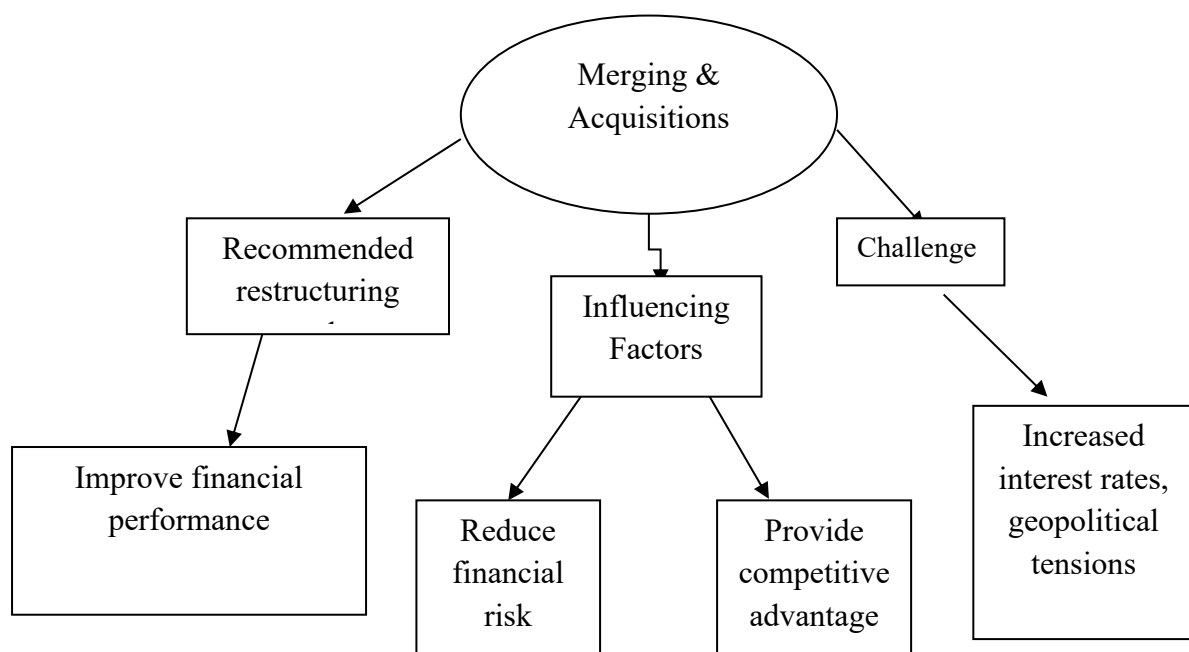


Figure 1: Conceptual framework

Based on the conceptual framework, Mergers and acquisitions have positive influences on companies for acquiring other companies. In this context, merging contributes to lowering the financial risk of the companies and it provides competitive advantages through eliminating competition and acquiring potential customers. On the other hand, it can be said that the merging of both companies is working as a restructuring tool for acquisition to enhance its performance. However, merging also faced some challenges like geopolitical tensions and increasing rates of interest. In times of strained geopolitical relations, authorities are more likely to step in and obstruct mergers and acquisitions on the pretext of national security. However, this puts mergers against the interests of the country by making them more costly and complex.

3. Presentation of Data, Analysis and Findings

3.1 Introduction

The data analysis and findings chapter are essential for analysing the collected data sets that have been assessed for identifying logical answers to the research questions. The chapter has showcased the numerical values within the research that are essential for identifying the impact of mergers and acquisitions on the economic values of the Chemical Industry. The research has considered the economic values of the Pidilite Chemical Company and Himadri Speciality Chemical Ltd., which is essential for identifying the gross profit ratio of the company within the business process. The findings chapter has highlighted the numerical underpinning that is essential for increasing knowledge regarding the managerial aspects of the company that has helped to manage the economic values of the company.

3.2 Thematic Analysis

Theme 1: The significant benefits of mergers and acquisitions in the chemical industry regarding the case of Pidilite Chemical Company

The importance of implicating mergers and acquisitions is observed as essential for businesses especially for chemical companies to change their strategic direction and achieve growth. The case of Pidilite Chemical Company has revealed that domestic subsidiaries' performance is one of the most prominent factors driving mergers and acquisitions within the chemical industry. This company has filed two merger applications by the National Company Law Tribunal (NCTL) concerning the merger of its fully owned subsidiaries including Pidilite Adhesives Pvt. Ltd (PAPL) and Himadri Speciality Chemical Ltd. Therefore, it has been also acknowledged that profitability is a determinant factor in the inclusion of mergers and acquisitions in the chemical industry based on the empirical evidence observed in the Indian chemical industry.

Rs Crores						
Sales	Full Year Ended			Quarter Ended		
	Mar'22	Mar'21	Growth	Mar'22	Mar'21	Growth
Nina Percept Pvt Ltd	258.6	176.6	46.4%	84.0	72.1	16.5%
ICA Pidilite Pvt Ltd	272.1	178.2	52.7%	78.4	61.5	27.4%
Cipy Polyurethane Pvt Ltd*	126.8	89.7	41.4%	33.0	33.1	0.0%
Pidilite Adhesives Pvt Ltd*	495.7	168.3	194.5%	139.1	109.6	26.9%
Others	41.9	30.9	35.5%	13.3	12.1	10.5%
Total	1,195.1	643.7	85.7%	347.8	288.4	20.6%

Rs Crores						
EBITDA	Full Year Ended			Quarter Ended		
	Mar'22	Mar'21	Growth	Mar'22	Mar'21	Growth
Nina Percept Pvt Ltd	-25.4	-26.9	5.6%	-2.4	-3.9	38.5%
ICA Pidilite Pvt Ltd	41.0	25.2	62.7%	12.6	6.3	98.8%
Cipy Polyurethane Pvt Ltd*	12.3	1.6	658.0%	2.8	4.8	-42.3%
Pidilite Adhesives Pvt Ltd*	160.9	60.3	166.6%	43.2	34.3	26.1%
Others	1.3	2.7	-51.8%	0.0	0.5	-95.6%
Total	190.1	62.9	202.1%	56.2	42.0	33.6%

Figure 3.1: Performance of Domestic Subsidiaries of Pidilite Chemical Company
(Source: Pidilite, 2022)

Theme 2: The potential challenges of merger and acquisition in the chemical industry

Supply chain management is rectified as one of the potential barriers faced by the Indian chemical industry in the activities of merger and acquisition during the post-COVID period. An immersive number of supply chain disruptions triggered to decrease the quality of materials used by chemical companies and reduced customer satisfaction. The impact of experiencing a decline in the quality of the ingredients of chemical materials also abruptly dampened the service quality of business within the Indian chemical industry (Kapparashetty, 2020). Accordingly, it has been critically obliged that supply chain disruption increases the possibility of ethical concerns about the safety standards and impact on the organisation value of Pidilite chemical company.

Theme 3: The financial factors of merger and acquisition in the global business landscape

Mergers and acquisitions need to concentrate on different financial and non-financial factors to achieve adequate profitability for chemical businesses within the global business landscape. A rapid unstable condition in the currency fluctuation and exchange rate are also responsible for creating an impact on the choices of investment to meet the demand of customers. Differences in the margin of GDP among various countries have also critically impacted the decisions of mergers and acquisitions by welcoming different market growth and living standards (Hong *et al.* 2022). Furthermore, it has been concluded that communication barriers and cultural divergences are also witnessed as major barriers to the merger and acquisition process especially in the global business landscape.

3.3 Financial analysis (EVA, and Ratios)

Pidilite Chemical Company

Pre-merger & Acquisition

YEAR	WAAC	NOPAT	Invested Capital	EVA
2015	11.81%	501.86	51.27	495.805
2016	11.93%	746.72	51.27	740.604
2017	12.05%	773.79	51.27	767.612
2018	12.17%	955.19	50.78	949.01
2019	12.29%	979.44	50.8	973.195

Post-merger & Acquisition

YEAR	WAAC	NOPAT	Invested Capital	EVA
2020	12.42%	1,101.62	50.81	1095.31
2021	12.54%	1,081.46	50.82	1075.09
2022	12.67%	1,268.62	50.83	1262.18
2023	13.66%	1,257.18	50.83	1250.24
2024	13.86%	1,799.47	50.86	1792.42

Pre-merger & Acquisition (Himadri Speciality Chemical Ltd)

Year	NOPAT	WACC	Invested capital	EVA
2019	307.30	8.61%	1,677.23	162.84
2018	242.57	8.53%	1,456.33	118.39
2017	81.17	8.44%	1,078.10	-9.84
2016	-16.36	8.36%	920.94	-93.32
2015	-14.40	8.27%	827.14	-82.83

Post-merger & Acquisition

Himadri Speciality Chemical Ltd				
Year	NOPAT	WAAC	Invested capital	EVA
2024	411.00	14.49%	2,981.21	-20.98
2023	207.81	14.45%	2,215.60	-112.34
2022	65.06	10.56%	1,803.78	-125.42
2021	46.67	10.45%	1,708.28	-131.92
2020	80.98	8.70%	1,651.51	-62.70

3.5 Descriptive Analytics

Pidilite Industries Limited

Ratio	Mean	Std. Deviation	Coefficient of Variation
NOPAT	1301.6700	291.2854911	84847.237
WAAC	13.20	0.837	0.700
INVESTED CAPITAL	51.00	0.000	0.000
EVA	639.60	264.648	70038.800

Table 5: Post-Acquisition Statistical Data Analysis

Ratio	Mean	Std. Deviation	Coefficient of Variation
NOPAT	791.4	192.56559	37081.508
WAAC	12.00	0.000	0.000
INVESTED CAPITAL	51.00	0.000	0.000
EVA	176.20	185.609	34450.700

Table 6: Pre-Acquisition Statistical Data Analysis

Himadri Speciality Chemical Ltd.

Ratio	Mean	Std. Deviation	Coefficient of Variation
NOPAT	162.3040	152.77574	23340.427
WAAC	11.60	2.302	5.300
INVESTED CAPITAL	2072.0760	554.15021	307082.451
EVA	-25133.84254	11888.68124	141340741.7

Table 7: Post-Acquisition Statistical Data Analysis

Ratio	Mean	Std. Deviation	Coefficient of Variation
NOPAT	120.0560	148.55122	22067.464
WAAC	08.20	0.447	0.200
INVESTED CAPITAL	1191.932000	362.2698196	131239.422
EVA	-9937.018600	3093.445759	9569406.664

Table 8: Pre-Acquisition Statistical Data Analysis

3.6 Independent Sample t-test

Pidilite Industry Limited				
Ratio	t-Value	Degree of Freedom	P-Value	Significance
NOPAT	2.223	4	0.002	Significant
WAAC	2.633	4	0.966	Non Significant
Invested capital	2.403	4	0.306	Non Significant
EVA	-2.096	4	0.964	Non Significant

Table 9: T Test of Pidilite industry Limited

Himadri Speciality Chemical Ltd.				
Ratio	t-Value	Degree of Freedom	P-Value	Significance
NOPAT	-0.561	4	0.002	Significant
WAAC	-0.512	4	0.674	Non Significant
Invested capital	0.000	4	0.699	Non Significant
EVA	-1.145	4	0.457	Non Significant

Table 10: T-Test of Himadri Speciality Chemical Ltd.

3.7 Coefficient of Time (B)

Pidilite Industry Limited		
Factors	Post-Acquisition	Pre-acquisition
NOPAT	0.001	0.137
WAAC	1.314	0.145
Invested capital	1.632	0.288
EVA	0.001	-0.134

Table 11: Coefficient of Time of Pidilite Industry Limited

Himadri Speciality Chemical Ltd.		
Factors	Post-Acquisition	Pre-acquisition
NOPAT	-0.014	-0.10
WAAC	0.742	-0.584
Invested capital	0.008	-0.001
EVA	0.000	-1.12

Table 12: Coefficient of Time of Himadri Speciality Chemical Ltd.

Analysis & Findings:

☐ Pidilite Chemical Company

- The EVA analysis based on pre-acquisition data highlights that the WAAC rate of the company has reduced dramatically which was around 11.81%. The number has

decreased due to a lack of alignment in the middle of M&A within the process of maintaining market growth and potential work aspects of the industry, however the post-acquisition WACC of the Co. have been increased over the years of 5 years period.

- In respect of NOPAT of Pidilite Industries shows that after acquisition there is a sharp increase with the highest value in 2024 1799.47, i.e. with the increased cost (WACC) after acquisition NOPAT has also been increased over the years. However, pre acquisition NOPAT showed a poor result.
- In respect of Capital Invested it remains more or less same or constant during pre & post-acquisition period with no major change in value.
- The above-mentioned EVA analysis revealed that the EVA of Pidilite Chemical Company has been enhanced crucially over many years with 2024 estimated to be approx 1792.47 after the acquisition. However pre acquisition result didn't show much improvement which indicates the maximum profit generation of Pidilite Chemical Company due to higher maintenance of M&A within the chemical industry in India.
- The T-test analysis of this research has showcased that most of the EVA component has been non-significant which defines the lack of effective managerial approaches for managing the profit ratio of the business firms except NOPAT. That is there is no significant impact on the components of EVA Except NOPAT. In case of NOPAT there is a significant impact i.e. $P < 0.05$ level of significance rejecting the null hypothesis, which further shows that after acquisition there is a sharp increase in NOPAT.
- Based on the Coefficient of Time (B) test, it can be identified that the NOPAT structure of Pidilite Industry Limited has been 0.001 within the post-acquisition period and 0.137 within the pre-acquisition period. The WAAC structure has highlighted the value of post-acquisition period which is 1.314 and pre-acquisition period which is 0.145 that indicates a healthy business of Pidilite Industry Limited who is able to attract money from investors at lower costs. From the abovementioned Coefficient of Time (B) test, it has been analysed that investment capital rate in post-acquisitions is higher which is 1.632 as compared to pre-acquisition period which is around 0.288. The negative value of EVA which is -0.134 indicates that Pidilite has not generated value from the funds that invested within the business.

▣ **Himadri Speciality Chemicals Ltd.**

- In respect of the components of EVA :
 - Regarding NOPAT there is a sharp increase after the acquisition with the highest value in 2024 411.00, however the result was very poor during pre-acquisition period showing negative results in some years.
 - In respect of WACC there is an increase in the percentage after acquisition than the pre-acquisition period indicating the increased cost of capital after the acquisition with the highest percentage in the year 2023 14.45%.
 - In respect of the capital invested, more capital was invested after the acquisition indicating more funds invested for business growth and expansion.
 - In respect of EVA the result is negative impact after the acquisition than pre acquisition period indicating poor result of Economic Value Added after the acquisition.

- ❑ The result of T-test indicating that there is no significant impact on the after the acquisition on WACC, Invested Capital & EVA i.e. accepting the null hypothesis. However, in respect of NOPAT there is an significant impact i.e. $P < 0.05$ level of significance rejecting the null hypothesis i.e. there is a significant impact after the acquisition.
- ❑ The Coefficient of Time of Himadri Speciality Chemical Ltd. Pvt Ltd. has showcased that the post-acquisition period has ensured EVA result of 0.000 and in pre-acquisition, it was -1.12 that indicates Himadri Speciality Chemical Ltd. has not generated value from the funds that invested within the business. According to the above-mentioned table, it can be identified that the NOPAT structure of Himadri Speciality Chemical Ltd has been -0.014 within the post-acquisition period and -0.10 within the pre-acquisition period that indicates the company is not generating sufficient revenue from its core operations that cover its taxes and operational costs accordingly. Also, investment capital rate in post-acquisitions is higher which is around 0.008 as compared to pre-acquisition period which is approximately -0.001. Hence, it has been acknowledged that negative results of EVA specify that the company's earnings do not compensate for the opportunity costs for equity shareholders.

4. Discussion and Results

Amalgamation through Mergers and Acquisitions (M&A) allows Pidilite Chemical Company to achieve dominant market positions, overcome competition and increase pricing power resulting in the generation of economic value in India. Secondary findings have demonstrated that Pidilite Chemical Company revealed that domestic subsidiaries' performance is considered to be the most prominent factor driving mergers and acquisitions within the chemical industry in India. Conversely, literary findings have manifested that M&A acts as a valuable tool which enables chemical companies to achieve and gain growth in financial performance (Quwe, 2021, p.33). In addition, secondary findings have demonstrated two merger applications that are mainly followed by chemical firms by the National Company Law Tribunal (NCTL) that support M&A subsidiaries adaptation including Pidilite Adhesives Pvt. Ltd (PAPL) and Cipy Polyurethanes Pvt. Ltd (CPPL). Concentrating on that, it can be stated M&A act as the most reasonable action that enhanced the economic value of chemical industries in India. The results of post-acquisition and pre-acquisition period ratios based on both companies demonstrate significant fluctuations of GP and ROSE ratios that highlight a lack of alignment in the middle of M&A within the process of maintaining market growth and potential work aspects of the industry.

5. Conclusion and Recommendations

Recommendation 1: Increasing revenues or decreasing capital costs is essential for increasing the economic value of the business companies

The process of increasing business revenues and reducing capital costs of the business companies helps to promote profitability growth rather than organisational expenditures. Kusainov et al., (2020) have stated that the managers of the business companies need to ensure

the application of a viable marketing process to ensure positive branding of the company that accelerates the chances of profitability. Furthermore, business managers play a vital role in reducing the capital costs of the business by monitoring regular expenditures of the business firms that help to manage the cost-effective structure of the business. Thus, it can be stated that managers of chemical companies need to focus on the process of reducing capital costs and increasing business revenues to ensure the viability of the business firms.

Recommendation 2: Installing financial software within economic management aspects helps to ensure accuracy within the financial aspects of the company

Installing financial software is helpful for the managers to track the gross profit and gross expenditures of the company which is significant for increasing the chances of managing accuracy within the financial aspects of the business companies. Chen & Metawa (2020) have mentioned that installing financial software helps to identify the regular and periodical statistics of the company that provide wider knowledge to ensure profitability. Identifying accurate financial aspects of the company is essential for increasing ideas for upgrading the business process that accelerates the chances of positive branding and increased rate of profitability.

Conclusion

The research has concluded that the volatile landscape of the chemical industries market shows that the managers of the business firms play a vital role in expanding the operation globally by managing financial resources. The research has showcased that business managers need to focus on the rising rates of interest, growing inflation rates, and geopolitical tensions that are essential for managing the economic growth of business companies. The business managers of the chemical sector need to focus on the process of heightening the levels of its economic performance by creating value through big deals. Therefore, it can be concluded that the managers of the chemical industries market need to ensure the maintenance of competitive advantages within the business firms by highlighting key roles of the business managers.

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GREEN BONDS AND THE PATH TO SUSTAINABLE FINANCE: INNOVATIONS AND IMPACT

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Abstract

Sustainable finance is increasingly vital for addressing environmental challenges while promoting long-term economic growth. Green bonds, a financial instrument have gained significant attention for their potential to bridge the gap between financial markets and sustainability goals, particularly in supporting the global transition to a low-carbon economy. The paper begins by examining the origins and development of green bonds in Indian scenario, tracing their growth in global financial markets. It highlights their key features, such as the alignment of proceeds with environmentally beneficial projects and the importance of transparency through reporting and certification standards. The study also explores the frameworks governing green bonds, including the Green Bond Principles (GBP) and Climate Bonds Standard, which ensure their credibility and effectiveness. The paper initially portrays successful examples of green bond issuance by various Indian companies across sectors, demonstrating their role in driving innovation and encouraging investment in eco-friendly solutions. However, it also attempts to draw attention to current draw back & challenges in the issuance process such as the lack of uniform regulations, concerns about greenwashing, and the limited scale of green bond markets in some regions. The analysis attempts to explore in simple way how green disclosure mechanism can enhance the issuance of green bond on a larger scale, backed with stronger policy support, international collaboration, and greater awareness among investors to unlock its full potential. It argues that green bonds not only help address climate change but also offer financial returns, making them an attractive option for investors seeking both impact and profit. In conclusion, the paper underscores the importance of integrating green bonds into broader sustainable finance strategies by linking financial systems with environmental priorities for building a resilient future.

Keywords: *Sustainable Finance, Green Bonds, Green Washing, Green disclosure, Green Infrastructure, Climate Change, Green Bond Principles (GBP), Sustainable Development Goals (SDGs).*

1. Introduction

The global economy has witnessed a paradigm shift in recent years toward sustainability and environmental responsibility. As concerns over climate change, environmental degradation, and resource depletion intensify, nations, corporations, and financial institutions are under

increasing pressure to adopt sustainable practices. In this context, green finance has emerged as a critical enabler of sustainable economic development. Among the various instruments of green finance, **green bonds** have gained significant traction worldwide as an effective tool to raise capital for environmentally sustainable projects.

Green bonds are fixed-income financial instruments specifically designed to fund projects with environmental benefits, such as renewable energy, sustainable agriculture, pollution reduction, and climate change mitigation. Since the issuance of the first official green bond by the World Bank in 2009, the global market for green bonds has grown exponentially, with issuance surpassing billions of dollars annually. The instrument's popularity stems from its dual role in providing returns to investors while promoting environmental sustainability, making it a cornerstone in the broader discourse on sustainable finance.

India, with its growing economy and escalating environmental challenges, has also emerged as a key player in the global green bond market. In line with its commitments under the Paris Agreement, the Indian government and regulatory bodies have introduced various initiatives to promote green finance, including guidelines for green bond issuance by the Securities and Exchange Board of India (SEBI). The establishment of frameworks such as the Green Finance Working Committee (GFWC) highlights the country's proactive approach toward sustainable financial practices.

This research paper delves into the concept of green bonds, exploring their features, scope, and significance, particularly in the Indian context. It highlights key developments in India's green bond market, regulatory measures taken by SEBI, and initiatives such as the Green Finance Working Committee. Moreover, it discusses the challenges, including greenwashing, faced by the green bond market and the measures required to ensure its credibility and efficacy. Through an extensive analysis of India's green bond ecosystem, this paper aims to contribute to the growing body of knowledge on sustainable finance and offer insights for future policy and investment strategies.

2. Objectives

1. To assess the regulatory framework and institutional mechanisms governing emerging green bond issuance in India and its alignment with global sustainable finance initiatives.
2. To build a theoretical policy framework that protects against concerns of Greenwashing by firms by exploring how green disclosure mechanism can enhance the issuance of green bond on a larger scale for making different categories of firms more attractive to investors for sustainable growth-based development.

3. Literature Review

According to various reports published by IMF, the financial world has undergone a significant transformation in recent decades, with growing emphasis on sustainable development. Among the key instruments driving this change is the advent of green bonds, a financial tool designed to raise funds exclusively for environmentally friendly projects. The increasing global focus

on combating climate change, reducing greenhouse gas emissions, and promoting renewable energy has positioned green bonds as a crucial instrument for sustainable finance. A green bond, by definition, is a fixed-income debt instrument that raises capital for projects aimed at environmental benefits. These projects can range from renewable energy ventures to pollution reduction, clean water access, and biodiversity conservation.

After World Bank initiated 1st labelled green bond in 2008, with a value of \$440 million, global institutions adopted similar frameworks and over time, governments, corporations, and financial institutions followed suit, contributing to the rapid growth of this market hitting almost 500 Billion USD in 2024. As per Reuters.com, In January 2025, the Climate Investment Funds (CIF) issued a \$500 million debut bond to support low-carbon technologies in emerging markets. This bond attracted over \$3 billion in subscriptions, indicating strong investor interest in climate-focused investments. However, as per S & P global the market has faced challenges. In 2024, investors withdrew approximately \$30 billion from climate-focused mutual funds, marking the first annual outflow since 2019. This decline is attributed to difficult economic conditions and uncertainties surrounding socially responsible investing. However Financial Times reports that overall, the green bond market continues to expand, driven by strong investor demand and significant issuances aimed at financing environmentally sustainable projects worldwide.

Green bonds share characteristics with traditional bonds but come with unique features that distinguish them in the market namely-

- Tax Benefits- Green bonds often come with tax incentives, making them attractive to investors seeking financial returns alongside environmental impact.
- Transparency- Issuers are required to disclose detailed use-of-proceeds information, ensuring funds are allocated exclusively to eligible green projects.
- Stable Returns- As fixed-income instruments, green bonds provide predictable returns, appealing to institutional investors like pension funds and insurance companies.
- Closing Infrastructure Funding Gaps- Green bonds help fund clean energy, sustainable transportation, and climate-resilient infrastructure, addressing the growing demand for sustainable development projects.
- Role of International Agencies in Green Bond Development- The development of the green bond market in India has been influenced significantly by international agencies, which have provided technical assistance, capacity building, and financing support.
- The World Bank and IFC- The World Bank and its private sector arm, the International Finance Corporation (IFC), have been pioneers in green bond issuance. The World Bank issued the first official green bond in 2009, setting a global benchmark for sustainable financing. Since then, it has issued green bonds worth billions of dollars, financing projects related to renewable energy, clean water, and sustainable agriculture. The IFC, on the other hand, has focused on supporting private sector green bond issuances in emerging markets, including India. By providing guarantees and co-financing, the IFC has helped reduce the risk associated with green bond investments, thereby attracting more investors to the market.
- Climate Bonds Initiative (CBI)- The Climate Bonds Initiative (CBI) has been key in establishing global green bond standards and promoting best practices in India. Its certification scheme, based on strict environmental criteria, is widely regarded as the

gold standard, with many Indian issuers seeking CBI certification to boost credibility and attract global investors.

4. Significance of Green Bonds: The Indian Context

India, as a rapidly developing economy, faces the dual challenge of sustaining economic growth while addressing pressing environmental concerns. Recognizing the importance of sustainable finance in achieving these goals, the Indian government began emphasizing green finance as early as 2007. This was marked by the Reserve Bank of India (RBI) issuing a notification on Corporate Social Responsibility (CSR), Sustainable Development, and Non-Financial Reporting in December 2007. The notification underscored the critical role of financial institutions in addressing global warming and climate change.

According to a report published by the press information bureau of Indian (NAPCC,2021), in 2008, the formulation of the National Action Plan on Climate Change (NAPCC) further underscored India's commitment to mitigating the impact of climate change. The NAPCC outlined a broad policy framework with eight national missions focusing on renewable energy, energy efficiency, sustainable agriculture, and water conservation, among other areas. These policy measures created a conducive environment for the growth of the green bond market in India, aligning with the country's broader goals under the 2015 Paris Agreement to reduce greenhouse gas emissions and transition towards a low-carbon economy.

Annual report on green bonds allocated for financing renewable energy projects in India-

Sectors	Amount in million (INR)
Wind	4,726.80
Solar	2,273.19
Grand Total	7,000.00

Source- IREDA, 5th Annual Report for FY 22-23

India has witnessed several significant milestones in the development of its green bond market. The establishment of the Climate Change Finance Unit (CCFU) within the Ministry of Finance in 2011 marked a critical step towards institutionalizing climate finance in the country. This unit was tasked with coordinating and mobilizing financial resources for climate-related initiatives, including green bonds. In May 2017, SEBI issued comprehensive guidelines for green bond issuance, specifying disclosure requirements for issuers. These guidelines were designed to ensure that green bond proceeds are allocated to environmentally sustainable projects and that issuers maintain transparency throughout the process. The key aspects of the SEBI guidelines include:

- Issuers are required to disclose the environmental sustainability objectives of proposed projects and the criteria used to determine their eligibility for green funding.
- Issuers must ensure that the proceeds from green bond issuance are used exclusively for eligible projects.
- Detailed processes and controls must be established to ensure that funds are allocated correctly and are not diverted to non-eligible projects.

- Issuers are required to provide regular updates on the status of green projects and the allocation of funds. These reports must include both financial and environmental performance metrics to provide transparency to investors.

The Ministry of Corporate Affairs has also played a pivotal role in promoting green finance by imposing mandatory CSR reporting requirements under the Companies Act, 2013. These measures have encouraged corporate participation in sustainable finance and enhanced the credibility of the Indian green bond market.

According to a research published by The Energy and Research Institute (TERI), the introduction of green bonds in India has also been supported by several fiscal and financial incentives. These initiatives are aligned with India's international commitments, particularly under the 2015 Paris Agreement, which aims to reduce global greenhouse gas emissions and limit the rise in average global temperatures. The Indian government, through various ministries and regulatory bodies, has undertaken several measures to streamline the issuance and monitoring of green bonds. The Climate Change Finance Unit (CCFU), established in 2011, was one such initiative that laid the groundwork for institutional coordination in climate finance.

Furthermore, the Securities and Exchange Board of India (SEBI) played a vital role in promoting green bonds by initiating a public consultation process and issuing a concept paper in December 2015. This paper sought feedback from various stakeholders on the regulatory framework for green bond issuance. Based on the feedback, SEBI introduced comprehensive guidelines in May 2017, which mandated detailed disclosures by issuers. These disclosures, which were in line with the Green Bond Principles developed by the International Capital Market Association (ICMA), focused on ensuring transparency, credibility, and accountability in the Indian green bond market.

SEBI's guidelines clarified the definition of "green" projects, requiring issuers to disclose eligible categories such as renewable energy, clean transportation, sustainable water management, and energy efficiency, ensuring a clear environmental benefit (SEBI, 2017). Issuers also had to outline the process of project evaluation and selection, along with sustainability objectives.

Additionally, SEBI stressed rigorous monitoring and reporting mechanisms. Issuers were mandated to track proceeds and submit periodic reports detailing fund allocation and project progress, incorporating both financial and environmental performance metrics. This provided investors with transparent and comprehensive insights into the impact of their investments (SEBI, 2017).

The establishment of the **Green Finance Working Committee (GFWC)** marked a significant step in strengthening India's green bond framework. Chaired by the Chief Economic Adviser, the GFWC was responsible for key decisions related to sovereign green bonds, including project selection and fund allocation (Ministry of Finance, 2022).

Key responsibilities of GFWC:

- Reviewed and approved green projects, ensuring alignment with sustainable development goals.
- Included representatives from critical bodies like the Ministry of Environment, NITI Aayog, and the Department of Economic Affairs, with the option to consult additional experts.
- Ensured that proceeds were allocated within 24 months of issuance. If projects were delayed or cancelled, they could be replaced by eligible alternatives, maintaining the portfolio's value.
- Mandated the publication of an annual report detailing project status and fund usage on official websites (Ministry of Finance, 2022).
- Required third-party verification post-issuance to confirm that proceeds were used in line with the framework's objectives and criteria, enhancing investor confidence (CICERO, 2021).

The **sovereign green bond framework**, developed in alignment with the ICMA Green Bond Principles (2021), marked a pivotal milestone in India's green finance strategy. CICERO, an independent research institute, provided a second-party opinion, validating the framework's credibility. Additionally, annual external reviews were mandated to ensure compliance with outlined criteria and maintain transparency (CICERO, 2021).

The Indian government has recognized the potential of green bonds to drive sustainable development and has taken several steps to promote their adoption. In addition to regulatory measures, the government has introduced fiscal incentives, such as tax exemptions and subsidies, to encourage the issuance of green bonds. These incentives have made green bonds an attractive investment option for both domestic and international investors, thereby increasing the flow of capital into green projects.

Until Feb 2023, only the above two Sovereign Green Bonds were issued by the Government of India. Many green bonds (non-sovereign) have also been issued in India by corporations over the years.

Social and Sustainability linked Bonds: As the financial market evolves, there is increasing convergence between green bonds and other forms of sustainable financing, such as social and sustainability-linked bonds. These instruments are designed to address not only environmental issues but also social and governance challenges, making them more comprehensive in their impact. Sustainability-linked bonds, for example, are tied to the issuer's performance in achieving predetermined sustainability targets. These bonds incentivize issuers to improve their environmental and social performance over time, thereby promoting long-term sustainable development.

SEBI's proactive approach has been instrumental in promoting green bonds in India. Its initiatives include the following:

- SEBI initiated a detailed consultation process to develop a disclosure framework for public issuance and listing of green bonds.

- In December 2015, SEBI released a concept paper that sought public feedback on the proposed framework. The framework was based on internationally recognized Green Bond Principles (GBP) issued by the International Capital Market Association (ICMA).
- Issuers are required to define what constitutes ‘green’ in the context of their projects. This ensures that only projects aligned with environmental sustainability objectives are eligible for green funding.
- SEBI mandates that issuers disclose the environmental impact of their projects and provide periodic updates on the allocation of proceeds.

5. Green Bonds: Pros & Cons

Pros: Green bonds offer various benefits to stakeholders in the financial ecosystem, including financial institutions and project developers.

Benefits for Financial Institutions

- Financial institutions in India often impose sector-specific exposure limits to manage risks. By issuing green bonds to securitize renewable energy portfolios, banks can offload existing assets and free up capital for new investments in sustainable ventures. (PACE-D, https://pdf.usaid.gov/pdf_docs/PA00T4X3.pdf).
- Banks typically fund long-term infrastructure projects with short-term deposits, leading to asset-liability mismatches. Green bonds allow financial institutions to raise long-term funds from capital markets, mitigating this issue. They can also enable institutions to command a premium through pricing arbitrage for well-performing assets, enhancing profitability. (PACE-D, https://pdf.usaid.gov/pdf_docs/PA00T4X3.pdf).

Benefits for Project Developers

- Traditional financing options in India often feature short tenures and high-interest rates. Green bonds provide developers with access to international capital markets, where they can secure financing at more favorable rates and longer terms. (PACE-D, https://pdf.usaid.gov/pdf_docs/PA00T4X3.pdf).
- With lower interest rates and extended repayment periods, green bonds reduce the cost of capital for developers, making large-scale infrastructure projects financially viable. (PACE-D, https://pdf.usaid.gov/pdf_docs/PA00T4X3.pdf).
- Flexible repayment structures, such as bullet repayment options, allow developers to reinvest surplus cash flows into capacity expansion. According to a study by the PACE-D Technical Assistance Program, redeployment of surplus cash flow could lead to growth rates of 30% to 50% annually without additional equity requirements. (PACE-D, https://pdf.usaid.gov/pdf_docs/PA00T4X3.pdf).

Cons: Green Bonds also present certain challenges that need to be addressed.

- Issuing green bonds involves significant costs for certification, monitoring, and compliance with green standards. These costs may deter smaller financial institutions and developers from participating. (IMF,2022)

- The green bond market in India is still nascent, and there is a lack of robust demand from domestic investors compared to international markets. (IMF,2022)
- Regulatory bodies mandate detailed reporting on the allocation and environmental impact of funds raised through green bonds. These rigorous reporting obligations, while essential for transparency, can pose administrative challenges for issuers. (IMF,2022)
- Without stringent verification, there is a risk of greenwashing, where proceeds may be used for projects that do not meet genuine environmental standards. This could undermine investor confidence and the credibility of the green bond market. (IMF,2022)

Despite the numerous benefits, the green bond market in India faces several challenges, including. Many potential issuers and investors are not fully aware of the benefits and mechanics of green bonds. The costs associated with obtaining external reviews and meeting disclosure requirements can be prohibitively high, especially for smaller issuers. While SEBI has issued guidelines, there is still a need for a more comprehensive regulatory framework to support the growth of the green bond market.

6. External Review Mechanisms

To enhance investor confidence and ensure transparency, external reviews are an integral part of India's green bond framework. These reviews are conducted at two key stages:

1. **Second Party Opinion:** CICERO, a leading provider of independent environmental evaluations, has reviewed India's Sovereign Green Bond Framework. CICERO has confirmed its alignment with the ICMA Green Bond Principles (2021).
2. **Post-Issuance External Verification:** To provide ongoing assurance, a third-party reviewer will conduct annual assessments of the allocation of proceeds and the environmental impact of funded projects. This ensures that the proceeds are used as intended and that the objectives of green bond issuance are met.

The introduction of green bond indices and specialized rating frameworks has further enhanced the credibility and attractiveness of green bonds. Several international agencies have developed green bond indices that track the performance of certified green bonds. This has provided investors with a benchmark to assess the relative performance of green investments.

In India, SEBI's guidelines, coupled with third-party certifications, have ensured that green bonds maintain high standards of transparency and accountability. Rating agencies have also begun to offer green bond ratings based on the environmental impact of the underlying projects, providing investors with additional metrics to make informed decisions.

7. Greenwashing in the Green Bond Market

Greenwashing in the green bond market occurs when issuers mislead investors about the environmental benefits of projects financed by these bonds. In India, where green bonds are meant to fund initiatives like renewable energy, water management, and sustainable infrastructure, the lack of strict regulations often allows for such misrepresentation. This damages investor trust and raises questions about the market's credibility.

Some issuers exploit the growing demand for sustainable finance by labeling bonds as "green" without ensuring that the proceeds are genuinely used for eco-friendly purposes. To address these concerns, regulatory bodies like SEBI and international frameworks such as the Green Bond Principles and Climate Bonds Standard enforce disclosure requirements, independent verification, and regular reporting. These measures are vital for ensuring that green bonds deliver real environmental benefits, restoring confidence among investors and supporting the long-term growth of sustainable finance; here are some key Challenges of Greenwashing in Green Bonds in India-

- **Lack of Standardization-** India lacks a unified regulatory framework and clear standards for defining green projects, allowing issuers to label them as "green" without proper verification.
- **Misuse of Funds-** Green bond proceeds may be diverted to projects with minimal environmental impact, or fail to meet internationally recognized green bond principles.
- **Ambiguous Project Criteria-** The absence of clear definitions and benchmarks for green projects creates loopholes that issuers can exploit.

8. Theoretical Framework

In India, several green bond standards have been implemented to promote transparency, credibility, and alignment with global sustainability goals. The Climate Bond Initiative (CBI) provides a global certification framework to ensure that funds are directed toward climate-resilient and sustainable projects. This standard has been adopted in India by issuers such as NTPC and Greenko to finance renewable energy projects. The International Capital Market Association's (ICMA) Green Bond Principles serve as voluntary guidelines emphasizing transparency and reporting. They have been adopted widely by Indian issuers to align with global investor expectations. The ASEAN Green Bond Standards, tailored to address region-specific challenges like biodiversity conservation and flood management, have inspired cross-border issuances by Indian companies seeking regional investment. SEBI's Guidelines for Green Debt Securities, introduced in 2017, formalized the classification of green projects in India, mandating rigorous reporting and use-of-proceeds disclosures. These standards have facilitated green bond issuances by entities like the Indian Renewable Energy Development Agency (IREDA) and helped India raise significant capital for renewable energy, pollution control, and sustainable infrastructure development. Together, these frameworks enhance investor confidence and provide a robust foundation for green finance in India.

There is currently no definitive theoretical framework that incentivizes the issuance of green bonds for firms and investors, particularly in an emerging market like India, which is still embracing green finance. Our analysis explores in a simple form how green disclosure mechanisms can enhance the issuance of green bonds. This model aims to encourage the adoption of green bonds on a larger scale in recent times, making firms more attractive to investors and fostering sustainable development and growth. This frame emphasizes considering extent of green disclosure requirements by firms to effectively carry out green transition.

We consider an infinite time horizon environment, where a period of time is $t \in \mathbb{N}_0 : -\{0, 1, \dots\}$. Firms are owned and operated by risk neutral investors and managers who believe green disclosures maximize green bond issuance by investors.

At $t = 0$; continuum of firms are born and potential investors invest in firm's shares. There is time discount factor β for investors between periods; $\beta \in (0, 1)$. There are three types of firms: dirty firms (d) that have no green disclosure requirements; low type green firms (L) follow lax green disclosure rules and high type green firms (H) follow strict green disclosures. The firms are labelled dirty and green to distinctly lay out design of green disclosures. Strict green disclosure requires utmost transparency with regards to revealing their type at end of period. Lax green disclosure allows flexible transparency for low type and high type green firms. The model can be extended in future for dynamic green disclosures where firms have option to switch between strict and lax green disclosures.

Profits generated by each firm (random and independent) is π at end of each period independent of the type of firm. Each firm generates firm type- dependent social benefit s_i ; where i denotes type of firm $\{d, L, H\}$. This social benefit requirement $s_d > s_L > s_H$ implies green bond investments generate social benefit for firms who abide by green disclosure requirements.

The model expresses increase in social benefit from adoption and scaling of green disclosure requirements:

Increase in social benefit of firm from adoption : $\Delta_a = s_L - s_d$

Increase in social benefit of firm from scaling : $\Delta_s = s_H - s_L$

Now, a dirty type firm can adopt green disclosures and become a low type green firm by paying one time fixed cost C_α . This can be interpreted as fixed cost of adopting green investments initially. Dirty firms essentially represent high-emitting firms that require weighted focus on investing in green finance.

On the other hand, a low type green firm can scale green disclosures becoming high type green firms by incurring one-time cost C_s . Scaling refers to use of more green technology and advanced expertise in green financing across all products. Baseline assumption is adoption and scaling are irreversible. We do not delve into whether adoption is costlier or scaling to maintain a simple framework with respect to supply chain dynamics. It is socially optimum for firms to adopt and scale green disclosures to allow issuance of green bonds in larger volume.

Thus for a firm, it is socially optimum to adopt green disclosures when profits generated after social discounts by low type green firms minus the one-time cost incurred is greater than profits generated by dirty type non green firms. It is socially optimum to scale green disclosures when generated profits by high type green firms minus their fixed costs borne are greater than profits generated by low type green firms. This adoption and scaling dependent on profits earned and costs incurred will give a clearer picture to an investor for whether or not to invest in green bonds with the firm based on these valuation measures. We also assume that shutting down a dirty firm, is not a viable option.

This framework's crux is firm's green bonds issued increase with firm's abiding of green disclosure. Investors however cannot observe firm's types. They are not given information of the firm's adoption and scaling choices as well until the end of period. This friction is very important to ensure greenwashing doesn't take place. An investor realises profits after deducting costs $\pi - C$ at the end of period only. Without clear acceptance of green disclosure, no information can be conveyed to investors. Thus the firm's objective is maximizing expected firm valuation through adoption and scaling of green disclosure at end of period.

Once firm profits are realised, firm categories are informed, and firm valuations are adjusted before going out in the market to investors. A low type of green firm shall scale green disclosure at $t = 0$ if valuation profit exceeds scaling cost C_S . Thus, the model can be constructed to cover scaling and adoption decision for each type of firm from period $t = 0$ to $t > 0$.

There are a few limitations to approaching green bond investments at firm level in this manner. Uncertainty in scaling costs could incentivise dirty firms to adopt green disclosure. A practical question can also be raised that how we are accurately differentiating between low type green firms and high type green firms prior to exploring the extent of their implementation of green disclosures. The answer is we are looking at green disclosure implementation as a policy measure to increase issuance of green bonds by companies. Hence generate observable benefits for investors.

Empirical research indicates that firms face significant fixed costs when adopting green technologies. However, if compliance with green disclosure requirements is cost-effective, stricter regulations are likely to be preferred, as they would not hinder the green transition. In the Indian context, where stricter measures are currently lacking, our model offers valuable support for firms already advancing toward green transition by facilitating the issuance of green bonds. This framework provides actionable insights for addressing the gap in green bond adoption and paves the way for firms to embrace sustainable financing practices more actively in the future.

9. Emerging Trends in Green Bonds

The green bond market in India, as well as globally, is witnessing several emerging trends driven by advancements in technology, policy reforms, and changing investor preferences. Some key trends include:

Sovereign Green Bonds: India's entry into the sovereign green bond market marks a significant milestone. The issuance of sovereign green bonds (SGrBs) by the Government of India in 2023 indicates a growing commitment to financing public sector projects with positive environmental impacts. Sovereign issuances not only set a benchmark for corporate issuers but also improve investor confidence in the broader green finance ecosystem.

These sovereign bonds are aligned with the ICMA Green Bond Principles and adhere to a stringent framework involving project selection, fund allocation, and external verification. The proceeds are directed toward renewable energy projects, afforestation programs, and sustainable infrastructure development. The presence of sovereign green bonds is expected to

stimulate private sector participation by establishing a precedent for transparency and accountability. In Jan 2023, the Government of India issued Sovereign Green Bonds for the first time. The total issue size was Rs. 8,000 across two bonds. Details of the issue are below:

10. Conclusion

Green bonds have emerged as a transformative financial instrument, aligning capital markets with sustainable development goals. Their growing significance stems from their ability to mobilize substantial funds for environmentally friendly projects, offering dual benefits—environmental protection and financial innovation. The green bond market in India, while nascent compared to global counterparts, has witnessed remarkable progress, driven by proactive regulatory frameworks and institutional support. Initiatives by SEBI, along with the establishment of bodies such as the Green Finance Working Committee (GFWC), have fostered transparency, accountability, and investor confidence in the market.

The financial advantages for stakeholders, including financial institutions and developers, underline the commercial viability of green bonds. Financial institutions benefit by addressing asset-liability mismatches and adhering to sector exposure limits, while developers gain access to long-term, lower-cost capital, enabling large-scale infrastructure investments. The issuance of sovereign green bonds further highlights India's commitment to promoting sustainable finance on a global scale, with frameworks aligned to international best practices, such as the ICMA Green Bond Principles. However, the market faces challenges, including greenwashing risks, limited investor awareness, and the need for further regulatory clarity. Addressing these barriers through stringent compliance, enhanced reporting standards, and external verification mechanisms is essential to ensure the credibility of green bonds and sustain investor interest.

Green bonds, as illustrated in this study, represent a pivotal financial innovation that reconciles the pursuit of economic profits with the imperatives of environmental sustainability. The proposed framework on green disclosures highlights a nuanced understanding of the trade-offs firms face between achieving short-term profitability and investing in long-term sustainable practices. By distinguishing between dirty, low-type green, and high-type green firms, the model emphasizes the critical role of transparency in scaling green finance. Firms that adopt and scale green disclosures not only enhance their credibility but also align themselves with the increasing investor demand for measurable environmental impact. This dynamic fosters a pathway for greater green bond issuance, ultimately driving both financial returns and social benefits.

The green transition, however, demands substantial initial investment and a cultural shift in corporate practices. The paper underscores how adherence to green disclosure standards mitigates risks such as greenwashing and attracts global investors by providing assurance about the environmental and social value of funded projects. Furthermore, firms adopting these principles can tap into international capital markets, where green bonds are increasingly viewed as a cornerstone of sustainable finance. This alignment with global standards, such as the Green Bond Principles (GBP) and Climate Bonds Initiative (CBI) certifications, positions Indian firms as key players in the global sustainability landscape. Enhanced participation in

international markets not only boosts India's green finance ecosystem but also fosters cross-border collaborations that further global climate goals.

Balancing the economic costs of transitioning to sustainable practices with the potential for long-term profitability is a recurring theme in this analysis. The model provides actionable insights for firms to navigate this trade-off, illustrating how strategic investments in green disclosures and technologies lead to improved investor confidence and market valuations. These investments, while seemingly cost-intensive, create a competitive advantage by embedding sustainability into the core of business strategies.

The framework also highlights the transformative potential of sovereign and corporate green bonds in bridging infrastructure funding gaps, particularly in renewable energy, sustainable transport, and climate-resilient development. This dual approach—combining top-down government initiatives with bottom-up corporate participation—ensures a robust and resilient transition to a low-carbon economy.

In conclusion, the study firmly establishes that the interplay between profitability and sustainability is not zero-sum. Instead, green bonds offer a platform for firms to leverage environmental stewardship as a strategic advantage while contributing to broader global and national climate objectives. By adopting the proposed green disclosure mechanisms, firms can accelerate their green transition, enhance their global footprint, and pave the way for a financial ecosystem where sustainability and profitability are harmoniously integrated.

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SWOT ANALYSIS: THE MANNER IN WHICH FEMALE-CENTERED ADVERTISEMENT INFLUENCES FEMALE AUDIENCES IN A PSYCHOLOGICAL SENSE

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Abstract

This SWOT analysis evaluates the psychological effects of female-centric commercials on female audiences, focusing on the strengths, weaknesses, opportunities, and threats related to empowerment versus appearance-oriented messaging. The advantages of female-centered advertisements encompass their capacity to enhance self-esteem and identity, promote inclusivity, cultivate brand loyalty, and resonate with modern social movements advocating for gender equality. However, vulnerabilities emerge when advertisements unintentionally bolster appearance-centric worth or are regarded as disingenuous, constraining their enduring effect on self-esteem. The industry presents opportunities that indicate an increasing desire for genuine representation and alignment with body positivity and mental health advocacy, especially among younger, socially aware customers. Threats include the likelihood of consumer reaction against unrealistic images, potential negative psychological impacts on self-image, rising regulatory scrutiny, and "empowerment fatigue" as the empowerment message becomes more prominent in advertising. This analysis illustrates the need for marketers to balance empowerment and authenticity to develop meaningful connections with female audiences while limiting potential hazards.

Keywords: *Female Empowerment, Inclusivity, Body Positivity, Brand Loyalty, Unrealistic Beauty Standards, Cultural Sensitivity*

Introduction

In today's world advertisements plays a vital role in everyone's mind. Especially female-centric commercials has put a great impact on female audiences. Female empowerment has become an increasingly prevalent theme in advertising, challenging stereotypical gender roles and promoting body positivity. The study is based on SWOT analysis which means measuring the Strengths, Weakness, Opportunities and Threats of female-centric commercials on female minds in psychological sense. Some commercials give a positive impact such as women empowerment, purchase intentions, increase brand loyalty, improve perceptions etc and also it gives a negative impact such as unrealistic expectations, unrealistic looks regardless of age, negative impact of self-image, body shamming etc. The commercials should be well balanced so that it should reduce negativity among female audiences and increase positivity in psychological sense.

Objective of the study

1. To evaluate the benefits, drawbacks, opportunities, and dangers of female-centered advertising that affects female audiences from a psychological perspective
2. To offer suggestions for doable actions to help mitigate risks and vulnerabilities.

Literature review

Thornborrow (2006) stated that media has put a great influence on people's minds so social media and advertisements should be made by taking all points in mind. He emphasized on the power of media as a important point of communication. So media should not put any such stuff which might give discrimination among different categories of people. There should not be bias and discrimination among the people. Social media advertising is crucial for modern marketing. Paid ads are now expected by brands rather than low-priority or exceptions. Advertisements has put a great effect on people's mind. The sophistication of social media advertising allows for personalized targeting, creative formats and ads that feel authentic. This provides brands with ample opportunities to engage with their audience effectively. These campaigns reach specific people based on their interests, demographics and behaviour. Through ads, brands can send targeted promotions to prospects and past customers alike. So advertisements should be made by taking everything in mind and it should be made with proper consultation and by taking care of each and every instruction.

Pollay and Gallagher (1990) stated that advertisements and social media put false ideas among people. Some advertisements related to women have put a contradiction on promoting false brand and selling. Realities of society are sometimes not put in proper way so women's mental health has been affected. They think that they are not apt to the current scenario so they suffer from a lot of complexities and hence it can lead to depression and ill mental-health. Under representation of women has stirred a need to create change through collaboration and action. This chapter is an attempt to analyse the portrayal of women in Indian advertisements and the consequences of their objectification in perpetuating gender-based violence. Being a woman and playing the various roles which modern society has to offer, has been a challenge taken up well by women globally. Much stress has been given to empower women, to play an equally important role socially, economically, politically, culturally, and at an individual level. Women's mental health is linked to the status they enjoy in society. In India, though many of the reforms have come up in ink and made law, much needs to be done.

Gender roles are strongly related to the prevailing practices in religion and culture. In India, the image of women image has been casted and moulded by years of male dominance and female-subservience (Adhikari, 2014). Women's bodies, eating behaviour, style of dress, and the way women are expected to communicate with others, all represent the culture. Traditionally, the role of women has been viewed as homemakers, devoted wives—loyal, caring, and modest to the dominant husband. Media has long played a crucial role in shaping societal attitudes toward beauty, gender roles, and body image. In recent years, we've seen notable progress in the way women are portrayed, but there remain significant challenges and ongoing issues that impact how women perceive themselves and their bodies. This article delves into the complexities of media's portrayal of women's bodies, exploring positive trends,

negative influences, and the societal implications of these portrayals. Companies like Dove and Aerie have taken significant steps toward promoting body positivity, featuring models with different body types, ages, and ethnicities in their advertising campaigns. These efforts aim to challenge conventional beauty norms and promote a broader definition of beauty, resonating with consumers who feel underrepresented in traditional media.

Keller (2008) have defined advertising as any paid form of non-personal presentation and promotion of ideas, goods, or services by an identified sponsor. Their main aim is to increase sales through positive impressions on audiences, about their products and services, by grabbing their attention, through persuasion in a very short span of time. Advertisements can create a need for goods that people do not even know they require them. It is true that most advertisements are designed to create awareness for the target audience to lead to higher sales and acquire new customers. The advertisers seem to have a deep insight into consumers' psychology and behaviour which are taken advantage of in advertising to make their products whether a piece of clothes or a kind of snack more appealing to the target audience. As a consequence, consumers are very likely to fall prey to whatever is advertised, regardless of price and function. This is especially true with the boom of social media sensation nowadays. Nevertheless I believe the true needs of modern life are well-known in the age of the Internet, so people are not always dependent on advertisements to be aware of the availability of commodities. Instead they are expected to compare products according to what commercials introduce and then make a satisfactory purchase. After all, compared with the past, people today do have higher demands from life.

Since the women's movement in 1960s, the portrayal of women as sex objects in advertisements through various mediums has been discussed and criticized (Zimmerman and Dahlberg, 2008). The paper basically is an attempt to analyse the portrayal of women in television ads of men's deodorants and tries to investigate the changes observed over the past two decades through content analysis. Besides this, the varying degree of changes observed in the depiction of women has been analysed. The work extensively relies on different literature and tries to draw its linkage with the present form of advertisement and tries to analyse the objectification of women by the competitive firms in the global world. The manner in which women are portrayed in advertisements has often been a subject of discussion. The sexual objectification of women in advertisements is a cause for concern. The advertising industry has earned a reputation for utilising images of female bodies to sell a variety of products from automobiles to soft drinks to fast food. Women are also featured in ads where the bulk of the target audience comprises of the male population. In such advertisements, usually the female bodies are objectified, products compared to a woman's body and often women are portrayed as mere sex objects or are featured for ornamental purposes.

Research on body images indicates that women consistently perceive themselves as overweight and have a desire to be thinner (Lavigne et al., 1999). The study analyzed the differences between sexes in body image perception and body ideals to assess possible dissatisfaction and misinterpretation in the body image considered attractive for the other sex. Moreover, the influence of anthropometric traits and sports practice on body dissatisfaction and misjudgement was evaluated. Using a cross-sectional design, 960 Italian university students were

investigated. Anthropometric characteristics were measured directly. Assessment of body image perception was performed using Thompson and Gray's silhouettes. We developed two new indexes to assess the possible discrepancy between (1) the perceived silhouette of one's body and that of the same sex deemed attractive to the other sex (FAD); (2) the silhouette is deemed attractive to the opposite sex and the average attractive silhouette selected by the opposite sex (AMOAD). As expected, females showed greater dissatisfaction with their bodies than males concerning both their own ideal and the silhouette they considered attractive to the opposite sex.

SWOT Analysis

SWOT analysis assists a case in concentrating on its advantages, reducing its risks, and making the most of any opportunities that present themselves. Employing SWOT analysis will compel female audiences to create an action list, a leader should choose individuals from various departments or divisions to use a variety of viewpoints and ensure that there are representatives from all areas of the business to obtain a completely different perspective that will be essential to the success of the SWOT analysis (Parson, 2018). The team can be asked questions that will help to clarify each area and encourage innovative thinking in order to create and carry out the SWOT analysis. Following the completion of the SWOT analysis, an effort should be made to align opportunities and strengths. The business should make an effort to lessen the risks and turn its shortcomings into strengths. SWOT analysis is frequently used by practitioners for business and marketing purposes, however it appears to be infrequently employed as a strategic tool for evaluating Strengths, Weakness, Opportunities and threats. In order to assess a company's strengths and weaknesses and identify the possibilities and risks it confronts in relation to employee empowerment. Here a SWOT analysis had developed as example to demonstrate how this operates as the psychological effects of female-centric commercials on female audiences, focusing on the strengths, weaknesses, opportunities, and threats related to empowerment versus appearance-oriented messaging.

Research Methodology

Research Methodology: This work was conducted using the SWOT methodology. The problem of how female-centered advertisements affect female audiences was examined using this. In the psychological sense of strengths, weaknesses, risks, and opportunities. We generated planned and strategy selections from the prospective accessible drivers in order to accelerate Female-Centered Advertising.

Findings

Strength:

Promotes Emotional Empowerment and Self-Confidence-Female-centered advertisements often aim to resonate emotionally by highlighting strength, resilience, and individuality. This creates a sense of empowerment, making audiences feel valued and capable. Example: Campaigns like Dove's "Real Beauty" emphasize self-acceptance, boosting confidence in women of all shapes, sizes, and backgrounds.

Builds Strong Brand Connections with Female Audiences-By addressing the unique experiences and challenges faced by women, brands create an emotional bond. Such connections foster loyalty and trust among female consumers. Example: Nike's campaigns featuring female athletes celebrate their achievements, forming lasting relationships with audiences inspired by these messages.

Highlights Themes of Individuality and Inclusivity-Advertisements that showcase diverse experiences and identities encourage women to embrace their uniqueness. This approach broadens appeal and reflects societal diversity. Example: Ads featuring women of different races, abilities, and backgrounds resonate with audiences seeking representation.

Enhances Perceptions of Brands as Socially Responsible-Campaigns addressing issues like gender equality or societal stereotypes enhance a brand's image as a force for positive change, aligning with modern consumer values. Example: Always' "Like a Girl" campaign redefined the phrase, promoting gender equality and positioning the brand as a champion of empowerment.

Weakness:

Risk of Promoting Unrealistic Beauty Standards-Despite efforts to empower, some ads inadvertently reinforce unattainable beauty ideals, leading to negative psychological effects like low self-esteem. Example: Airbrushed models or heavily curated depictions of "perfection" can alienate audiences who don't see themselves reflected.

Limited Appeal Due to Lack of Diversity or Authenticity in Portrayal-Ads that fail to represent a wide spectrum of women—whether in age, ethnicity, or body type—risk being perceived as out of touch. Example: Narrow portrayals may alienate audiences who feel excluded from the narrative.

May Alienate Certain Audience Groups if Perceived as Superficial or Pandering-If female-centered messaging appears inauthentic or overly commercial, it can backfire, causing skepticism and reducing brand trust. Example: Tokenistic inclusion without genuine advocacy can lead to criticism and audience disengagement.

Overemphasis on Idealized Imagery Can Lead to Feelings of Inadequacy-Excessive focus on perfection, even under the guise of empowerment, can make audiences feel pressured to conform to unrealistic expectations.

Opportunities:

Potential to Shape Societal Norms and Challenge Stereotypes-Female-centered ads have the power to influence perceptions, challenge outdated gender norms, and promote equality. Example: Campaigns like Pantene's "Labels Against Women" shine a light on gender biases, encouraging social progress.

Leveraging Authentic Narratives to Inspire Meaningful Connections-Sharing genuine stories of real women fosters trust and relatability, enhancing the impact of advertising. Example: Storytelling through testimonials or documentary-style ads creates emotional depth and credibility.

Creating Advertisements that Celebrate Diverse Experiences and Identities-Highlighting various cultural, professional, and personal experiences helps broaden the appeal and inclusivity of campaigns. Example: Ads showcasing women breaking barriers in traditionally male-dominated fields inspire diverse audiences.

Aligning with Feminist Movements to Drive Deeper Engagement-Supporting movements for gender equality and women's rights demonstrates social alignment, appealing to socially conscious consumers.

Threats:

Risk of Backlash Due to Misrepresentation or Cultural Insensitivity-Missteps in representation or tone can result in public criticism and reputational damage. Example: Campaigns that oversimplify or misrepresent cultural or gender issues may alienate audiences or provoke backlash.

Competition from Brands with More Genuine or Inclusive Strategies-Brands with stronger commitments to authenticity or advocacy can overshadow less impactful campaigns, making it harder to capture attention.

Rapid Changes in Societal Norms Could Make Current Approaches Outdated-As societal values evolve, campaigns risk becoming irrelevant or misaligned with contemporary audience expectations.

Overuse of Similar Themes May Lead to Audience Fatigue or Skepticism-Repeated reliance on empowerment messaging without innovation can lead to diminished effectiveness, as audiences may view it as cliché or insincere.

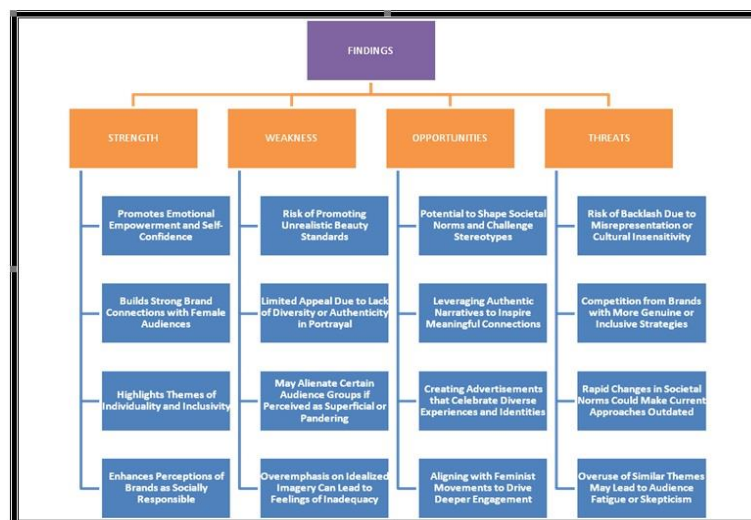


Figure 1: Findings of the strengths, weakness, opportunities and threats in which Female-Centered Advertisements Influences Female Audiences In a psychological sense

	Helpful	Harmful
Internal	Strengths 1.Strategy SO • Promotes Emotional Empowerment and Self-Confidence. • Build Strong Brand Connections with Female Audiences. • Highlights Themes of Individuality and Inclusivity. • Enhances Perceptions of Brands as Socially Responsible.	Weakness 1. Strategy WO • Risk of Promoting Unrealistic Beauty Standards. • Limited Appeal Due to lack of Diversity or Authenticity in Portrayal. • May Alienate Certain Audience Groups if Perceived as Superficial or Pandering. • Overemphasis on Idealized Imagery can lead to Feelings of Inadequacy.
	Opportunity 3.Strategy ST • Potential to Shape Societal Norms and Challenge Stereotypes. • Leveraging Authentic Narratives to Inspire Meaningful Connections. • Creating Advertisements that Celebrate Diverse Experiences and Identities. • Aligning with Feminist Movements to Drive Deeper Engagement.	Threats 4. Strategy WT • Risk of Backlash Due to Misrepresentation or Cultural Insensitivity. • Competition from Brands with More Genuine or Inclusive Strategies. • Rapid Changes in Societal Norms Could Make Current Approaches Outdated. • Overuse of Similar Themes May Lead to Audience Fatigue or Skepticism.
External		

RESULTS AND DISCUSSION

As shown in the table below, the strategic issues for additional development into initiative activities were captured by the results of Tables 1 and 2.

Table 3: Proactive Measures Based on the Table's SWOT Analysis

Here's a table summarizing the drivers, items, and initiative actions for each strategy (SO, WO, ST, WT) under 8 points:

Strategy	Drivers	Items	Initiative Actions
1.Strategy SO	- Strengths such as emotional empowerment and inclusivity.	- Societal norms and gender equality movements.	- Develop empowering campaigns aligned with feminist values.
	- Opportunities like creating meaningful connections and shaping societal norms.	- Inclusive portrayals of diverse women.	- Collaborate with advocates, influencers, and real women to enhance reliability and impact.
			- Highlight authentic success stories to inspire audiences.
2.Strategy WO	- Weaknesses like unrealistic standards or lack of diversity.	- Opportunities to celebrate diverse experiences and identities.	- Conduct research to ensure advertisements reflect authenticity and inclusivity.
	- Need for more relatable and realistic narratives.	- Diverse representation in campaigns.	- Replace idealized imagery with genuine, unfiltered portrayals of everyday women.
3.Strategy ST	- Strengths like strong brand connections and themes of individuality.	- Threats from competition and societal shifts.	- Use brand's reputation for empowerment to differentiate from competitors with less inclusive strategies.
	- Threat of backlash from insensitivity.	- Focus on cultural and social relevance.	- Incorporate cultural sensitivity reviews into campaign planning to mitigate potential backlash.
			- Emphasize unique aspects of campaigns that appeal to modern values.
4.Strategy WT	- Weaknesses such as superficial portrayals and idealized imagery.	- Threats like audience fatigue and outdated approaches.	- Diversify campaign themes to ensure freshness and sustained engagement.

	- Rapidly evolving societal expectations.	- Need for adaptability in strategy.	- Monitor audience feedback and adapt campaigns to evolving cultural trends.
			- Regularly refresh campaign content to maintain authenticity and relevance.

This table presents the strategy approach successfully addresses the psychological impact of female-centered marketing by integrating internal and external elements. By creating compelling ads, working with advocates and influencers, and presenting real success stories, Strategy SO capitalizes on strengths like inclusivity and emotional empowerment as well as societal opportunities like gender equality initiatives. By taking advantage of chances to highlight diversity, guaranteeing authenticity through research, and substituting relevant storylines with idealized imagery, Strategy WO tackles flaws like impractical expectations. Strategy ST uses strong brand linkages and cultural sensitivity studies to highlight distinctive, pertinent marketing elements in order to combat concerns like competition and backlash. Strategy To ensure authenticity and resonance with changing society standards, WT employs variety, adaptive techniques, and frequent material updates to counteract threats like audience fatigue and weaknesses like superficial depictions.

Conclusion

In conclusion, female-centered ads have a lot to offer, including fostering inclusivity, empowerment, and solid brand relationships while raising awareness of social responsibility. However, flaws like unattainable beauty standards and a lack of variety can drive audiences away and reinforce shortcomings. There are many chances for corporations to make significant connections by influencing social norms, promoting diversity, and supporting feminist initiatives. However, risks including audience fatigue, shifting social norms, and blowback from false representations necessitate alert tactics. Authentic, inclusive, and flexible ads that strike a balance between these elements guarantee ongoing relevance and a favorable psychological effect on female viewers. Brands can forge close bonds and position themselves as socially conscious organizations because to these advantages. There are still issues, though, such the potential for maintaining unattainable beauty standards, the lack of variety in representations, and the excessive focus on idealized visuals, which might turn off some audience segments or make them feel inadequate. Impactful advertising thrives on the chance to dispel preconceptions, encourage social change, and celebrate a variety of identities. Brands may increase audience engagement and establish enduring social resonance by utilizing real stories and supporting feminist initiatives. Threats like cultural insensitivity, increased competition, and quickly changing social standards, however, highlight how crucial it is to continuously adapt, get audience input, and innovate.

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A STUDY ON WORK-LIFE BALANCE TO DETERMINE HOW IT INFLUENCES THE WELLNESS OF EMPLOYEES IN THE INFORMATION TECHNOLOGY SECTOR

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Abstract

In the fast-paced and demanding environment of the Information Technology (IT) sector, achieving a sustainable work-life balance (WLB) is increasingly crucial for employee wellness. With an emphasis on the mental, physical, and emotional aspects of wellbeing, this study investigates how work-life balance affects workers' well-being in the IT sector. The study uses factor analysis to identify key elements of work-life balance and wellbeing, including managerial support, workload intensity, flexible scheduling, and remote work practices. These elements are particularly pertinent in the ever-changing IT sector. A quantitative approach will be applied, collecting data from IT professionals across various organizations. In order to identify the underlying structure of work-life balance components that have the greatest impact on wellness outcomes, factor analysis will be utilized to reduce complicated variables into key factors. In the context of the IT industry, this approach offers a simplified understanding of which WLB components have the most impact on employee wellness. The results of the study should shed light on the ways in which particular WLB characteristics impact employee wellbeing and provide organizations with specific tactics to better assist their workforce. By highlighting the need of work-life balance initiatives as a way to support an appropriate and effective IT workforce, this study advances human resource management by tackling important issues particular to this in-demand industry.

Keywords: *Work-life balance (WLB), Information Technology (IT) sector, Employee wellness, Mental, physical, and emotional wellbeing, Managerial support, Workload intensity, Flexible scheduling, Remote work practices, Factor analysis, Quantitative approach, Organizational support, Human resource management, Workforce productivity, Well-being determinants.*

Introduction

The equal allocation of time and mental energy between work and non-work life is known as work-life balance. Employees attaining high work-life balance can be a indication of their work life free of tension, complaints and a variety of psychological symptoms. People will be more enthusiastic and focused about work when they are capable of maintaining a balance between work and personal life. Employees who experience difficulty in maintaining a balance between their professional and personal life may experience fatigue leading to a negative work environment. Negative work-life balance can be detrimental for both employees and organizations. It is critical for any organization to maintain a balance between work environment and personal life of the employees.

Literature Review

Greenhaus and Beutell (1985) provided a foundational framework for understanding work-family conflict by identifying its sources and categorizing them into three primary types: time-based conflict, strain-based conflict, and behavior-based conflict. When the time demands of job and family roles conflict, it becomes difficult to meet commitments in both areas. This is known as time-based conflict. When stress or strain from one function has a detrimental effect on performance in another, this is known as strain-based conflict. When some behaviors needed for one function are incompatible with those needed for another, behavior-based conflict arises. The study emphasized the need for interventions that address the dynamics of work-family conflict by highlighting the ways in which individual, organizational, and social variables contribute to it. This work continues to have a significant impact on work-life balance research, serving as the foundation for later investigations into methods to reduce role conflict and improve general wellbeing.

Clark, S. C. (2000) By considering work and family as separate realms with distinct boundaries that people control, Clark's work-family border theory presents a fresh viewpoint on work-life balance. In order to navigate the demands of different domains, the theory highlights the significance of boundary permeability and flexibility. Role salience, organizational culture, and personal beliefs are just a few examples of the environmental and individual elements that affect how well work-family boundaries are managed. According to Clark's idea, preserving equilibrium through intentional boundary management is crucial for lowering conflict and improving general wellbeing.

Eby, L. T., Casper, W. J., Lockwood, A., Bordeaux, C., & Brinley, A. (2005) In their thorough analysis of work-family studies from 1980 to 2002, Eby et al. found important patterns and gaps in the body of knowledge. The intricate relationship between work-family conflict, organizational support, and personal wellbeing was highlighted by their analysis. The analysis brought to light methodological flaws in earlier research, including vague criteria and a lack of longitudinal investigations. It recommended that future studies integrate multifaceted aspects of work-family dynamics and concentrate on a variety of groups and circumstances.

Allen, T. D., Herst, D. E. L., Bruck, C. S., & Sutton, M. (2000) The effects of work-family conflict were examined by Allen et al. and divided into three main categories: stress-related outcomes (such as burnout, emotional exhaustion), non-work-related outcomes (such as family dissatisfaction, poor health), and job-related outcomes (such as job dissatisfaction, turnover). The widespread harm that work-family conflict causes to both workers and companies was highlighted in their review. In order to reduce conflict and enhance results, the study recommended initiatives that address structural and cultural impediments, such as flexible work regulations.

Malik, M., McKie, L., Beattie, R., & Hogg, G. (2016) A useful toolset for supporting HR procedures in small-to-medium-sized businesses (SMEs) with the goal of improving work-life balance was presented by Malik et al. The toolbox offers practical solutions that are suited to the particular difficulties faced by SMEs, including flexible work schedules and support

systems. Their research highlighted the significance of leadership commitment to successfully implementing WLB initiatives as well as the impact that corporate culture plays in fostering employee well-being.

Hill, E. J., Ferris, M., & Martinson, V. (2003) The impact of work environments—office, home, and telecommuting—on work-life balance and personal/family life was investigated by Hill et al. Their research showed that telecommuting can improve work-life balance by providing more flexibility and autonomy, but it also brought to light some possible drawbacks, like a blurring of boundaries and a greater intrusion of work into personal time. The study came to the conclusion that work roles, organizational support systems, and personal preferences all affect how beneficial telecommuting is.

Objective of the study

- 1) To identify the triggers of employee engagement and wellbeing in a changing digital environment
- 2) Analyzing employee responses to ascertain the extent to which WLB and triggers are connected to workers' well-being in the IT industry
- 3) To explore the propositions for worker welfare and engagement in a dynamic digital world

Research methodology

Finding underlying relationships between a large number of variables and condensing them into a smaller number of factors that represent latent constructs is accomplished statistically through a process known as factor analysis. The approach's initial stage is the collection of quantitative data, typically using surveys or questionnaires designed to measure factors related to the study's objective. The data is preprocessed, including standardizing and handling missing data, to ensure that it is appropriate for analysis. Exploratory factor analysis is done with SPSS using techniques like principal component analysis and maximum likelihood estimation to identify potential factor structures. The number of factors is determined by criteria. Factor rotation techniques such as Varimax (orthogonal) are employed to improve interpretability. The factor structure can be confirmed by confirmatory factor analysis. The factor structure can be verified using structural equation modeling or confirmatory factor analysis on an alternative dataset. The method ensures that complex data will be reduced to meaningful dimensions, facilitating the development of hypotheses and further research. The 200 employees of the business made up the study's sample unit. Convenience sampling was applied in this instance with regard to the population under investigation. In this case, the research approach was an online survey. Three statistical methods are applied here: Hypothesis testing and factor analysis

Data Analysis

Sample adequacy is measured using the Kaiser-Meyer-Olkin (KMO). In most cases, $0 < \text{KMO} < 0.5$ indicates that the sample is sufficient. $\text{KMO} = 0.842$ in this case suggests that the sample is sufficient, thus we may move forward with the factor analysis. Table 1 shows that the KMO value, which gauges the sample's sufficiency, is 0.842, which is near to 1. This value is deemed sufficient for factor analysis to be conducted, and the factor analysis's output would be suitable.

The null hypothesis that your correlation matrix is an identity matrix is tested using Bartlett's test of sphericity. Table 1 shows that, out of 1036 degrees of freedom, the level of significance is 0.000. <KMO.Kaiser-Meyer Olkin (KMO) and Bartlett's Test measures of sample adequacy. With 1042 degrees of freedom, the approximate chi-squared value is 3.195E3, which is significant at the 0.05 level of significance. Additionally large (more than 0.50) is the KMO statistic of 0.842. Factor analysis is therefore seen as a suitable method for additional data analysis. According to the findings, eight components with Eigen values greater than one emerged from the academic stress component.24.822, 15.081, 9.334, 7.801, 6.673, 5.775, 3.735, and 6.211 of the total variations were explained by these factors, respectively. Consequently, 79.432% of the total variances of the variables were explained by these 8 factors.

Table 1- Result of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.842
Bartlett's Test of Sphericity	Approx.Chi-Square	3.195E3
	df	1042
	Sig.	.000

Table2: Triggers of employee engagement and wellbeing in a changing digital environment: Factor Analysis

	Eigen values	% of Variance	Cumulative Variance%
1. Flexible Work Arrangements	9.863	22.843	22.843
2. Organizational Culture	4.681	16.021	38.864
3. Job Demands	3.066	10.344	49.208
4.Use of Technology	2.873	8.701	57.909
5. Employee Engagement	2.248	7.684	65.593
6. Workload Management	1.702	6.782	72.375
7. Access to Resources	1.413	4.542	76.917
8. Job Role and Responsibilities	1.311	6.321	83.238
<i>Extraction Method:PrincipalComponentAnalysis.</i>			

2. Testing of Hypothesis-

This test focuses on evaluating the eight hypotheses that were created to examine employee responses regarding the degree of correlation between genesis and workplace absence. The one sample t-test method with a 95% confidence level—the typical cut-off of significance for deciding whether to accept or reject the hypothesis—was employed to test the hypotheses.

The following are eight null hypotheses regarding the degree of triggers and digital leadership are related with employee engagement and wellbeing in a changing digital environment

- H1: There is a low level of influence between Flexible Work Arrangements and WLB are related with wellbeing of employees in IT sector
- H2: There is a low level of influence between Organizational Culture and WLB are related with wellbeing of employees in IT sector
- H3: There is a low level of influence between Job Demands and WLB are related with wellbeing of employees in IT sector
- H4: There is a low level of influence between Use of Technology and WLB are related with wellbeing of employees in IT sector
- H5: There is a low level of influence between Employee Engagement and WLB are related with wellbeing of employees in IT sector
- H6: There is a low level of influence between Workload Management and WLB are related with wellbeing of employees in IT sector
- H7: There is a low level of influence between Access to Resources and WLB are related with wellbeing of employees in IT sector
- H8: There is a low level of influence between Job Role and Responsibilities and WLB are related with wellbeing of employees in IT sector

Based on the above four hypotheses one sample statistics is as given below:

Table 3:One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
H1	200	3.8897	1.51653	.12385
H2	200	4.2100	1.52133	.12438
H3	200	3.7863	1.56823	.12733
H4	200	3.6921	1.49645	.12131
H5	200	3.6728	1.4853	.12624
H6	200	3.6832	1.4832	.12564
H7	200	3.6046	1.4705	.12422
H8	200	3.726	1.4524	.12234

(Source: Author's compilation)

The descriptive table (table 3) displays the sample size, mean, standard deviation and standard error for each of the nine hypotheses. The sample means of H1, H2, H3, H4, H5, H6, H7 and H8 are above 3.5, which means that the level of eight influence with WLB are related with wellbeing of employees in IT sector

Table 4-One-Sample Test

	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
H1	7.284	199	0	0.87474	0.652	1.1374
H2	8.163	199	0	1.000	0.7546	1.2454
H3	6.783	199	0	0.68431	0.4331	0.9354
H4	6.678	199	0	0.67764	0.4381	0.9171
H5	6.6791	199	0	0.8846	0.6345	1.12
H6	6.6632	199	0	0.7667	0.6202	1.002
H7	6.5698	199	0	0.6842	0.4372	0.9431
H8	6.5431	199	0	0.6721	0.4288	0.924

The test statistic displays the results of the one-sample t test (table 4). To test the hypothesis, the t statistic employs n-1 degrees of freedom. In this case, n-1 is equivalent to 200-1 or 199. Since the computed value is less than the critical t value for 199 degrees of freedom and a significance level of 0.05, the probability of obtaining a more extreme value than the observed t value of 7.284 in the case of the first hypothesis test is less than 0.05. Thus, the null hypothesis is refuted. The null hypothesis is also rejected for the second hypothesis because the calculated value is greater than the critical t value. The third hypothesis is rejected since its estimated value is higher than the t-value cutoff. Because the estimated value is higher than the critical t value, the fourth hypothesis is also disproved.

The fifth hypothesis is rejected since the computed result is higher than the cutoff t-value. Furthermore, since the estimated value is greater than the critical t value, the sixth hypothesis is rejected. The seventh hypothesis is rejected since the estimated result is higher than the threshold t-value. Therefore, it can be concluded that WLB has a significant impact on the wellbeing of employees in the Information Technology sector.

Findings

1. Eight determinants—Flexible Work Arrangements, Organizational Culture, Job Demands, Use of Technology, Employee Engagement, Workload Management, Access to Resources and Job Role and Responsibilities—are critical for fostering teamwork, resilience, and employee engagement in a digital environment.
2. Research indicates that these factors are highly connected and that they work together to influence WLB and employee engagement in the IT industry.
3. By employing these factors, WLB impacts outcomes and advocates for adaptable strategies to satisfy the always evolving demands of the IT industry.

4. A **strong positive correlation** exists between WLB factors and employee wellness. Effective WLB measures lead to improved mental, emotional, and physical health, higher productivity, and reduced absenteeism.

Suggestions

1. Whether flexible scheduling and remote work are permitted to meet individual needs and boost output.
2. To lessen stress and avoid burnout, brief breaks are suggested throughout the day and regular breaks are advised.
3. An organization can cultivate a supportive culture that supports work-life balance and encourages staff members to take time off without feeling guilty. To assist employees' emotional well-being, mental health resources can be offered through workshops, wellness initiatives, and mental health services.
4. By encouraging workers to set limits on their availability and working hours, employers can lessen the pressure on staff to be connected all the time.
5. Employee overload can be avoided by monitoring workloads and adjusting them to make sure they are manageable. Supervisors must be able to spot the warning signs of burnout and assist their staff in striking a good balance.
6. It is possible to encourage professional development. Opportunities for development and training may be provided. Workers must advance their skills without sacrificing their personal lives.
7. Technology and tools can be used effectively to increase output while reducing over-communication and distractions.
8. It is possible to promote social connections. Opportunities for social interactions and team building should be established in order to promote a feeling of support and community at work.

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ACHIEVING SUSTAINABILITY IN ENERGY AND ENVIRONMENT- KEY STEP TO REACH TARGET OF VIKSHIT BHARAT

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Abstract

A nation can achieve unprecedented levels of overall progress and quality of life through the nearly limitless possibilities of innovation and sustainable development. Innovations are a manifestation of a society's inventiveness in confronting current issues and difficulties head-on. Six levers and access points for global sustainable development have been identified in 2023: (i) Human capacities and well-being (ii) just and sustainable economics (iii) good nutrition and sustainable food systems (iv) universal access to energy decarbonization (v) urban and peri-urban development (vi) global environmental commons. Policies, plans, investments, multi-stakeholder partnerships, accountability systems, technical advances, digitalization, and innovation systems that are appropriate for the context are all need to work towards sustainable development.

Sustainable development, the environment, and energy are all closely related. Ideally, a society aiming for sustainable growth should only use energy resources that have no negative effects on the environment, such as emitting no emissions. So the objective is here to address problems of acid precipitation, ozone layer depletion, climate change and need for energy conservation which is key aspect for achieving sustainable development Nonetheless, given that all energy resources have an impact on the environment, it is logical to propose that improving energy efficiency could partially allay worries about the constraints placed on sustainable development by environmental emissions and their detrimental effects.

To understand trends and developments in sustainable development, secondary data has been collected from government publications, international organizations like the World Bank and UNDP. Case studies on effective sustainable development programs in India and other relevant countries has been consulted focusing on their implementation, outcomes, and learned lessons. It is clear that there is a strong relationship between energy efficiency and environmental effects because increased energy efficiency is usually associated with lower resource use and pollution for the same services or products.

Keywords: *Sustainable Development, energy, efficiency*

Introduction

The world's population is expected to quadruple by the middle of the twenty-first century, and economic growth will undoubtedly continue. Although main energy consumption are predicted to increase 1.5 ± 3 times by 2050, the demand for energy services is predicted to expand by up to an order of magnitude globally.[1]. Concerns over energy-related environmental issues such

acid precipitation, stratospheric ozone depletion, and global climate change are also expected to grow.

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" is one of the common definitions of sustainable development that have been proposed [2]. The attainment of sustainable development is influenced by various factors. One of the most important is the requirement for an entirely sustainable supply of energy resources.

While environmental issues in general have long impacted energy sector progress, climate change poses a particular kind of challenge. Administrative interventions that affect relatively few economic actors, such as power plant pollution restrictions or car exhaust standards, could help address issues like acid precipitation. The issue might be contained by technical solutions with a somewhat narrow scope, like catalytic converters or equipment for cleaning exhaust gases. However, because greenhouse gas emissions are so widely distributed, addressing climate change with a localized and relatively limited method is not feasible. Given the intricacy of the fact, a more comprehensive outlook to energy policy is required, which affects how energy consumers behave.

Energy & Technology

The development of contemporary human society has been closely intertwined with the identification of several energy and power sources. The writings of Andrews, Bronowski, and Buchanan, for instance, trace this historical link. Known by names like the "iron age," "steam age," and more recently, "nuclear age," early societies were distinguished by their level of technological advancement. In light of the current discussion over alternative energy sources, it may seem ironic that humanity used what are now referred to as "renewable" energy sources—primarily solar energy—during the pre-industrial era.

The discovery of fossil fuel resources and the building of the infrastructure required for the energy system made it easier for the West to form sophisticated, industrialized societies. The earliest energy source for heating and cooking was fire, which utilized fuel wood. However, coal was the fossil fuel that propelled the first industrial revolution in Britain in 1700. Later, high-energy converters like steam engines and turbines appeared, followed by a variety of internal combustion engines. In industrial societies, oil has been the primary fuel for automobiles and the foundation of the contemporary transportation sector. Nowadays, post-World War II energy systems are also heavily reliant on other energy sources, such as nuclear, hydropower, and natural gas.

The Energy and Sustainable Development Sector

The necessity of developing methods for sustainable development—which balances social and economic advancement with environmental preservation—has come to light more since the 1992 Rio de Janeiro Earth Summit. Sustainable development, according to the WCED in the groundbreaking Brundtland Report, is "meeting the needs of the present without compromising

the ability of future generations to meet their own needs." As a result, intergenerational ethics play a significant role.

Established in 1995 by the former Conservative Government, the UK Round Table seeks to unite people with different backgrounds and roles in relation to the topic of sustainable development. The following five core concepts that underpin sustainable development were highlighted.

- **The Precautionary Principle:** It states that where there is a significant environmental danger, the absence of scientific proof should not be an excuse for delaying taking economical steps to stop or lessen possible harm.
- **The Integration Principle:** This acknowledges that all aspects of policymaking must be defined and implemented with consideration for environmental concerns. Significant efforts have been made by the new Labour Government to place environmental issues at the "heart" of policymaking.
- **The Polluter Pays Principle:** It states that the expenses of preventative or corrective measures should be borne by the people who cause environmental harm, not by society as a whole.
- **The Preventative Principle:** According to this theory, society would benefit more in the long term by avoiding the expenditures of cleaning up waste and pollution that may arise from development operations.
- **The Participation Principle:** It recognizes that widespread and informal public participation is necessary for effective decision-making in the area of sustainable development. The Round Table considers itself an integral component of this process of involvement.

The planet's resource base is poorly defined and boundaries are frequently not apparent until they are nearly approached. In order for humanity to "walk lightly on the earth," one of the biggest tasks for the future is to significantly increase the efficiency of resource use, especially of exhaustible resources worldwide. It is obvious that the industrial countries must lead, as their civilizations are by far the most resource-intensive. Long-term sustainability probably requires a more equitable distribution of global income and resources.

Literature Review

Like capital and labor, energy is seen as a fundamental factor of production and the fundamental building block of all sectors of contemporary economic growth (Alam et al., 2016; Solarin et al., 2017). Azam et al. (2020a; Azam et al., 2020c; Iheonu et al., 2020; Azam et al., 2021a; Azam et al., 2021c)[3] state that energy consumption has emerged as a critical component of any country's GDP. Globalization and industrialization are causing energy consumption to rise quickly due to the world economy's rapid expansion (Shafique et al., 2020; Shafique et al., 2021a)[4]. Fossil fuel energy sources account for the majority of this demand, with global consumption of coal (CC, 38%) and oil (OC, 23%). The main cause of global warming is the burning of fossil fuels, which has led to the production of greenhouse gases (GHGs), with carbon dioxide (CO₂) being the main source of pollution in the environment.

The effects of CO₂ emissions put the atmosphere in jeopardy and cause global climate change. The two most prominent global threats are climate change and global warming (Liu et al., 2020; Shafique et al., 2021b)[5] Our economy and health are significantly impacted by the prevalence of environmental deterioration (Yahya and Rafiq, 2020)[6]

Among the escalating issues that have evolved into worldwide human rights issues are the need for clean energy justice, rapid climate change, and environmental degradation. (Azam et al., 2021e; Azam et al., 2021; Baloch et al., 2019)[7] To solve the aforementioned environmental and health issues, ecologists and energy economists are advising politicians to change their energy consumption toward clean energy sources (nuclear and renewable).

Since ICT is becoming more and more important to many economic sectors in the current period of industrialization and globalization, its environmental performance cannot be disregarded (Cheng et al., 2021)[8]. ICT is essential for increasing energy consumption in the context of industrialization; Therefore, industrialization-induced increases in energy consumption have a detrimental effect on environmental quality (Khan et al., 2018)[9] On the other side, ICT—such as e-banking, e-government, e-commerce, and virtual education—reduces mobility and physical presence, which is why it is essential for reducing CO₂ emissions. Significant advancements in ICT can help reduce ambient air pollution (Añón Higón et al., 2017)[10]. As a result, significant investments in cutting-edge technologies reduce environmental deterioration (Wang et al., 2015)[11]

Objectives:

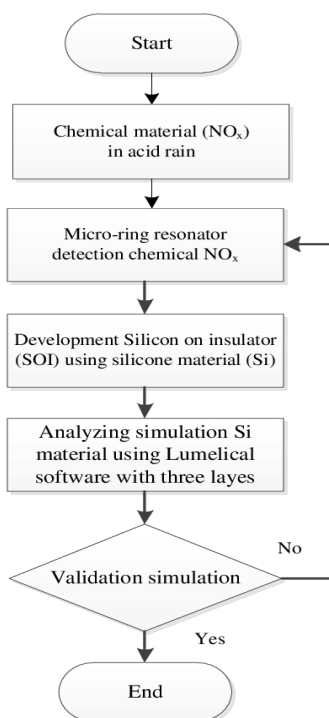
- To highlight on impending danger of acid precipitation, Ozone layer depletion and Green house gases effect (Climate change) and link it with energy conservation.

Data Collection: To understand trends and developments in sustainable development, researchers examine **secondary data** from government publications, international organizations like the World Bank and UNDP, and earlier studies. Scholars conduct case studies on effective sustainable development programs in India and other relevant countries, focusing on their implementation, outcomes, and learned lessons.

Acid Precipitation:

Burning fossil fuels releases acids into the atmosphere that can spread far and land as precipitation on ecosystems that are especially vulnerable to damage from too much acidity. Examples of these include non-ferrous ore smelters, industrial boilers, and automobiles. It was discovered that SO₂ and NO_x emissions were mostly responsible for this acid precipitation. It was discovered that SO₂ and NO_x emissions were mostly responsible for this acid precipitation.

Other components, such as trace metals, ozone, volatile organic compounds (VOCs), and chlorides, have come into focus as awareness of their importance in the transboundary and regional problem of acid precipitation has grown. These substances may be involved in the complex series of chemical reactions in the atmosphere that lead to acid precipitation and the formation of other regional air pollutants.

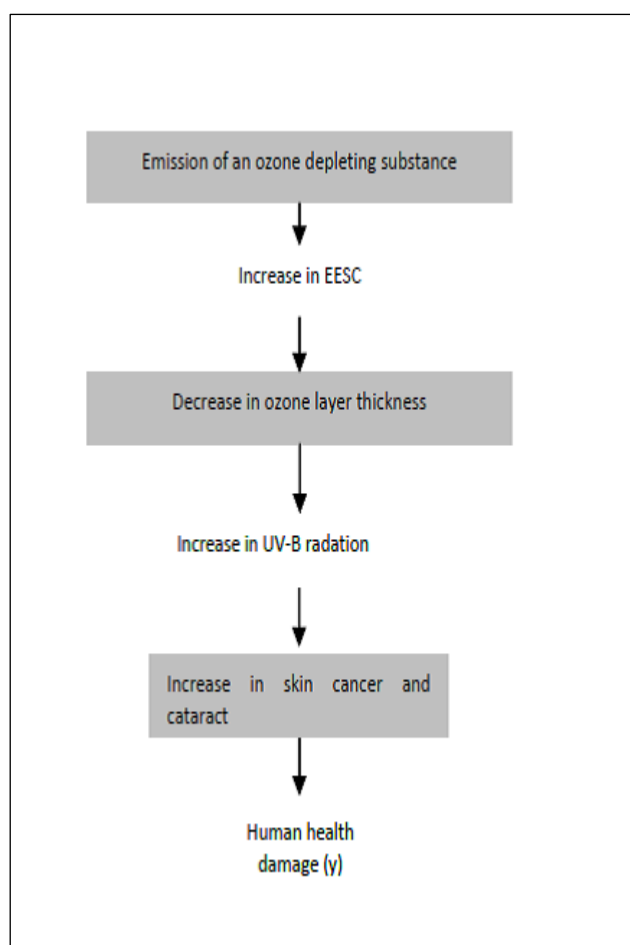


Picture-1(Acid precipitation)

Energy-intensive activities, such as home heating, industrial energy use, and electric power plants, are responsible for 80% of SO₂ emissions; coal use alone is responsible for more than 70%. Sour gas treatment, which generates H₂S that combines with air to make SO₂, is another source of acid precipitation. 48% of all NO_x emissions in OECD nations come from road transportation, making it a significant source of emissions [7]. The burning of fossil fuels in stationary sources accounts for the majority of the residual NO_x emissions.

Ozone Depletion

It is well known that the ozone in the stratosphere, which is situated between 12 and 25 km above sea level, naturally keeps things in balance by absorbing infrared and ultraviolet (UV) radiation [6]. An international environmental concern is the distortion and regional depletion of the stratospheric ozone layer, which has been connected to N₂O emissions, halons (chlorinated and brominated organic compounds), and chlorofluorocarbons (CFCs). Increased levels of harmful UV radiation reaching the earth due to stratospheric ozone depletion can harm many biological species by increasing the risk of skin cancer, eye damage, and other conditions. Even though there has been scientific discussion on ozone depletion for more than ten years, a historic international agreement to limit the production of CFCs and halons was only reached in Montreal in 1987. The need to equitably spread the financial costs associated with a CFC ban is a crucial one, especially when it comes to emerging nations, some of whom have made significant investments in CFC-related technologies. The need to equitably spread the financial costs associated with a CFC ban is a crucial one, especially when it comes to emerging nations, some of whom have made significant investments in CFC-related technologies.



Picture-2 (Depletion of Ozone layer)

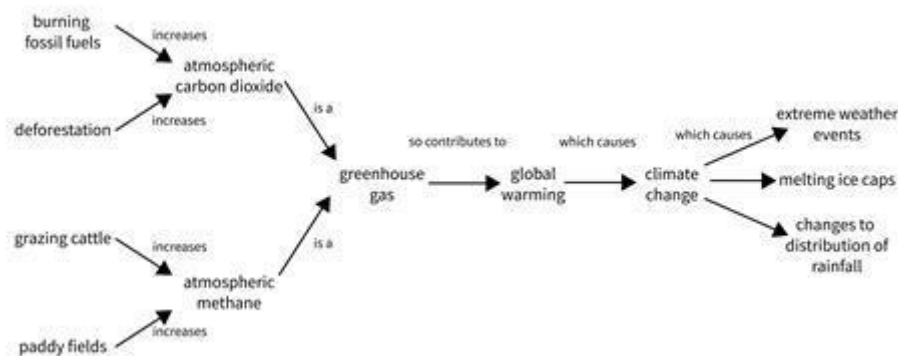
Climate Change

A significant portion of the dangerous UV rays are blocked by the stratospheric ozone layer before they reach the surface. However, some compounds (mainly including chlorine and bromine) have the ability to deplete stratospheric ozone, increasing the amount of radiation that reaches the surface and harming "Human Health."

Global climate change, sometimes referred to as the greenhouse effect or global warming, may be the most significant environmental issue associated with energy use. Because greenhouse gases including CO₂, CH₄, CFCs, halons, N₂O, ozone, and peroxyacetyl nitrate are becoming more prevalent in the atmosphere, their ability to trap heat released from the earth's surface is expanding. This raises the earth's surface temperature. The sea level is thought to have risen by around 20 cm as a result of the earth's surface temperature rising by roughly 0.6°C over the past century [9]. Human activities around the world may be significantly impacted by such changes. According to current estimates, CO₂ accounts for roughly 50% of the anthropogenic greenhouse effect.

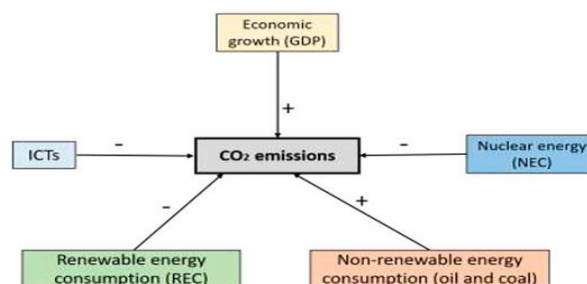
Fossil fuel combustion, CO₂ emissions, methane from increasing human activity, CFCs, and deforestation are the main causes of the greenhouse effect. CO₂ and other powerful greenhouse gases are produced both directly and indirectly by energy-related activities. CO₂ emissions

from the combustion of fossil fuels are thought to be responsible for half of the changes in radiative balance caused by greenhouse gases. A significant portion is also made up of methane emissions, which are partially caused by coal mines and natural gas leaks.



Picture-3 (Effect of climate change)

The trend toward higher energy usage needed to maintain economic growth will not be reversed, even while increasing energy efficiency would limit the growth of energy use and carbon emissions. It would take significant adjustments to the way societies evolve in order to drastically reduce the energy requirements of economic development.



Picture-4 (hypothetical model)

The above model states that in addition to increasing the economic structure, variable economic growth also increases CO₂ emissions through transportation, the burning of fossil fuels, structural changes, and consumer behavior, all of which eventually degrade the nation's environmental quality. Furthermore, because ICT and energy use are mutually reinforcing, ICT contributes to environmental damage by supporting industrial expansion. In a similar vein, reducing CO₂ emissions requires effective and dependable nuclear and renewable energy.

B. Possible Solutions:

Energy Conservations:

The operational and financial characteristics of renewable energy systems differ significantly from those of conventional, fossil fuel-based technologies. These characteristics include modularity and flexibility, as well as low running costs that indicate relative cost certainty. The costs and advantages of renewable energy technologies are typically evaluated using methods

developed for the current technology since they are sometimes seen as straightforward replacements for existing technologies.

Technical (such as lack of availability, reliability, and knowledge of efficient technologies), institutional (such as lack of proper technical input, financial support, and program design and monitoring expertise), financial (such as lack of explicit financing mechanisms), managerial (such as improper program management practices and other energy commodities training), pricing policy (such as inappropriate pricing of electricity and other energy commodities), and information diffusion (such as improper information) are some of the reasons why there aren't any conservation programs.

Energy and Sustainable Development

It scarcely has to be said that the most effective use of energy resources is necessary for sustainable development. By doing this, society minimizes the drawbacks (such environmental harm) and optimizes the benefits it receives from harnessing its energy resources. Given that all energy resources are somewhat limited, so more effective use of them helps them to maintain development over a longer time span, or to make development more sustainable.

Environment & Sustainable Development

An essential component of sustainable growth is environmental concerns. A society aiming for sustainable development should ideally only employ eco-friendly energy sources. But since all energy has an effect on the environment, it stands to reason that improving energy efficiency might allay worries about how environmental pollution and their detrimental effects restrict sustainable growth.

Furthermore, since all energy resources have an effect on the environment, it is fair to say that increasing energy efficiency can allay some (though not all) of the worries about how environmental emissions and their detrimental effects limit sustainable development.

Reduced energy losses are the result of increased energy efficiency. The majority of efficiency enhancements directly benefit the environment in two ways. First, the amount of energy used per unit of output is decreased, and the pollutants produced are likewise decreased. Second, if the full life cycle of energy resources and technologies is taken into account, it appears that increased efficiency lessens the environmental impact at the majority of life cycle phases.

The Effects of Traditional Energy Technologies on the Environment

Fossil fuel combustion produces pollutants that can have a number of negative effects on the environment and human health. Greenhouse gasses are the cause of global warming. Nitrous oxides (NO_x) and carbon dioxide (CO₂) H₂O, or water vapor, Particles of dust, condensation nuclei, Sulfur dioxide (SO₂) and nitrous oxides (NO_x) are responsible for it. About 80% of all greenhouse gas emissions come from CO₂, and the energy sector is responsible for this.

Energy Efficiency: Factor 4 or More

Promoting energy conservation from the "bottom up" and assisting with general resource usage efficiency improvements are obviously necessary. Such a strategy would have to be combined with actions to slow down the rate at which fossil fuels are consumed and encourage the growth of renewable energy sources. In order to address market weaknesses, it would involve a consumer-focused approach to the market together with intervention through a variety of methods, such as economic tools, environmental restrictions, and land use planning procedures. Scenarios like the "dematerialization" or "Factor Four" theories proposed by Ernst von Weizsacker, Amory, and Hunter Lovins suggest that resource consumption may be cut in half while economic welfare doubles in the modern world.

Systems analysis techniques would be required to optimize the energy cascade in order to make such an approach a viable engineering alternative. One crucial method for determining the possibility of process improvement will be thermodynamic analysis. The various ways that the energy system interacts with the requirements of sustainable development are described in the London Communiqué 3.

Strict adherence to the Brundtland Commission's directive would require a swift transition to renewable energy sources and the preservation of non-renewable resources, such as uranium and fossil fuels. This could therefore result in a notable decrease in emissions of pollutants, which are undesirable byproducts of the energy industry that have detrimental impacts on a local, regional, and worldwide level.

Conclusion

It is obvious that a strong transitional energy plan is needed, with an emphasis on reducing emissions of major pollutants and increasing energy efficiency (a move toward Factor 4 or greater technologies). The components of such a strategy will evolve throughout time, and from the present, it will be difficult to determine the "optimal" blend at any particular time. By applying thermodynamics and other analytical techniques, engineers can help find chances for process improvement. Since industrialized nations currently release the majority of pollutants into the atmosphere, it is imperative that they contribute fully to preserving environmental sustainability. However, a global perspective is also necessary for sustainable development. Nearly 80% of the world's population lives in developing nations, and they face an overwhelming burden. Their populations are typically expanding quickly, which will increase energy use and pollution levels in the environment. The climate in the wealthier countries will change as a result, affecting the entire world. As a result, they require aid from developed nations to advance Third World economic expansion (which will eventually trigger a "demographic transition") and enhance their energy infrastructure.

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SOCIAL MEDIA INFLUENCE ON THE BUYING BEHAVIOUR AMONG GEN Z CONSUMERS: A STUDY

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Abstract

In today's customer-centric business landscape, companies prioritize customer satisfaction to drive growth, profits, and value. The proliferation of social media has significantly impacted not only corporate reputations but also customer knowledge, lifestyles, and standards of living. Consequently, social media plays a substantial role in influencing the buying behaviour of Gen-Z consumers. Social media advertisements profoundly affect consumers' minds, building desires and altering habits, ultimately shaping their purchasing decisions. This research paper aims to investigate the factors by which social media influences Gen-Z consumers' buying behaviour, using a combination of primary and secondary data. Primary data was collected through questionnaires and surveys administered to Gen-Z individuals. The findings indicate that social media significantly impacts Gen-Z buying behaviour. This study provides a detailed framework for understanding decision-making processes and the vital role of influential factors in shaping buying behaviour.

Keywords: *Social Media, Consumer Behaviour, Gen-Z, Marketing, Customer Satisfaction*

INTRODUCTION

In the recent years, social media has emerged as a powerful influence on consumer's buying behaviour, mostly among Gen-Z, also known as Zoomers is the demographic who are environmentally conscious and value sustainable products and brands they not only prioritize to save money but they also shape the culture of social media and they too even use social to develop their own brands publicly. Gen-Z is the second youngest generation consists of an individual who are born between 1997s - 2010s. They strive to be more price conscious tend to save money and make practical instant decision by getting influenced more by the influencers, social media, social trends, online reviews, continuous advertisements on smart devices. As they are growing their taste and preferences, purchasing habits are shaped more by the social media they get easily influenced by the influencers as well as advertisements on the social media sponsored by the brands respectively. Gen-Z prefer to choose from variety resources available in the marketplace which are having unique modernize items in a budgeted price. Kolkata as a city of culture hub of West Bengal offers a various options for shopping to

people. It has a diverse shopping destination from traditional items to modern lifestyle contemporary items which equally fulfils the demand, desire and need of Gen-Z consumers. Kolkata has a vibrant street markets and the seller nowadays also use social media platform to earn income by selling their products online as they are more knowledgeable of what their customers prefer and usually nowadays Gen-Z prefer more to shop from online as it is more convenient for them they can purchase anytime from anywhere according to their convenience and preferences. Social media as an immensely growing platform not only serves as a marketplace but also as a platform for community engagement and Gen-Z usually express themselves freely in the social media. This study aims to research the buying behaviour of Gen-Z consumers influenced by social media in Kolkata. The research specifies the key concept of consumers buying behaviour and the impact of social media on Gen-Z consumers. The primarily aspect strive to tend the consumer's buying behaviour which depend on their attitude, taste and preferences, intentions, desire and self-decision making nature in the marketplace while making an approach to purchase on social media. In this study a thorough analysis has been conducted to understand the buying patterns of Gen-Z consumers by monitoring what they usually buy, how they prefer to buy, when they buy whether in the regular basis or specifically on occasions, etc. Secondly, the most important segment describes the impact of social media on Gen- Z consumers and the significant it contributes to consumers buying decisions and why it viewed as a key factor in buying decisions of the consumers based on the recent researches. Social media finally culminates in the rise of awareness of products and services of a reputed brand or a newcomers or upcoming brands. Social media generates the demand, brand loyalty, promote customer allegiance leading towards enhancing their loyalty and in return increases revenue and profitability. Social media has become as an essential element for brand communication it usually persuades the consumers to purchase and use for lifetime period and toss them aside without consideration. Gen-Z gravitates towards digital platforms which contents visual effects, music, animations, graphics, etc. And usually gets attracted towards the fashion content. They rely on recommendations of influencers, bloggers, celebrities, persuading advertisements content for fashion garments purchases as in they usually try to adapt the style and basic lifestyle fashion of the social media personalities and try to implement those attitude and nature in their day to day activities. Gen -Z uses such platforms to share their opinion and express feelings in a vast platform and is actively adopt the viral trends which they get to know in the social media contributing to the advancement of the upcoming generation by participating in the contribution of social trends. Gen-Z interact with the brands swiftly who connects with them in social media actively and in an accurate manner as they expect fast and quick access to products and therefore they appreciate such brands. In Kolkata there is a wide choice of styles and recommendations and Gen-Z from this metropolitan city they usually get encouraged by the fashion choices availability in the marketplace. Gen-Z consumers actively take part to post their new purchased outfits or some tips for different types of wear in a day to day activities and this proactive engagement bolsters their engagement to fashion brands and communities as well. Therefore, this study aims to analyse the implications by investigating the dynamics and studying the connections of social media and Gen-Z consumers how social media impact the buying behaviour of Gen-Z in respect of fashion garments in Kolkata. By analysing the interaction between social platform,

customer attitude and behaviour, brand connection, engagement of communities, etc. These researches have shed light on the dynamic landscape of fashion garments in Kolkata.

Literature Review

The fashion industry has undergone a significant transformation with the advent of social media, and Gen-Z consumers are at the forefront of this shift. As digital natives, Gen-Z consumers are highly influenced by social media, which has become an integral part of their daily lives. Despite the growing importance of social media in fashion marketing, there is a need for a comprehensive understanding of its impact on Gen-Z consumer's buying behaviour. This literature review aims to explore the existing research on the impact of social media on Gen-Z consumer's buying behaviour in relation to fashion garments. Salman et.al, (2015), in their work describes how social media has evolved over the years and how various businesses are using social media as a promotional tool. A total of 130 responses were collected from a total of five organizations in this study, with the two main topics mentioned being the fashion industry and social media. They consider social media as a cost effective opportunity for the marketers for effective results. According to his research, the results show that social media marketing gives better reach than the traditional marketing. As it has been proved that nowadays, Gen Z has a distinct preference or social media they follow it as well as influencers. Effective advertising makes positive attitude towards brand which lead towards purchase intention of consumers. Researchers have also concluded that reaching to Gen Z, social media's influencers can be utilized effectively. Najjuko and Tracy (2023), in their work on specifically addresses consumers' last-minute holiday shopping and reveals exactly what role online fashion influencers play in this move. The study was conducted among female Generation Z consumers in Sweden. Liu and Yitong (2023) conducted a study among China's Generation Z consumers. Research shows that Chinese Generation Z consumers are turning to online shopping as opposed to going to stores and how they fulfil their shopping needs by watching live streams of various social media influencers. The main objective of this study is to find out the importance of influencer marketing and influencers on the purchasing behaviour of Generation Z. The study collected responses from a total of 227 Chinese Generation Z people. Kadam et.al (2021), in their work describes how social media and social media influencers are important to Gen-z customers' buying behaviour and lifestyle. This study is done on Pune city because Pune city is one of the important cities in India which has a large number of young citizens or Gen-z customers. A total of 157 responses were collected in this study to find out how much customers trust social media influencers. Kadam and Deshmukh (2021) stated that social media is a free tool for public relations as it connects potential buyers to marketers. The designers as well as luxurious labels use social media to promote and create awareness, using social media as one of their marketing strategies. The brands and designers have incorporated social media as a fundamental part of their marketing strategies and have embraced it as overwhelming. Parwal et al (2023), in their work describes how Instagram affects consumer behaviour. That is, what is the importance of Instagram influencers in terms of consumer behaviour. This study describes how a brand or a marketer can attract consumers through Instagram influencers. A total of 91 responses have been collected from different cities in this study. Lalwani et al (2021), in their work describes how social media acts as a tool in the buying

behaviour of Gen- z consumers. A total of 200 responses were collected from Bangalore, New Delhi and Hyderabad in this study. This study highlights several possible factors that influence consumers to make purchases from social media. Kumar et al (2023), in their work discusses the buying decisions of Generation Z consumers as well as millennial. Also, this study highlights the digital engagement, sustainability preferences, financial considerations of Generation Z consumers and millennial. In this study, responses were collected from people aged 16 to 42 years. Fazith et al (2023), in their work describes the purchasing behaviour of Generation Z consumers. Descriptive research design was used in this study and a total of 140 responses were collected. Bhuwaneshwari et al (2023), in their study it shows just how modern Generation Z is, how digitally connected and how educated they are. The main purpose of this study is to find out the influence of social media on the buying behaviour of Generation Z and a total of 150 responses have been collected in this study. Mehta and Aditya (2022), in their study tells how social media platforms such as Facebook, Instagram, Twitter and other platforms influence the purchasing behaviour of Generation Z consumers. The study also notes how Generation Z consumers are increasingly drawn to social media post-Covid-19. The study also described Generation Z consumers spending more time on social media post-covid. A total of 150 responses were collected in this study. While there have been numerous studies on the impact of social media on consumer behaviour, there is a lack of research specifically focusing on Generation Z's buying behaviour in relation to fashion garments in the context of a metropolitan city like Kolkata. The existing studies have primarily concentrated on Western countries or have been generic in nature, neglecting the unique cultural and socio-economic dynamics of Indian cities like Kolkata. Moreover, the rapid growth of social media platforms and their influence on young consumers purchasing decisions necessitates an in-depth examination of this phenomenon. This study aims to explore the impact of social media on the fashion consumption patterns, preferences and behaviours of Gen Z in Kolkata, providing insights for fashion marketers and retailers to effectively target this demographic. This research gap highlights the need for a localized study that considers the cultural, social, and economic nuances of Kolkata's Gen Z consumers, providing a more accurate understanding of their behaviour and preferences in the fashion industry.

Research Gap

Although there have been many studies on the impact of social media on consumer behaviour, there is a dearth of research focusing specifically on the shopping behaviour of Generation Z in terms of fashion garments in the context of a metropolitan city like Kolkata. Existing studies have primarily focused on Western countries or are general in nature, ignoring the unique cultural and socio-economic dynamics of Indian cities like Kolkata. Furthermore, the rapid growth of social media platforms and their impact on the purchase decisions of young consumers warrants an in-depth examination of this phenomenon.

This study aims to explore the impact of social media on the fashion consumption patterns, preferences and behaviours of Gen Z in Kolkata, providing insights for fashion marketers and

retailers to effectively target this demographic. Studies that consider the cultural, social and economic nuances of Z consumers in Kolkata provide a more accurate understanding of their behaviour and preferences in the fashion industry.

Objective

The objective of the study is to explore the factors which have effect on social media influence on the buying behaviour among the Gen-z consumers.

Research Methodology

The research is descriptive cross-sectional research as it analyses the existing facts. In this research, Social Media Influence on the Buying Behaviour is a dependent variable and Social Media Price Consciousness, follow any social media Influencer, Knowledge about the quality of the product, Reward & Offer, social media develops sense of trust, Advertisement influences to purchase, How Frequently Gen-z purchased are the independent variables. An influence is measured in forms of intent to buy, buying decisions, frequency of buying, trust towards influencers. Both primary and secondary data has been used by the researcher. Secondary data has been collected from research papers. Primary data has been collected through a structured questionnaire; the sampling is done from youth aged below 18 and 18-24 from Kolkata city. Sample size of the data is 125. Convenience sampling method is used for collecting samples. The collected data is edited and coded in MS-Excel. Differential statistic is used for understanding the data. Data analysis is done to prove the hypothesis with the help of Regression Analysis as a test of independence.

Table 01: Details of Coding

Coding	Details
SMIBB	Social Media Influence on the Buying Behavior
SMPC	Social media Price Consciousness
FSMI	Follow any social media Influencer
KAQP	Knowledge about the quality of the product
RAO	Reward & Offer
SMDST	Social media develops sense of trust
AITP	Advertisement influences to purchase
HFYP	How Frequently you purchased

Hypothesis

- H₀₁: The ‘Social media Price Consciousness’ has neutral effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.
- H₀₂: The ‘Follow any social media Influencer’ has neutral effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.

- H₀₃: The ‘Knowledge about the quality of the product’ has no effect or negative effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.
- H₀₄: The ‘Reward & Offer related information which influences to purchase’ has no effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.
- H₀₅: The ‘Social media develops sense of trust’ has no effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.
- H₀₆: The ‘Advertisement influences to purchase’ has neutral effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.
- H₀₇: The ‘How Frequently you purchased’ has no effect on ‘Social Media Influence on the Buying Behaviour’ among Gen Z consumers.

Table 02: Dependent Variable: Social Media Influence on the Buying Behaviour (SMIBB)

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	SMPC	.441	.108	.378	4.072	.000
	FSMI	.208	.070	.234	2.971	.004
	KAQP	-.015	.097	-.014	-.150	.881
	RAO	.034	.103	.033	.335	.738
	SMDS T	.078	.101	.071	.766	.445
	AITP	.185	.089	.185	2.081	.040
	HFYP	.004	.076	.004	.053	.958
a. Dependent Variable: SMIBB						

Data Analysis

Overall data is collected from 125 samples was coded and edited in MS Excel. Descriptive statistics is used to understand the different dimensions of the data. Inferential statistics like Regression analysis test is performed for testing hypothesis. The total sample size is of 125 out of which 86 were males while 39 are females. The sample size consists of youth between the age of 15-24 which is again categorized in to two age groups. Close to 99.2% the respondents are between the age of 18-25 and 0.8% of respondents are below 18 years of age. The majority

of respondents are students. In this research, the independent variable SMPC (Social media Price Consciousness) has a neutral or positive effect on the dependent variable SMIBB (Social Media Influence on the Buying Behaviour). Because being price conscious is very important nowadays and Gen-z consumers are very conscious about this. They rely on social media for this and almost majority of Gen-z consumers in this research (about 65% of people) agree on this and the rest about 35% of Gen-z consumers are neutral and disagree on this. Next independent variable FSMI (Follow any social media Influencer) and the dependent variable SMIBB (Social Media Influence on the Buying Behaviour) have a neutral effect because nowadays Gen Z consumers are very fashion conscious. So they follow their favourite influencers while shopping and the influencers also refer Gen-z consumers to satisfy their followers and grow their own follower base. The independent variable AITP (Advertisement influences to purchase) has a neutral or positive effect on the dependent variable SMIBB (Social Media Influence on the Buying Behaviour), about 42% of Gen Z consumers in this research think that advertising generally has no effect on their purchases.

Generally, no effect is observed on other independent variable KAQP (Knowledge about the quality of the product) and dependent variable SMIBB (Social Media Influence on the Buying Behaviour). Because Gen Z consumers are generally not aware of product knowledge and quality when it comes to buying fashion related items. In many cases, Gen Z consumers follow their favourite influencers and buy many things without thinking about the quality of the product. No effect was generally observed on RAO (Reward & Offer) and SMIBB (Social Media Influence on the Buying Behaviour). Gen Z consumers often ignore rewards and offers when purchasing their favourite products. That's why most of the Gen-z consumers in this research felt that rewards and offers have no effect on their purchases. Also, independent variables like SMDST (Social media develops sense of trust), HFYP (How Frequently you purchased) have no effect on SMIBB (Social Media Influence on the Buying Behaviour). Because many times the product is not trusted but Gen-z consumers buy that product only by being influenced by the influencers. Again, if a product is heavily advertised, it is not likely that the product will end up on the wish list of Gen-z consumers or that Gen-z consumers will buy the product in large numbers.

Conclusion

As we have all witnessed how social media has a huge significance in the life of Gen-Z consumers and how this platform has become as a tool for the consumers to make informed decision before purchasing any goods or services. Social media has become an integral part in the daily lives of the people in an economy. This study has conducted to analyse the influence of social media on buying behaviour of Gen-Z consumers in the metropolitan city Kolkata. We have explore the factors how social media sway buying behaviour of Gen-Z consumers with our aim to inter-relate the factors by using primary as well as secondary data. As a result of this research we have gained detailed information about consumers buying behaviour how advertisements in social media impact the habits of Gen-Z. The study has highlighted the emerging role of social media in the daily lives of the Gen-Z consumers; it has been proven also that businesses must adapt good resources of advertisement in this platform to earn more goodwill as a result the value of the brand increases by managing social media correctly as it

reaches to the youth population immensely. Consumers in Kolkata are likely to purchase based on peer recommendation, high advertisements, and are more likely prefer to embrace in adapting new changes in styles and fashion.

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THE ROLE OF WOMEN EMPOWERMENT IN VIKSIT BHARAT'S ECONOMIC AMBITION IN WEST BENGAL

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Abstract

Viksit Bharat 2047 aims to transform the country into a developed entity through economic prosperity, social advancement, sustainability and social governance. The Prime Minister's "Developed India" or Viksit Bharat vision is a blueprint for maximising India's potential, expertise, and prosperity in order to elevate the nation to a position of worldwide prominence. The four pillars of Viksit Bharat consist Garib, Yuva, Annadata and Nari (GYAN). Thus, women empowerment plays a key role in holistic development of nation through the Viksit Bharat mission. Women empowerment not only increase their involvement in work force but also significantly linked with economic prosperity, higher GDP and fostering economic resilience within families and communities. Despite being one of the major corner-stone of the mission, deeply entrenched social and cultural barriers continue to create perpetuate disparities in women's active participation in work force, educational attainment and skill building. Thus, this paper is aiming to comprehend the impact of Viksit Bharat in Women Empowerment and also identifies the present challenges of women empowerment in India with the primary focus of rural West Bengal which is causing hindrances in Viksit Bharat's Economic ambitions. It further attempts to draw attention to mitigate the gaps of women empowerment in Viksit Bharat Mission to provide a gender neutral sustainable development for India.

Keywords: *Women Empowerment, Viksit Bharat, Economic ambition, Sustainable Development*

Introduction

The year 2024 is remarkably crucial for India's political landscape as well as Prime Minister Shri Narendra Modi's vision of Amrit Kaal or a golden era which aims to transform India from developing to developed country by 2047 with multiple changes and development in almost every sector of the nation. The core of this vision is to make a 30 trillion economy for India. Viksit Bharat 2047 aims to transform the country into a developed entity through economic prosperity, social advancement, sustainability and social governance. The Prime Minister's "Developed India" or Viksit Bharat vision is a blueprint for maximising India's potential, expertise, and prosperity in order to elevate the nation to a position of worldwide prominence. Equal participation, decision making and gender neutral society formations are the major cornerstone of Viksit Bharat programmes.

In this regard, Programmes like Pradhan Mantri Awas Yojana (PMAY), Bharatmala, Sagarmala, Smart City Mission are trying to improve India's global standing. To expand

essential services and to ensure the inclusive development and social welfare of marginalised groups, programmes like Ayushman Bharat for health care, Swachh Bharat Mission for sanitation, Pradhan Mantri Jan Dhan Yojana for financial inclusion and Beti Bachao Beti Padhao for gender equality are playing significant role for sustainable and better development of every citizen of the country. The government further tries to ensure social security, equal political rights and access to resources for all by ensuring efficient transparency in governance and technical usage in platforms like Aadhar Card, Direct Benefit Transfer (DBT), registration and usage of programmes through digital networking. This mission further aims to create a more resilient, inclusive and holistic country on a global scale by promoting environmental preservation, climate resilience infrastructure, solar alliances, and cultural revitalisation.

Women empowerment and Viksit Bharat

The four pillars of Viksit Bharat consist Garib, Yuva, Annadata and Nari (GYAN). Thus, women empowerment plays a key role in holistic development of nation through the Viksit Bharat mission. Empowerment of women basically signifies the control of their lives, freedom and self-esteem to live a quality of life. In this regard, Chen and Mahmud (1995) have describe women empowerment as a positive change from the existing situation and identifying different way outs for the cognitive, perceptual and relational development in the existing society. Besides, it not only increases their involvement in work force but also significantly linked with economic prosperity, higher GDP and fostering economic resilience within families and communities (Balasubramanian, et.al, 2024). As a result, women's empowerment emerged as a critical component of development, wherein both genders' active participation and exercise are vital for the nation building (Sharma, 2024).

Women empowerment can be measured in different dimensions such as education, health, economical and political participation. But lack of mutual participation, educational growth, patriarchal norms and gender disparities further restricts the development of women in multiple levels (Mahida, 2024). It further increases women's financial exclusion, property rights, land holding, labour force participation in different parts of India (Dreze and Sen, 1995).

Keeping these in mind, in the preamble of India, article 14 and 15(1) are trying to ensure gender equality. Women empowerment became a vital part of country's development objectives where National Commission for Women (1990) is trying to uphold the rights and legal entitlements of women in the country. 73rd and 74th amendment further ensures decision making and political rights of women through reservation of seats in local bodies. Moreover, various schemes and policies, like MGRGA, Beti Bachao Beti Padhao, STEP, National Mission for the Empowerment of Women (2010), Sukyasmridhi Yojana, small scale industry and co-operatives are trying to bridge the gap for mainstreaming participation and overall growth of women in every part of India.

Though gender equality is one of the major stone for nation building and development but empowering women faces multiple obstacles, such as participation of women and gender disparities in labour force has witnessed a serious upward growth from 2000 to 2013. However,

as government policies and interventions were implemented, the gap margin gradually decreased relative to the prior data structure (World Bank 2015). Similar situations are found in respect to decision making and participation of women in health development as NFHS3 data further shows that only 37% of women in India can take independent or joint decisions in these areas and rests have to either depend on their families or husbands which is nowhere represents a positive outcome of women empowerment in this country. The situation is much more alarming in the global level as the Gender Gap Index 2014 describes India's position in 114 among 142 countries behind Sri Lanka and China (The Global Gender Gap report 2014).

More complicated scenario can be found in the rural areas of the country as the resource availability, impact of patriarchy and participation of women in social, economical and political spheres are relatively low due to extreme gender discrimination and lack of decision making (Banerjee and Pan, 2023). The participation rate of women in the state is relatively low i.e. 18.1% lesser than countries average 25.5% (Tab 1) (Census of India, 2011).

Table 1 Gender Disparity in work participation

State	Participation Rate		Participation Rate		Decadal Change	Decadal Change
	Male		Female		Male	Female
West Bengal	<i>2001</i>	<i>2011</i>	<i>2001</i>	<i>2011</i>		
	54	57.1	18.3	18.1	+3.1	-0.2
India	51.7	53.3	25.6	25.5	+1.6	-0.1

Source: Census of India 2011

In regards to decision making, NFHS 3 shows 60% of married women cannot independently take decisions about their health-care, but 47-48% can participate in domestic choices. 14% women have bank accounts that they independently use and only 45% women have privilege to travel outside community which shows an alarming situation of women in the state.

Therefore, it is important to identify and mitigate the gaps in grass root level to ensure sustainable women empowerment for successful Viksit Bharat agendas not only in West Bengal but also across the country.

Methodology

Objectives:

This paper is aiming to comprehend the impact of Viksit Bharat in Women Empowerment and also identifies the present challenges of women empowerment in India with the primary focus of rural West Bengal which is causing hindrances in Viksit Bharat's Economic ambitions. It

further attempts to mitigate the gaps of women empowerment in Viksit Bharat Mission to provide a gender-neutral sustainable development for India.

Study Design:

Qualitative research design has been adopted for meaningful understanding of objectives. 72 female respondents were chosen from 6 sub divisions of Bankura and Birbhum districts of rural Bengal to serve as the study's samples. The respondents were selected based on the women's population and the resources available to fulfil the study's criteria. 5 case studies, 12 focused group discussions, a semi-structured interview schedule, and key informant interviews were all employed by the researcher to analyse the study objectives. For the study's theoretical interpretation, a strength-based viewpoint has been chosen. Informed consent was provided by the respondents, and the researcher conducted the study without bias.

Findings

Issues and Challenges of Women Empowerment in Viksit Bharat's economic ambition

- **Economic status of respondents**

Since the majority of the respondent's family members works as day labourers, agricultural labourers, or toto drivers, their average monthly income falls between 5000 and 10,000 rupees. The family income is mainly coming from the male counterpart's income sources. Women earnings are mostly considered as secondary source for meeting the daily needs of the family.

- **Educational Attainment issues**

Sarba Siksha Mission, Kanyasree Prakalpa and state or central scholarships though have a significant favourable influence on respondent's literacy and academic choices but still their educational attainment is restricted to only school levels. Furthermore, respondents from early 20s have completed their schooling from the near-by villages while respondents from 30s and have not completed their school education due to severe family pressure, social taboos and lack of resources. Apart from that, limited opportunities after schooling, preference of boy's education, lack of infrastructure and female teacher's availability further complicates the situation.

“In our village higher education of women is extremely low. An educated woman is still considered as waste of resources as we hardly can participate in economic contribution of the family” (Case 2)

The situation is more complicated for the tribal and muslim respondents as socio economic constraints, cultural stigma and social hurdles are more prevalent. In addition to that, geographical location of the village, resource availability and awareness of educational attainment of women played a significant role in shaping respondent's knowledge, decision making, participation in their academic advancement.

- **Child marriage and Social taboos**

The highest age of getting married is 18 years across the districts due to Rupashree prakalpa but practice of child marriage among both muslim and hindu respondents are very much prominent in the study areas. Though, every respondent has showcased their knowledge regarding the legal age of marriage but still almost every respondent has acknowledged the tremendous family and social pressure of getting married from the age of 15. Not only that, it also includes the incidents of domestic violence, reputational issues, school drop-out, social isolation as a part of this practice.

“I was forced to get married at the age of 17 as in our community getting married after that creates reputational issues and all my friends got married before that” (FGD 3)

Moreover, decisions of respondents have very less impact in this process as socio-cultural practices, safety concerns and family planning played the most crucial factors for the family members to take decisions on behalf of them.

- **Decision making, political participation and social exclusion of women**

Traditional gender roles and expectation have highly impacted the decision-making capabilities and social standing of women. For the tribal and muslim respondents the social standing further created an alarming scenario as it has ingrained into their choices and further made it normal part of their life cycle. Though, women have their choices in domestic matters where they jointly or sometimes take decisions independently like the choices of food, home decor, cloth materials and sanitation. On the other hand, matters like daughter’s marriage, education, health expenses, family planning, house expenses are still subjects to father’s or husband’s decisions. Due to lack of education and skill of women this situation continues to remain like this.

“My husband has always taken decisions on behalf of us and he is a man so obviously he will take a right decision. I never question about it as it is my duty to respect his decisions” (FGD 1)

Apart from that between the choices of actively participating in community festivals, Self- help groups and purchasing things, respondents are highly dependent on the male members of the family. Even in case of voting, though they actively exercise their voting rights but their choices are highly regularized by either their father or husband. The most unfortunate thing is that neither they ever tried to understand or question about political rights and freedom of choices.

“I have little interest in politics and only trust my father to vote for the best political party in elections as of the persistent socioeconomic status of women in our community.”(FGD 7)

Unfortunately, the political and community participation of woman in their socio-economic development is extremely low among the study areas which further denoted serious implications on women’s participation, decision making and social standing in rural Bengal.

- **Gender disparity**

Women empowerment has been greatly influenced by the gender role and unequal treatments of women in the community. Though the respondents have agreed that the status of women have developed a lot but the rigidity, restrictions and disparities are still significantly prevalent in the rural areas of Bengal.

"In urban areas, women have the opportunity to participate in the labour market on an equal basis with men, but in rural areas, women are confined to domestic duties and are rarely regarded as capable contributors to economic growth" (Case 3)

Preference of boy child, educational disparities and unequal distributions of resources are still visible in every village as boys are considered as the breadwinners of the families. The inclination of boy's higher education, job and skill development have directly impacted the educational and economical skill development, options of job opportunities of women. Unfortunately, the respondents themselves considered the boys as superior, intelligent and technically skillful than them. As a result, the lack interest in skill development, technical knowledge building, personal growth has impacted in economical participation and exercising the equal rights in society.

- **Labour force participation and economic empowerment**

Due to lack of skill education, enrollment in vocational courses through PMKVY, Utkarsh Bangla Projects and academic knowledge, participation of respondents in organized job markets is extremely negligible whereas participation in agricultural labour work, daily works and handcraft makings are visible either as a hobby or just meeting the daily needs of life. Though due to JAM trinity, Lakshmir Bhandar Prakalpa and SHG involvement, majority of the women have personal bank accounts and monthly financial assistance but the awareness regarding banking transactions and economic production are significantly low. Independent property holding, systematic savings or utilization of money and active financial contributions are still associated with gender roles whereas contributions of women are considered as unnecessary and solely for their personal expenses. Unfortunately, managing the roles and responsibilities both at domestic and professional sectors are quite challenging for them as co-operation and positive responses of the family members are extremely poor and it often question their roles as a mother or wife.

"I only work when it is needed otherwise it is extremely difficult to manage household works, children and perform productively in a job. Besides it is extremely challenging as we hardly get additional support from our families" (FGD 9)

As the job options are restricted to the near-by community due to limited options in skill educational courses, distance from the community, safety issues and cultural barriers therefore they mainly rely upon the free assistance of government for their economic gain. Moreover, the unequal treatments and on-going harassment issues further restraints them and their family

members to consider equal economic participation as a positive tool for their economic empowerment.

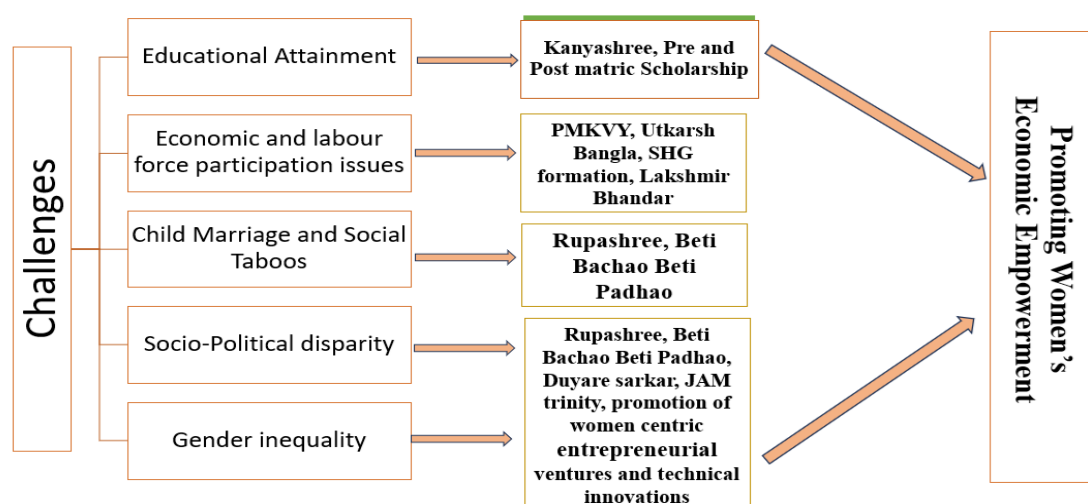
Impact of Viksit Bharat Mission in Rural Bengal

Since empowering women is a fundamental aspect of Viksit Bharat Mission, it challenges preconceptions and discriminatory behaviours while prioritising social justice and equitable treatment to support women's overall growth. There is still more work to be done to achieve sustainable development, even though programs like Kanyashree, JAM Trinity, Beti Bachao Beti Padhao, Lakshmi Bhandar, and Rupashree are attempting to address and solve the issues of women in community. The WDOs and Block officers are attempting to improve the economic status of the women in study regions by engaging respondents in STEM-related fields and entrepreneurial endeavours. Dey Sarkar has developed into a one-stop hub for bridging the gap between government facilities and respondents, guaranteeing awareness and seamless service delivery. Moreover, utilization of traditional knowledge and technology has sparked the creativity, innovation and sustainable growth for women. Environmental conservation and sustainable resource utilization are given priority in the small-scale industry and entrepreneurial endeavors by women. The government's major strategy has relied heavily on participation in skill building, digital literacy, innovation and vocational training programs to meet the market's expectations and gradual expansion of women engagement through PMKVY, Utkarsh Bangla projects by the government personnel in society.

“Our main motto is to make a more inclusive and progressive society by unlocking the full potentialities, uniqueness of all the women in our community for a sustainable, resilient and thriving society” (WDO)

Moreover, a number of service providers like ICDS, ASHA, school and WDOs are collaborating to promote cultural transformation, awareness in gender roles, social, political and economic resilience by ensuring the rights of women in active participation, decision making, *family* planning and educational upliftment in the study area. The following figure is showcasing impact of Viksit Bharat mission and programs in targeting challenges of rural women in achieving economic empowerment in West Bengal

Figure 1: Impact of Viksit Bharat in rural West Bengal



Formulated by the Authors from the finding of the study

Recommendations and ways of mitigating the Gaps

With persistent government initiatives and programs, the status of women though has improved but the current reviews and data are still showing a prominent gap between genders and decision making from country's total average. Moreover, for a positive outcome of Viksit Bharat Mission, it is important to identify and work on problems at the grass-root levels. To mitigate the existing gap, it is important to highlight innovative market driven vocational training and various course options for women based on their needs, mandatory technological learning and personality building from the very beginning of the school. Moreover, community level awareness and uses of the programs like Kanyashree, Sabuj Sathi, Swabalamban, JAM trinity for ensuring sustainable solution and enrolment of women in STEM courses are essential to uplift the situation from the ground level. Engaging community women, female school teacher and SHG members are imperative for generating awareness and an inclusive gender neutral socio-economic and cultural improvement of women in the rural belts of Bengal. It is high time to involve women actively in cultural and political decision making specifically during festivals and elections and formation of one stop centers at the community level to mitigate the gaps of women's need, rights and social justice.

Conclusion

More than the moral imperatives, strategic frameworks are mandatory for women empowerment. Continuous deliberate and sustainable efforts by government and NGOs are important to ensure equal economic opportunities, gender neutral community and access to a market driven education alternative. As India approaches 2047, it is high time to leverage the maximum potentialities of women for robust community and inclusive governance for Viksit Bharat Mission, economic well-being and ultimate development for the future citizens.

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CLIMATIC DISASTERS AND ENVIRONMENTAL MIGRATION IN THE SUNDARBANS: CHALLENGES, RESPONSES AND FUTURE PATHWAYS

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Abstract

The Sundarbans, a highly vulnerable ecological region, is increasingly affected by recurring climate-induced disasters such as cyclones, river erosion, and sea-level rise. These environmental hazards disrupt livelihoods, damage infrastructure, and intensify existing socio-economic vulnerabilities, particularly for marginalized communities. As these challenges grow, environmental migration is becoming a widespread response—often not by choice, but by necessity. This study explores the impact of climate disasters on different aspects of life and livelihood in the Indian Sundarbans and critically assesses the effectiveness of governmental responses. Based on qualitative fieldwork conducted across ten villages in five administrative blocks, data were collected through focus group discussions and key informant interviews. The findings show that while people adopt various coping strategies—including short-term relocation and occupational shifts—migration often becomes the only viable option due to the lack of consistent institutional support. Government interventions largely remain reactive, focused on disaster relief and evacuation, with limited attention to long-term adaptation, livelihood security, or relocation planning. The study highlights the urgent need for integrated, inclusive, and forward-looking policy measures to support at-risk populations and reduce the compulsion to migrate.

Keywords: *climate vulnerability, environmental migration, livelihood insecurity, disaster response, Sundarbans*

Introduction

India has set an ambitious target to become a middle-income country within the next decade and a developed nation by 2047, and to do that, it undertakes wide-ranging reforms to strengthen human capital, governance, and economic productivity (Virmani, 2024). However, this developmental path faces critical challenges, with climate change emerging as the most difficult due to its far-reaching socio-economic consequences. Empirical studies have demonstrated that climate variability negatively affects industrial productivity (Dua & Garg, 2024), agricultural output (Gupta et al., 2014), public health, and overall economic resilience. Among climate change's most visible and human-centered impacts is the rise in forced environmental migration. As recurring environmental hazards intensify, many communities are being pushed beyond their threshold of resilience, making migration the only viable survival strategy (Kaczan & Meyer, 2020).

The Sundarbans region, spanning parts of India and Bangladesh, exemplifies this crisis. Home to the world's largest contiguous mangrove forest and inhabited by some of the most socio-economically vulnerable populations in South Asia, the Sundarbans face multiple, overlapping environmental threats—including tropical cyclones, riverbank erosion, and sea-level rise (Mondal et al., 2022). These hazards are compounded by an accelerated rate of sea-level rise, which exceeds the global average significantly (Das & Hazra, 2020). According to a government-led shoreline change study, West Bengal's coastline—broadly encompassing the Sundarbans—has experienced the highest rate of transformation in India, with over 70% of its coastal area affected (Noujas, Thomas, & Ajeesh, 2017). The degradation of land and freshwater resources has gravely undermined agriculture, fisheries, and forest-based livelihoods, deepening socio-economic distress and contributing to widespread, often involuntary, migration (Ghosh, 2012; Bandyopadhyay, Mallik, & Roy, 2023).

These environmental stressors directly infringe upon constitutionally guaranteed rights, including the right to life, livelihood, property, and food (Articles 21 and 300A). As the impacts of climate change disproportionately affect communities in the global South—particularly low-income, Indigenous, and socio-economically marginalized groups—the Sundarbans stand as a stark example of broader environmental injustice (Mohai, Pellow, & Roberts, 2009). In this context, migration does not reflect a proactive decision but rather emerges from a lack of adaptive resources and the failure of policy systems to provide viable alternatives. The people of the Sundarbans are not only affected by environmental forces but are also caught in a cycle of governance shortcomings that have long failed to translate their vulnerabilities into sustainable, long-term solutions.

This research investigates how environmental disasters in the Indian Sundarbans impact various dimensions of livelihood vulnerability and examines the responsiveness of governmental policies and programs to these challenges. Drawing on qualitative data collected from ten villages across five blocks in the Sundarbans, the study explores the lived experiences of environmental migrants and assesses the adequacy of state interventions in disaster risk reduction, climate adaptation, and livelihood sustainability. This research seeks to identify ideal pathways for enhancing adaptive capacity, promoting environmental justice, and reducing forced migration through appropriate governance frameworks that are both inclusive and responsive.

Methodology

This study adopts a qualitative research design to capture the nuanced, lived experiences of climate-affected populations in the Indian Sundarbans, along with institutional responses to environmental vulnerabilities. The methodology is grounded in **grounded theory**, which provides a comprehensive framework for understanding how individuals and communities adapt—or fail to adapt—to recurring environmental stressors.

Study Area and Sampling

The study was carried out across five administrative blocks in the Sundarbans, selected to capture the region's geographical and ecological diversity. Two villages were purposively chosen from each block to ensure the representation of areas affected by various environmental hazards, including cyclones, river erosion, and sea-level rise. Ten villages were included in the fieldwork, allowing the research to reflect variations in hazard exposure, institutional engagement, and community resilience.

Data Collection Methods

Primary data was gathered through ten **Focus Group Discussions (FGDs)** and five **Key Informant Interviews (KIIs)**, involving a total sample of 65 participants.

Focus Group Discussions: One FGD was conducted in each village, with six participants selected to reflect a diverse range of demographic and occupational backgrounds, including farmers, fisherfolk, women, and youth. These discussions focused on key themes such as the impacts of disasters, migration decisions, livelihood disruptions, and perceptions of government support.

Key Informant Interviews: In each of the five selected blocks, one government official was interviewed to gather institutional perspectives on disaster preparedness, relief distribution, and long-term adaptation planning. These informants were primarily affiliated with disaster management, rural development, or irrigation departments.

The discussions and interviews were conducted in Bengali and subsequently translated and transcribed into English for analysis. A semi-structured interview guide was used to maintain consistency across interviews while allowing participant-driven narratives to emerge organically.

Ethical Considerations

All participants provided informed consent, and the study adhered to established ethical guidelines for social science research. Anonymity and confidentiality were strictly maintained, and sensitive topics—such as political bias in aid distribution or forced displacement—were approached with cultural awareness and emotional sensitivity.

Data Analysis

The collected data were analyzed using thematic analysis, identifying recurring patterns and inconsistencies across various locations and respondent groups. Coding was conducted both deductively—based on the research objectives—and inductively—based on themes that emerged from the data.

Research Findings

Building on the study's aim to examine the impact of environmental disasters and the role of state responses, this section presents key field-level findings. It explores how physical vulnerabilities manifest in daily life and evaluates the effectiveness of governmental interventions across affected blocks in the Sundarbans.

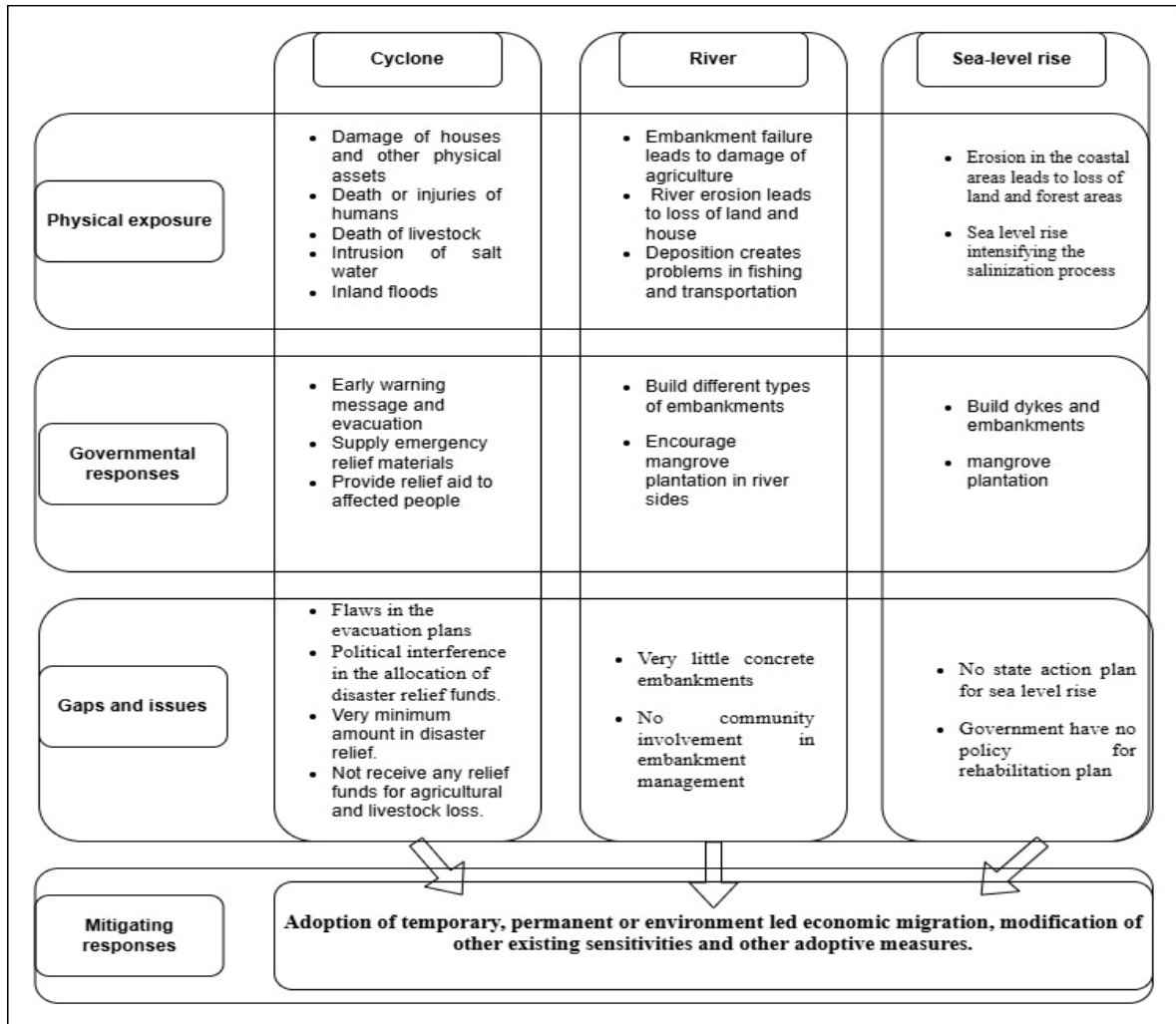


Figure 1. Conceptual framework illustrating the relationship between environmental disasters and migration in the Sundarbans (designed by the author).

Physical Vulnerabilities

The physical vulnerabilities confronting the residents of the Sundarbans are complex and closely linked to the region's distinctive geographical setting and heightened climate exposure. These vulnerabilities are primarily associated with three key environmental hazards: cyclonic storms, riverbank erosion, and sea-level rise. Each of these factors exacerbates existing socio-economic hardships, placing considerable strain on livelihoods and contributing to patterns of environmentally driven migration. The following sections provide a detailed examination of these interrelated risks.

Physical Vulnerabilities Related to Cyclones

The Sundarbans, situated in the cyclone-prone Bay of Bengal, have a long history of devastating tropical storms. These cyclonic events impact the region in multiple ways, causing widespread damage to physical, natural, and human assets. The high wind speeds characteristic of cyclones often destroy fragile housing infrastructure, particularly the mud-walled, tin-roofed houses that dominate the landscape. While some households have managed to build concrete structures, the vast majority remain exposed to the catastrophic impacts of storms. Since most houses in the Sundarbans are still made of mud or are only partially concrete, nearly all respondents reported some level of damage to their homes. As noted by Pal and Ghosh (2018), the devastating impact of Cyclone Aila was a stark example of this vulnerability, affecting five lakh houses and affecting the lives of nearly five million people across the region.

Cyclones also damage critical infrastructure, including roads, electricity lines, and fishing equipment, further disrupting daily life and economic activities. In many cases, the collapse of houses during storms leads to loss of life, either through physical injury or electrocution. The destruction of natural assets—such as the uprooting of trees, damage to mangroves, and the loss of crops—further erodes the resilience of communities.

A particularly insidious impact of cyclones is the storm surge phenomenon, which often leads to saltwater intrusion into agricultural fields and freshwater ponds. The combination of storm surges and tidal waves frequently overwhelms weak embankments, flooding farmland and rendering it unproductive for several years. As focus group discussions revealed, many farmers have yet to see their land fully recover, even years after a single cyclone. The salinization of ponds similarly devastates freshwater fish stocks, which are critical for household nutrition and income. The consequences are far-reaching, as the loss of agricultural and aquacultural productivity not only undermines food security but also diminishes the capacity of families to cope with future shocks. In one of the focus group discussions, a farmer shared,

“Before Aila, we used to get 12 bags of rice from one bigha of land, but now we are only able to harvest 7–8 bags.”

This statement reflects the long-term impact of salinization on agriculture, showing a significant decline in crop yields that continues to affect farmers today.

In the aftermath of cyclones, temporary migration emerges as a survival strategy, with families seeking refuge in cyclone shelters or relatives' homes in less-affected areas. However, these relocations are often short-term and precarious, highlighting the lack of systemic, long-term adaptive solutions for cyclone-affected communities.

Physical Vulnerabilities Related to River Erosion

As an active deltaic system, the Sundarbans is shaped by the dynamic processes of sedimentation and erosion. While some areas experience land accretion, others face severe and irreversible land loss due to riverbank erosion. This phenomenon disproportionately affects communities living in low-lying, river-adjacent areas, where the collapse of embankments and

riverbanks leads to the displacement of entire villages. The cases of Lohachara and Ghoramara islands—now submerged or significantly reduced in size—are stark reminders of the long-term risks associated with erosion-driven displacement.

The region's tidal rivers, fill with saline water, exacerbate these vulnerabilities. The earthen embankments, which serve as the primary line of defence against tidal surges and saline intrusion, are frequently breached during storms, resulting in the devastating flooding of agricultural lands. When these embankments fail, the consequences are twofold: the immediate displacement of families and the long-term degradation of soil fertility due to increased salinity, which renders land unsuitable for cultivation for years.

River fishing, once a primary source of livelihood, has also been severely impacted by these ecological changes. Focus group discussions reveal that fish species' quantity and diversity have declined, undermining the economic stability of households dependent on traditional fishing practices. This loss of livelihood options forces many to seek alternative, often precarious, forms of employment, contributing to distressed migration from the region.

Physical Vulnerabilities Related to Sea-Level Rise

The Sundarbans are at the frontline of global sea-level rise, with rates of increase significantly higher than the global average. This has led to the permanent submergence of land, particularly in blocks like Sagar, Namkhana, and Patharpratima. The loss of habitable land due to encroaching waters directly reduces agricultural land availability, displacing families and intensifying socio-economic vulnerabilities.

Sea-level rise also results in saltwater intrusion into soil and freshwater systems, degrading soil quality and compromising agricultural productivity. Even in areas where land has not been fully submerged, the increased salinity of the soil leads to declining crop yields, pushing farmers to abandon their traditional occupations.

The erosion of land and encroachment by the sea not only displace families but also create a sense of perpetual uncertainty, as people live under constant threat of losing their homes and livelihoods. This continuous risk exposure, coupled with limited governmental support for long-term relocation or livelihood diversification, exacerbates chronic vulnerability and leaves communities with few choices but to migrate. One elderly participant expressed his sorrow by saying,

“The house you see now is my fourth one—my previous homes were all lost to the ocean. I don’t know where I will go if this one is destroyed too, as I had to take a loan to build this small house.”

His words highlight the emotional and financial toll of repeated displacement and the growing uncertainty faced by vulnerable households in the Sundarbans.

Governmental Response to Physical Vulnerabilities

Government responses to the growing physical risks in the Sundarbans have mostly been reactive and uncoordinated, focusing mainly on disaster relief and early warning systems. Even though cyclones, river erosion, and sea-level rise happen often and cause serious damage, long-term solutions are still uneven and not applied consistently. This section looks closely at how the government has responded to these three major threats and points out both the strengths and the weaknesses of these efforts.

Response to Cyclone-Related Vulnerabilities

The government has made measurable strides in cyclone preparedness, primarily through satellite-based forecasting systems. These technologies typically provide early warnings 4–5 days before a cyclone lands, allowing for preliminary disaster risk reduction measures. State authorities disseminate alerts through television, radio, and increasingly through mobile and social media platforms, urging evacuation from vulnerable dwellings to cyclone shelters.

However, ground realities often diverge sharply from planned strategies. Although the government encourages relocation to multipurpose cyclone shelters, access remains uneven. Proximity to administrative centers correlates with better-prepared shelters and resource allocation, while remote islands or embankment-bound communities are often left with inadequate support. Focus group discussions indicate that while some cyclone shelters are well-provisioned—offering two meals daily and emergency supplies—such instances are the exception rather than the norm.

Financial assistance following cyclones is delivered through disaster relief funds. Compensation for house and crop damage is officially available, but the distribution process is frequently marred by political favoritism, bureaucratic opacity, and logistical delays. Many eligible households report receiving only partial relief or none, underscoring systemic gaps in accountability and transparency.

Response to River Erosion

River erosion management in the Sundarbans is centered on embankment construction and maintenance and is overseen by the West Bengal Irrigation Department. The region contains over 3,500 kilometers of embankments, theoretically designed to protect against tidal surges and saline intrusion. However, these barriers are often compromised by poor construction quality, irregular maintenance, and limited community involvement in their planning and upkeep.

In response to the catastrophic damage wrought by events such as Cyclone Aila, the government initiated the construction of concrete embankments as a more durable alternative to traditional mud barriers. Despite their proven resilience, progress has been sluggish. A confluence of funding shortages, land acquisition disputes, and bureaucratic inertia has resulted in only a fraction of the necessary infrastructure being completed more than a decade later.

In practice, emergency maintenance often falls to local residents rather than government agencies. This community-led intervention, while commendable, reflects a deeper institutional failure to uphold long-term risk reduction responsibilities.

Response to Sea-Level Rise

Sea-level rise presents the most insidious and least addressed physical vulnerability. Governmental interventions have included the construction of coastal dykes and the plantation of mangroves—often in collaboration with NGOs—to buffer tidal incursions. While these efforts offer ecological benefits, their reach remains limited, particularly in severely affected blocks such as Sagar, Namkhana, and Patharpratima.

No comprehensive national or state-level policy specifically addresses sea-level rise and its long-term impacts. Past relocation efforts for submerged islands like Lohachara and parts of Ghoramara were conducted with some success, including land redistribution and housing schemes. However, similar strategies have not been replicated on a broader scale in recent years. Presently, governmental support often consists of one-time relief payments, which are grossly insufficient in light of the permanent loss of land and livelihood.

Despite the existential threat posed by rising seas, long-term planning for managed retreat, resettlement, or livelihood diversification is notably absent. This policy vacuum contributes to ongoing insecurity and compels many families to make uninformed, desperate migration decisions without institutional support.

Discussion

The findings from this study underscore the deeply intertwined nature of environmental hazards and socio-economic vulnerabilities in the Sundarbans, where physical risks are not isolated incidents but enduring structural forces that shape long-term livelihood instability and migration patterns. The consequences of cyclones, river erosion, and sea-level rise extend far beyond the immediate damage—they disrupt food systems, destabilize local economies, and gradually weaken community resilience. Despite some governmental responses, they remain fragmented and lack the adaptive depth needed to contend with these climate-induced threats' recurrent and overlapping nature.

Environmental disasters in the region produce cascading effects—such as the collapse of agriculture, increased salinity in soil and water sources, damage to infrastructure, and displacement from traditional occupations—that collectively foster a state of chronic insecurity. These are not one-time shocks; households face a continuous cycle of vulnerability and partial recovery, which steadily diminishes their capacity to cope with future risks. Exacerbated by poverty and the erosion of farming and fishing livelihoods, this ongoing exposure creates a sense of existential instability, where migration becomes less a choice and more a form of forced adaptation.

The study further reveals that the impact of disasters is shaped not only by their physical severity but also by local socio-economic conditions—such as access to alternative livelihoods,

land tenure, infrastructure quality, and financial protections like insurance. Vulnerability in this context is not merely a product of natural forces but is co-produced through entrenched inequalities and systemic neglect. For instance, when salinization or embankment breaches render land infertile, food insecurity and the loss of income-generating opportunities particularly affect landless and low-income households. These pressures frequently result in seasonal or permanent migration to urban and peri-urban areas as a coping strategy.

Although policy frameworks and relief mechanisms exist, their implementation remains highly uneven. Some cyclone shelters are sufficiently stocked and maintained, but many remote or politically marginalized areas lack proper support. Similarly, the delivery of financial aid is plagued by administrative inefficiencies and allegations of political bias, which undermine the reach and credibility of state interventions.

While the construction of embankments is a key pillar of the government's approach to erosion and flood control, progress in replacing vulnerable mud structures with durable concrete alternatives has been notably slow. Limited funding, bureaucratic delays, and weak institutional capacity have stalled these efforts. Even ecologically beneficial initiatives, such as mangrove plantation and afforestation, are inconsistently applied and rarely embedded within a broader adaptation strategy, including relocation or livelihood transition.

Most concerning is the absence of a coherent, forward-thinking policy to address the long-term impacts of sea-level rise. Strategies like a planned retreat, permanent resettlement, or the facilitation of livelihood change remain underdeveloped, revealing a reluctance to confront the scale of environmental displacement already underway. While short-term relief may provide immediate relief, it does little to mitigate the structural causes of vulnerability or support the development of durable, community-centered solutions.

To address these overlapping challenges, disaster risk reduction in the Sundarbans must embrace physical and socio-economic vulnerability dimensions. This calls for integrated, long-term planning that moves beyond reactive measures and is rooted in resilience, justice, and sustainability. Government action must prioritize decentralized investments in resilient infrastructure—such as all-weather roads, reinforced embankments, and disaster-proof housing. Equally critical is ensuring transparency and equity in relief distribution, supported by inclusive mechanisms for identifying and supporting those most at risk. Strengthening economic resilience through skill development, microfinance, and accessible insurance schemes will also be essential. Ultimately, institutionalizing adaptation strategies—including managed retreat, resettlement assistance, and land redistribution—will be vital to securing the future of communities facing irreversible environmental losses. Through such comprehensive, justice-oriented governance, meaningful and lasting resilience can be realized in the Sundarbans.

Many of these communities are already losing their land and homes to permanent environmental changes. Without steady and meaningful support, people may be forced to leave, not because they want to, but because they have no other way to survive—making poverty worse and causing long-term displacement.

Conclusion

In conclusion, the increasing frequency and severity of climate-induced disasters in the Sundarbans have identified significant gaps in governmental response, particularly about long-term adaptation and the protection of livelihoods. Although early warning systems and emergency relief mechanisms are in place, their implementation remains inconsistent and insufficient to address the region's persistent vulnerabilities. Safeguarding the rights and well-being of affected communities requires a shift from reactive relief efforts to a more proactive and forward-looking model of climate governance. This entails investing in climate-resilient infrastructure, ensuring equitable and transparent distribution of government assistance, and promoting sustainable livelihood opportunities. Without such an effort, environmental migration from the Sundarbans is likely to intensify, further entrenching socio-economic inequalities and intensifying climate injustice.

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DEFINING THE FACTORS AND SCALE FORMULATION FOR IMPLEMENTING EFFECTIVE USER EXPERIENCE IN TRAVEL WEBSITES AS SUSTAINABLE INNOVATION IN DIGITAL MARKETING

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Abstract

Digital platform has revolutionized the marketing with the rapid advancement of the technology and automation. While using various digital platform the customers always look for experiences that are seamless, delightful, convenient, informative, and personalized. Emphasizing on the user needs, UX – User experience (design thinking) is leveraged by the companies to design and develop these various kinds of digital channels to provide the users a convenient, pleasant online environment addressing the customers' functional goal along with a pleasant user journey and optimal digital experience. With the growing importance of user experience for different social medium in the field of digital marketing, this paper explores the different attributes for travel website that can be leveraged to provide optimal user experience for online customer of travel websites. The different models proposed so far for online platforms mainly consider Hedonic and Utilitarian features but there is a lack of an integrated approach considering the behavioral design and motivational factors of the online customers. Using the SOR (Stimulus - Organism - Response) theory, Flow theory along with hedonic and utilitarian factors this paper formulates a scale based on the Quantitative questionnaires' that can be used to identify and evaluate the attributes and access the corresponding impact of optimal user experience for the online customer using travel website. The objective of this paper is to formulate the scale that can be leveraged for future research to identify and validate the attributes that underline an effective user experience framework and template for travel website.

Keywords: *Digital Marketing; User Experience; SOR Theory; Flow Theory*

Introduction

Digitalization is happening in a rapid pace. The companies are going through the journey of digitalization across their value chain. There has been a paradigm shift in the field of marketing as well with the evolving of Digital Marketing. Digital marketing can be defined as web marketing, online marketing, or internet marketing. Digital Marketing uses the digital technologies to build multi channels to reach the prospective customers and more effectively satisfy their requirements. The swift development of various social networking sites has significantly enhanced various digital platforms like Facebook, Twitter, Instagram etc. In 2024, retail e-commerce sales are estimated to exceed 6.3 trillion U.S. dollars worldwide, and this figure is expected to reach new heights in the coming years (Statista.com). Social commerce allowed the companies to enable their websites for the consumers for interaction for socialization for better buying experiences. It has changed the purchase process decision

process by enabling optimal user experience. The user experiences are gaining more importance for better development of websites and other digital medium to allow rich experience for online customers. The quality of website design and plays an important role to offer good user experiences and has become a key tool for marketing. Flow theory provide a valuable framework to analyze the user experience in digital marketing perspective for user's satisfaction, engagement, and loyalty. It can be state that the online customer gain optimal experience i.e. attains a state of flow while using a website. Leveraging flow theory to enhance user experience in digital platform to captivate and engage users leading to higher conversion rate and better brand loyalty. The flow state can be experienced during the website navigation which include viz. seamless interactivity with the system, intrinsically enjoyment, a loss of self-consciousness, and self-reinforcing. Although flow theory identifies several antecedents and characteristic that contribute to effective optimal experience and positive state of flow experience for online customer while visiting websites and digital platforms but it lack a comprehensive understanding of the various triggers both external, internal and corresponding drivers that should be taken into consideration for uncovering the pattern of user experience design for website and other digital medium that can lead to optimal user experience and achieve flow state for online users. The flow theory should be complemented with other framework and research work for a comprehensive understanding of the Product Psychology. In this context the SOR (Stimulus - Organism - Response) theory entails certain stimuli both external and internal that can be leveraged for enriched user experience for positive behavioral response and defining the antecedents for designing the website allowing uninterrupted engagement of the online customers. Leveraging the SOR (Stimulus - Organism - Response) theory, Flow theory and considering the hedonic and utilitarian factors this paper formulates a scale based on the Quantitative methodology that can be used to identify and evaluate the various attributes and evaluate the corresponding impact of optimal user experience for the online customer using travel website. The objective of this paper is to formulate the scale as a pilot project that can be validate and leverage for future research to identify and evaluate the attributes that underline an effective user experience framework and define an integrated model for designing travel website to ensure optimal user experience.

Literature Review and Hypothesis Formulation

Digital Marketing and its Importance

Though the presence of Digital marketing existed from the early 90s but it gained its momentum after the pandemic of COVID 19. There has been a paradigm shift for digitalization across the industries, and it gain significance in the marketing sector as well. Many scholars have been working on the detailed insight on 'Online Marketing'. In his paper Daugherty described digital marketing as the mode of selling the goods and services on online platform and he defined the same as 'through this pattern of marketing the investors are achieving their marketing objectives by applying digital technologies' (Chaffey,2009). In his study Chaffey explained Digital Marketing as a tool which used several technologies to help marketing activities and try to improve the customer knowledge about the need of any product. He also pointed out that by using this application one can easily matched his / her need and accordingly choose the preferable product (Chaffey, 2013). Chaffey agreed with the view that in order to

improve the business capacity an organization should include digital marketing platform along with their existing traditional marketing pattern which can meet the needs of customers more precisely (Parsons, Zeisser, Waitman, 1996). In 1998 Kiani published his study on this new marketing pattern where opportunities for marketers to promote their product increases and this new pattern with the objective for creating a web site for marketing the organizations are different in different digital platform in which the investors or marketers can support their business effectively and fulfill their objectives in different manner. (Kiani, 1998). In his article Shu-Chuan Chu established the increasing use of Facebook which has led to the importance of this social medium as a new avenue for marketing environment and marketers promote their product information in different social medium like Facebook, Instagram etc. Creating a new window for online marketing. From this study the marketers also identify variations in predictors of pass-on behaviors between group members and non-members of the various digital platform (Shu-Chuan Chu, 2013). In this context in 2009 Pelling and White published their work on young youth's behavior towards the social network and according to them social media is the most popular social networking media among the college goers (Pelling, E. L., & White, K. M., 2009). Different social medium like Facebook, Twitter, YouTube etc. obtain maximum popularity among the internet users (Kaplan and Haenlein, 2010; Mangold and Faulds, 2009). Hence with increasing use of the online platforms and its acceptance across the population resulted to the improvement of digital marketing platform and the investors are more attracted to these platforms because they can get a global reach by using digital tools as their marketing strategy. Effective usage of digital platforms allows the marketers to reach a wide range of population and promote their products and services globally in more cost-efficient way. So, one can understand that at present in this digital era various digital platforms and social networks are gaining utmost importance and is being leveraged as effective medium to reach the customers to promote and sell their products and services.

User Experience

User Experience (UX) can be defined as the process of designing products or services that will provide relevant meaningful experience to the users. In the present digital era the User Experience has become an important aspect of product and service design across various domain including digital medium and website design as well. In the context of human computer interaction (HCI) User Experience can be described as understanding and enhancing the interaction between the users and the systems. Many scholars have given their views on User Experience according to them in the current environment User Experiences the most advantageous tool for the marketers for effective design of their product for the end users and to enhance the acceptance of their products and services to the consumers. In this context Hassenzahl, M published his work in 2008 and defined user experience as the multidimensional feature covering user's perception, emotions and behaviors when interacting with a product or a system. In 2007 Desmet and Hekkert's introduce an extensive framework for product experience. This framework can be applied to all affective responses experienced in human-product interaction. According to the author there are three categories which are "aesthetic experience", the "experience of meaning" and the "emotional experience" (Desmet and Hekkert's, 2007). Enriched User of Customer Experience (EX or UX) leads to positive

customer satisfaction that leads to repetitive visits and increase engagement. User Experience (UX) define the experience and how the flow communicated to the users while interacting with the product or services. It allows the transformation of product or services into an emotional optimal experience as perceived by the users. With the rapid development of digital technology understanding the various components of User Experience has become very important to design websites and different digital medium for delivering the optimal seamless experience to end user and remain competitive. In their study on the Digital Marketing Strategies and the Impact on Customer Experience: A Systematic Review by (Mohammed, et al., 2023) has defined the customer experience as perceptions and experience of the consumers or users, conscious and subconscious due to the interaction with the product or services and the customer experience become positive if the information is distributive in nature backed by peers and colleagues. In 2020 (Watulingas & Permana, 2020) published their work on “The Influence of User Interface, User Experience and Digital Marketing toward Purchase Intention’ where they tried to establish that the User Experience (UX) has a positive and significant effect on Purchase Intention in the field Digital marketing. According to Ghazali the quality of the website has a positive significant impact on the intention to purchase (M. S, MohdShahril, N. A. S, & Rosle, 2021) . A well-designed user experience can allow the users to navigate through the sale funnel and convert to a customer. As per the McKinsey report companies with top-quartile McKinsey Design Index scores outperformed industry-benchmark growth (mckinsey.com). Managing and defining the customer experience is important for sustainable businesses advantage in this digital world (Accenture, 2015; Rawson, Duncan, & Jones, 2013)

Flow Theory

Flow theory was developed to understand how people feel when they most enjoyed themselves, and why. This theory was developed by Csikszentmihalyi in 1975. Flow theory was developed to understand how people feel when they most enjoyed themselves, and why. According to Csikszentmihalyi, flow is a "crucial component of enjoyment" and is "the holistic sensation that people feel when they act with total involvement". It can be defined as a mental state where the individual is focused, motivated and fully immersed in an activity or a task. Flow Theory, which was developed in the field of psychology but also used as basis of research for different disciplines and has significant usage in the field of marketing and understanding the consumer’s behavior also. In his book *Flow: The Psychology of Optimal Experience* he teaches how by ordering the information which enters our consciousness for which we can discover true happiness, unlock our potential, and greatly improve the quality of our lives (MihalyCsikszentmihalyi, Desmet, & Hekkert, 1990). For online platform Hoffman and Novak (1996) extended the flow theory and defined flow as an experience that happen during human computer interaction. The optimal experience can be obtained by online users by the successful implementation of flow for online platforms (Hoffman & Novak, 1996). The websites should be designed to allow users to have optimal experience leading to positive consequences (Barta, Flavián,, & Gurrea, 2021) . In their paper Pine and Gilmore suggested that offering unique experience is crucial and consumers appreciate the experience while navigating the websites more than the tangible value (Pine, B. J., & Gilmore, J. H. 2011). In 2015 Bilgihan published their study on user – web interaction in service-related field and suggested that websites

pleasurable features along with utilitarian and hedonic elements are important for creating a flow that will lead to a positive user experience (Bilgihan, Nusair, Okumus, & Cobanoglu, 2015). The role of flow over online users was analyzed, and result revealed that flow can boost ease of usefulness and eventually make the purchase decision by online users in social media more useful and easier (Xu, Wang, Khan, & Zhao, 2021). In their study Algharabat & Rana examined the impact of flow in social media and its effect on the users' online engagement (Algharabat & Rana, 2021). (Daniel Rare Obada, 2013) analyzed the definition of flow considering both the online and offline perspective to evaluate the online behavior. It can be found that different characteristic of flow exhibits conceptual similarities but as far a comprehensive understanding of flow is concern it remains elusive. Considering the swift development of social networking sites which resulted significant increase of the number of digital platforms like Facebook, Twitter, Instagram etc. a suitable definition of flow cannot be identified with a clear definition. The rapid digitalization has created significant changes in online customer's experience hence research should continue to study the online behaviors in various social platforms. From the above literature review we can conclude that Flow theory is a valuable framework to examine the user experience in digital marketing and understanding the user's satisfaction, engagement, and loyalty. Although flow theory identifies several antecedents and characteristic that contribute to effective optimal experience for online customer while visiting websites and digital platforms but it lack a cohesive understanding of the various triggers both external, internal and corresponding levers that should be considered to understand the different attributes of user experience design for website and other digital medium that can lead to optimal user experience and achieve a state of flow state for online customers. Hence, we can suggest that flow theory should be complemented with other framework to identify the different antecedent and for a comprehensive understanding of the Product Psychology for an effective user experience.

Stimuli-Organism-Response (S-O-R)

The S-O-R framework stands for Stimuli-Organism-Response (S-O-R), according to this theory Stimulation is the trigger that result the change of the internal and organize state of the individual which resulting in their responses. In 1982 this framework was first used by Donovan and Rossiter where they used it to test the effect of the relating environment on the decision making of the consumer. Hence S-O- R interprets that when a person gets exposed to external stimuli, his/ her 'inner organism changes' which leads to behavioral responses. In their book A. Mehrabian and James B Russell proposes that environmental stimuli are linked to behavioral responses of arousal, pleasure, and dominance (Mehrabian & Russell, 1974). (Fiore & Kim, 2007) presented an integrative framework that leverage and extends the S-O-R model to analyze the consumer's hedonic and utilitarian shopping experience. This framework defines three types of stimuli viz. ambient factors (non-structural elements of the retail environment), design cues (architecture, physical elements, and display features), and social factors (human features related to interactions with staff and other shoppers). In October 2014 Chen Peng and Young Gug Kim uses the SOR model to study consumers' reasons for shopping and how website stimuli affect their purchasing attitudes toward online shopping (Peng & Kim, 2014). It also examines the ability to regulate the consumer's emotional purchases and their repurchase

intentions. In the research paper they extended the SOR model to the online market and indicated that the environmental stimuli both hedonic and utilitarian aspects have a positive influence on the online consumers' attitude leading to the emotional purchase. (Peng & Kim, 2014) . Based on the S-O-R framework (Koo & S. H, 2010) analyzed the effect of online environmental stimuli like color, graphics etc. and impact it has on customers' emotions and purchase intentions. In the present digital era the social presence like in digital platform act as a stimulus and have a positive significant impact triggering impulsive buying (Ming, Jianqiu, Bilal, Akram, & Fan, How social presence influences impulse buying behavior in live streaming commerce? The role of SOR theory, 2021). The social presence and various kind of sales promotion create stimuli and flow experience leading to impulsive buying behavior of consumer (Huo C. , Wang, Sadiq, & Pang, 2023). In their study Liu, Y., Zhang, Y., Qiu, C., & Ma, Y. based on the SOR theory it has been found that the online shopping experience affects consumers' mood, sensory experience, cognitive experience and practical experience significantly leading to consumer pleasure and impulsive buying (Liu, Zhang, Qiu, & Ma, 2019). Integrated S-O-R model is a suitable theoretical framework that can be used to enhance the shopping experience of the consumer. The findings suggest that well-designed digital media with relevant, useful, and entertaining content could impact the shoppers in a mall leading to their unplanned purchases (Roux & Maree, 2021). (Hewei & Youngsook, 2022) conceptual model was defined, and it can be found that interactivity in social medium platform has a significant impact on perceived experience, immersion experience leading to continuous purchase intention which can be leveraged for the marketing and design of social medium e-commerce platform. Using the SOR model it can be found that the customers' response rate was higher with personalized recommendations than that of bestseller recommendations, and also when there is a cash discounts than earning redeemable points (Jeong, et al., 2022). Although there are many papers on understanding SOR model, extending the model, identifying the stimuli both external and internal in the digital marketing concept and how it led to users' responses, but it seems there is a limitation to fully consider and analyze the complexities of the consumer behaviors from digital marketing perspective. The unique factors like online interaction, personalized feed, gamification etc. and its impact in the product psychology have been not addressed and the theory further lost the significance with the rapid evolution of digital technology.

From the above literature review we can conclude that flow theory should be complemented with other framework and research work for a comprehensive understanding of the Product Psychology and define the user experience for an effective website development. The flow theory defines the state of the mental pleasure a person experience however the various stimulus both external and internal are not taken into consideration. In this context the SOR (Stimulus - Organism - Response) theory entails certain stimuli both external and internal that can be leveraged for delivering enriched user experience and defining the antecedents for designing the website allowing uninterrupted engagement and flow experience for the online customers. Leveraging the SOR (Stimulus - Organism - Response) theory, Flow theory and considering the hedonic and utilitarian factors a scale can be formulated and validated as a pilot work that can be leveraged to identify and evaluate the various attributes and analyze the corresponding impact of optimal user experience for the online customer using travel websites.

Research gaps

From the above literature review we can understand that providing optimal user experience to the client in digital platform like websites is a key factor for product and service marketing. Although flow theory identifies several antecedents and characteristic that contribute to effective optimal experience for online customer while visiting websites and digital platforms but it lack a cohesive understanding of the various triggers both external, internal and corresponding levers that should be considered to understand the different attributes of user experience design for website and other digital medium that can lead to optimal user experience and achieve a state of flow state for online customers. The flow theory should be complemented with other framework and research work for a comprehensive understanding of the Product Psychology. In this context the SOR (Stimulus - Organism - Response) theory entails certain stimuli both external and internal that can be leveraged for enriched user experience for positive behavioral response and defining the antecedents for designing the website allowing uninterrupted engagement of the online customers. Leveraging the SOR (Stimulus - Organism - Response) theory, Flow theory and considering the hedonic and utilitarian factors a scale can be defined for future research to identify and evaluate the attributes that underline an effective user experience framework and define an integrated model for designing travel website to ensure optimal user experience.

Research objectives

The objective of this paper is to formulate the scale that can be leveraged for future research to identify and evaluate the attributes that underline an effective user experience framework and define an integrated model for designing travel website to ensure optimal user experience. The flow theory should be complemented with other framework and research work for a comprehensive understanding of the Product Psychology. In this context the SOR (Stimulus - Organism - Response) theory entails certain stimuli both external and internal that can be leveraged for enriched user experience for positive behavioral response and defining the antecedents for designing the website allowing uninterrupted engagement of the online customers.

Research Questions

Based on the above requirement and literature gap which can be addressed by defining the quantitative scale, this scale can be leveraged to answer the following questions

- To what extent the user experience strategy plays a significant role in digital marketing for developing a habit-forming product in travel websites
- Is there any suitable user experience strategy and design prototype in place for different business domains across the industries that can be leveraged and extended to provide optimal user experience to the end users?
- To what extent the behavioral design is considered in defining the various attributes for user experience strategy while building the website

Methodology

Research instrument developed in this study was a questionnaire carefully developed after a deep review of relevant literature. A standardized self-administered quantitative questionnaire was formulated based from previous studies in the table as mentioned below. The questionnaire developed is reviewed and finalized by subject matter expert (SMEs) which include Web site developer, Academician, Travel operators and End users

Attribute	Sources	
This website is attractive.	The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences	Heather Lynn O'Brien (2010)
I liked the graphics and images used on this shopping website.	The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences	Heather Lynn O'Brien (2010)
This website was aesthetically appealing.	The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences	Heather Lynn O'Brien (2010)
I spend more time to navigate around applications because of its appearance, colors and advertising, images	How does visual merchandising in fashion retail stores affect consumers' brand attitude and purchase intention	Park, H. H., Jeon, J. O., & Sullivan, P. (2015)
My shopping experience was rewarding	The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences	Heather Lynn O'Brien (2010)
I feel that I belong to the group of shoppers who shop at this site	Prioritizing values to be provided to online shoppers during website design and upgrade	Ashish Kakar (2023)
I accomplish just what I want to while shopping online.	Introducing Flow Theory to Explain the Interactive Online Shopping Experience in a Travel Context	Khaldoon Nusair & H. G. Parsa (2011)
I am satisfied with the experience from shopping applications	Determinants of perceived web site interactivity	Song, J. H., Zinkhan, G. M (2008)

Attribute	Sources	
The experience in mobile shopping applications are exactly what I needed	Determinants of perceived web site interactivity	Song, J. H., Zinkhan, G. M (2008)
My shopping online experience is always rewarding	Engaging shoppers through mobile apps: the role of gamification	Francesca De Canio; Maria Fuentes-Blasco; Elisa Martinelli (2021)
It was easy to navigate the website	Prioritizing values to be provided to online shoppers during website design and upgrade	Ashish Kakar (2023)
The website is well-organized	Prioritizing values to be provided to online shoppers during website design and upgrade	Ashish Kakar (2023)
The search function gives me useful results	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
You can find what you want with a minimum number of clicks	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
I like to share my online shopping with my friends online	Engaging shoppers through mobile apps: the role of gamification	Francesca De Canio; Maria Fuentes-Blasco; Elisa Martinelli (2021)
E-commerce's social media allows me to share and update the existing content	Measuring consumer perception of social media marketing activities in e-commerce industry: Scale development & validation	Mayank Yadav , Zillur Rahman (2017)
This e-commerce brand interacts regularly with its followers and fans	Measuring consumer perception of social media marketing activities in e-commerce industry: Scale development & validation	Mayank Yadav , Zillur Rahman (2017)
The web pages loaded quickly	Prioritizing values to be provided to online shoppers during website design and upgrade	Ashish Kakar (2023)

Attribute	Sources	
Pages at this site do not freeze after I enter my order information.	E-S-QUAL A Multiple-Item Scale for Assessing Electronic Service Quality	A. Parasuraman
It is quick and easy to complete a transaction at this website.	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
I feel like my privacy is protected at this site	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
The website has adequate security features	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
I feel safe in my transactions with this website	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
When I buy at this site, I am guaranteed the best possible deal	Prioritizing values to be provided to online shoppers during website design and upgrade	Ashish Kakar (2023)
This website gives you personal attention	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
This site has features that are personalized for me	eTailQ: dimensionalizing, measuring and predicting etail quality	Mary Wolfinbarger , Mary C. Gilly b (2003)
E-commerce's social media facilitates personalized information search	Measuring consumer perception of social media marketing activities in e-commerce industry: Scale development & validation	Mayank Yadav , Zillur Rahman (2017)

Population and Sample Profile

The population considered for present study is female IT professionals working in top 7 MNC in Kolkata. Thought process behind this selection is to ensure non impulsive buying, mature decision taking ability, working professional having financial independent and fair amount of understanding of the web related staffs.

Selection Criterion for IT MNC Company

- IT MNC Nasdaq or NSE listed
- Present in more then 30+ countries
- 5,000+ workforce in Kolkata

The total population size is 30,000

Sample Selection criteria

Inclusion criteria:

- Female age group from 30 - 40 Years
- Residing in Metro city (Kolkata)
- Travel at least once in a year domestic or international travel
- Follow various travel sites and travel booking sites (Hotels sites, MakeMyTrips, Agoda etc.)

The total population size is 20,000. Considering 95% Confidence Level and 5% Margin of Error the sample size is 377. Considering this a pilot project and time consideration a sample size of 200 have been considered.

Constructs and measurement items

All the items were measured on a five-point Likert scale ranging from 1 = extremely irrelevant to 5 = extremely relevant.

Items	Factors
Aesthetics	This website is attractive.
	This website was aesthetically appealing.
	I liked the graphics and images used on this shopping website.
	I spend more time to navigate around applications because of its appearance, colours and advertising images
Self-Efficacy	My shopping experience was rewarding.
	I feel that I belong to the group of shoppers who shop at this site
	I accomplish just what I want to while shopping online.
Experiential	I am satisfied with the experience from shopping applications
	The experience in mobile shopping applications are exactly what I needed
	My shopping online experience is always rewarding
Ease of Use	It was easy to navigate the website
	The website is well-organized
	The search function gives me useful results.
	You can find what you want with a minimum number of clicks.
Interactive	I like to share my online shopping with my friends online
	E-commerce's social media allows me to share and update the existing content
	This e-commerce brand interacts regularly with its followers and fans
Technical Performance	The web pages loaded quickly
	Pages at this site do not freeze after I enter my order information.
	It is quick and easy to complete a transaction at this website.
Trust	I feel like my privacy is protected at this site.

Items	Factors
Quality of Information	The website has adequate security features.
	I feel safe in my transactions with this website.
	When I buy at this site, I am guaranteed the best possible deal
	This website gives your personal attention.
	This site has features that are personalized for me
	E-commerce's social media facilitates personalized information search

Analysis and Findings

The data was obtained using the Workplace Stress Scale with a 5-point Likert Scale attached to the instrument. The data was collected from 248 respondents.

The Cronbach's Alpha value of internal scale reliability was found to be adequately significant at 0.868 (George and Mallery, 2003)

Reliability Statistics

Cronbach's Alpha	N of Items
.889	27

From the statistical validity, V value more than 60% as shown in the below table we can conclude that the result of the conducted survey can be accepted with confidence and is suitable for its intended use to derive conclusive results.

VARIABLE	NAME	V VALUE
A1	This website is attractive	90%
A2	This website is aesthetically appealing	88%
A3	The graphics and images used on this shopping website are appealing	82%
A4	More time is being spend to navigate around applications because of its appearance, colours and advertising images	75%
S1	Shopping experience are rewarding.	77%
S2	Sense of belonging to the group of shoppers who shop at this site	68%
S3	Users complish just what he/she wants to while shopping online	86%
E1	It is easy to navigate the website	84%
E2	The website is well-organized	87%
E3	The search function gives useful results	83%

E4	Users can find required information with a minimum number of clicks	85%
I1	Users prefer to share online shopping experience with friends online	89%
I2	E-commerce's social media allow user to share and update the existing content	88%
I3	This e-commerce brand interacts regularly with its followers and fans	92%
T1	The web pages load quickly	95%
T2	Pages at the site do not freeze while doing transaction	95%
T3	It is quick and easy to complete a transaction at this website	95%
TR1	Privacy of the users are protected at this site	91%
TR2	The website has adequate security features	92%
TR3	Website provide safe transaction	94%
TR4	Website provide best possible deal	94%
Q1	This website gives user specific personal attention	77%
Q2	This site has features that are personalized for users	75%
Q3	E-commerce's social media facilitates personalized information search	77%
EX1	I am satisfied with the experience that I preceived while using the website	89%
EX2	The experience in mobile shopping applications are exactly what I am looking for	87%
EX3	Online shopping experience are always rewarding for me	91%

Question wise average score mentioned below

Average Mean	Mean	Median	Std. Deviation
This website is attractive	4.28	4.00	0.64
This website is aesthetically appealing	4.22	4.00	0.64
The graphics and images used on this shopping website are appealing	4.13	4.00	0.68
More time is being spend to navigate around applications because of its appearance, colours and advertising images	4.02	4.00	0.76
Shopping experience are rewarding.	4.03	4.00	0.71
Sense of belonging to the group of shoppers who shop at this site	3.83	4.00	0.66
Users complicit just what he/she wants to while shopping online	4.14	4.00	0.63
It is easy to navigate the website	4.04	4.00	0.59
The website is well-organized	4.06	4.00	0.56
The search function gives useful results	4.13	4.00	0.68
Users can find required information with a minimum number of clicks	4.08	4.00	0.62

Users prefer to share online shopping experience with friends online	4.40	5.00	0.68
E-commerce's social media allow user to share and update the existing content	4.37	4.00	0.69
This e-commerce brand interacts regularly with its followers and fans	4.48	5.00	0.64
The web pages load quickly	4.65	5.00	0.58
Pages at the site do not freeze while doing transaction	4.67	5.00	0.57
It is quick and easy to complete a transaction at this website	4.71	5.00	0.55
Privacy of the users are protected at this site	4.44	5.00	0.66
The website has adequate security features	4.39	4.00	0.64
Website provide safe transaction	4.49	5.00	0.60
Website provide best possible deal	4.46	5.00	0.62
This website gives user specific personal attention	4.00	4.00	0.67
This site has features that are personalized for users	3.90	4.00	0.62
E-commerce's social media facilitates personalized information search	3.98	4.00	0.65
I am satisfied with the experience that I perceived while using the website	4.42	5.00	0.69
The experience in mobile shopping applications is exactly what I am looking for	4.38	5.00	0.71
Online shopping experience is always rewarding for me	4.42	5.00	0.66

Construct mean score, category wise given below

	Mean	Median	Std. Deviation
Aesthetics	4.16	4.25	0.55
Self-Efficacy	4.00	4.00	0.57
Ease of Use	4.08	4.00	0.49
Interactive	4.42	4.67	0.58
Technical Performance	4.68	5.00	0.49
Trust	4.45	4.50	0.51
Quality of Information	3.96	4.00	0.55
Experiential	4.41	4.67	0.59

Correlation Matrix table showing correlation coefficients between variables measuring the degree of linear relationship between each pair of variables, suggesting that the variables were not highly collinear and therefore the dataset was ideal to conduct factor analysis and meaningful factors could be extracted.

			Aesthetics	Self Efficacy	Ease of Use	Interactive	Technical Performance	Trust	Quality of Information	Experiential
Spearman's rho	Aesthetics	Correlation Coefficient	1.000	-0.011	0.296	-0.035	0.024	-0.013	0.125	0.046
		p Value		0.862	0.000	0.588	0.710	0.842	0.049	0.471
	Self Efficacy	Correlation Coefficient	-0.011	1.000	0.169	0.744	0.573	0.609	0.125	0.231
		p Value	0.862		0.008	0.000	0.000	0.000	0.049	0.000
	Ease of Use	Correlation Coefficient	0.296	0.169	1.000	0.160	0.118	0.175	0.476	0.368
		p Value	0.000	0.008		0.012	0.063	0.006	0.000	0.000
	Interactive	Correlation Coefficient	-0.035	0.744	0.160	1.000	0.752	0.467	0.135	0.222
		p Value	0.588	0.000	0.012		0.000	0.000	0.034	0.000
	Technical Performance	Correlation Coefficient	0.024	0.573	0.118	0.752	1.000	0.380	0.118	0.169
		p Value	0.710	0.000	0.063	0.000		0.000	0.063	0.008
	Trust	Correlation Coefficient	-0.013	0.609	0.175	0.467	0.380	1.000	0.127	0.174
		p Value	0.842	0.000	0.006	0.000	0.000		0.046	0.006
	Quality of Information	Correlation Coefficient	0.125	0.125	0.476	0.135	0.118	0.127	1.000	0.721
		p Value	0.049	0.049	0.000	0.034	0.063	0.046		0.000
	Experiential	Correlation Coefficient	0.046	0.231	0.368	0.222	0.169	0.174	0.721	1.000
		p Value	0.471	0.000	0.000	0.000	0.008	0.006	0.000	

The Kaiser-Meyer-Olkin (KMA) value was 0.773 which stated moderate adequacy of data (Kaiser, 1974) in conducting the factor analysis.

Bartlett's Test of Sphericity assesses whether the correlation matrix of the data is significantly different from an identity matrix. An identity matrix implies that the variables are uncorrelated, which would make factor analysis inappropriate. The test was used to verify that the data contains enough inter-correlations among variables for factor analysis to be meaningful.

The objective was to test the null hypothesis:

(H₀): The correlation matrix is an identity matrix (no significant correlations among variables).

The approximate Chi-square value was 350.079 with df (degree of freedom) = 6. The significance level was 0.000 which was <0.05 (Bartlett, 1950). It allowed the researcher to reject the null hypothesis and accept the alternative hypothesis to conclude that the variables are highly correlated which makes it amenable for EFA.

The KMO and Bartlett's Test of Sphericity were presented in below table

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.773
Bartlett's Test of Sphericity	Approx. Chi-Square	350.079
	df	6
	Sig.	.000

Extraction Method: Principal Component Analysis. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.567	28.026	28.026	7.567	28.026	28.026	5.191	19.226	19.226
2	4.155	15.390	43.416	4.155	15.390	43.416	4.328	16.029	35.255
3	2.770	10.257	53.673	2.770	10.257	53.673	3.069	11.365	46.620
4	1.857	6.880	60.552	1.857	6.880	60.552	2.669	9.884	56.504
5	1.444	5.348	65.901	1.444	5.348	65.901	2.537	9.397	65.901
6	.966	3.579	69.480						
7	.856	3.172	72.652						
8	.781	2.892	75.543						
9	.691	2.558	78.101						
10	.596	2.207	80.308						
11	.563	2.086	82.393						
12	.509	1.884	84.277						
13	.481	1.780	86.057						
14	.458	1.696	87.753						
15	.377	1.396	89.149						
16	.366	1.355	90.504						
17	.356	1.319	91.823						
18	.331	1.226	93.049						
19	.307	1.137	94.186						

20	.270	1.001	95.187						
21	.253	.935	96.122						
22	.214	.794	96.916						
23	.200	.741	97.657						
24	.173	.639	98.296						
25	.168	.621	98.917						
26	.160	.593	99.510						
27	.132	.490	100.000						

From the above table we can identify six factors having Eigen Value 1 or greater then 1

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.

	Component				
	1	2	3	4	5
This website is attractive	0.070	-0.110	-0.024	0.821	0.025
This website is aesthetically appealing	-0.024	0.313	0.013	0.717	0.076
The graphics and images used on this shopping website are appealing	-0.054	-0.114	0.008	0.796	0.279
More time is being spend to navigate around applications because of its appearance, colours and advertising images	0.058	0.051	-0.026	0.826	0.122
Shopping experience are rewarding.	0.657	0.253	0.455	0.020	0.018
Sense of belonging to the group of shoppers who shop at this site	0.576	0.148	0.397	0.033	-0.115
Users complish just what he/she wants to while shopping online	0.568	-0.019	0.489	-0.054	-0.106
It is easy to navigate the website	-0.062	0.078	0.086	0.113	0.854
The website is well-organized	0.097	0.185	-0.054	0.205	0.763
The search function gives useful results	0.175	0.458	0.068	0.092	0.631
Users can find required information with a minimum number of clicks	0.162	0.365	0.133	0.215	0.561
Users prefer to share online shopping experience with friends online	0.781	0.157	0.223	0.013	0.056

E-commerce's social media allow user to share and update the existing content	0.831	0.084	0.097	0.027	0.061
This e-commerce brand interacts regularly with its followers and fans	0.754	0.074	0.268	-0.016	0.031
The web pages load quickly	0.777	0.039	0.077	0.038	0.058
Pages at the site do not freeze while doing transaction	0.806	0.043	0.038	0.040	0.112
It is quick and easy to complete a transaction at this website	0.811	0.074	0.088	-0.005	0.128
Privacy of the users are protected at this site	0.231	0.153	0.798	0.021	0.112
The website has adequate security features	0.218	0.095	0.791	-0.007	-0.019
Website provide safe transaction	0.274	-0.057	0.763	-0.024	0.001
Website provide best possible deal	0.128	0.031	0.643	-0.026	0.452
This website gives user specific personal attention	0.089	0.793	-0.030	0.148	0.013
This site has features that are personalized for users	0.068	0.794	0.126	0.092	0.197
E-commerce's social media facilitates personalized information search	0.022	0.755	0.037	-0.077	0.235
I am satisfied with the experience that I preceived while using the website	0.136	0.786	0.016	-0.003	0.103
The experience in mobile shopping applications are exactly what I am looking for	0.101	0.817	0.058	0.013	0.002
Online shopping experience are always rewarding for me	0.096	0.731	0.083	-0.091	0.160

Looking at the above table we can conclude

- Factor 1 is the combination of 4 variables which can be related to aesthetic nature and look and feel of the website
- Factor 2 is the combination of 3 variables which can be related to the seamless services provide by the website to the users

- Factor 3 is the combination of 4 variables which is can be related to the ease of use of the website
- Factor 4 is the combination of 6 variables which is can be related to the Platform for customer Interactions and website performance
- Factor 5 is the combination of 4 variables which is can be related to the security provide by the websites
- Factor 6 is the combination of 4 variables which is can be related to the personalized experience and customer delight

Conclusion

From the above findings we can conclude that the following attributes which include Aesthetic nature of the website, seamless transaction, ease of navigation, personalized and interactive characteristic along with trust and security are the key factors in defining the quantitative scale which can be leveraged to develop effective website and to ensure optimal user experience to the online visitors. How ever in the above study the parameters have been identified based on which the scale has been proposed, the defined quantitative scale needs to be implemented and tested and there is always a scope for further refinement as part of future research

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THE ROLE OF SMART AND SUSTAINABLE PACKAGING IN SHAPING CONSUMER PURCHASE INTENTIONS: A STRUCTURAL EQUATION MODELLING APPROACH

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Abstract

As environmental concerns gain momentum, consumers are increasingly considering eco-friendly packaging in their food choices, especially within the organic sector. This study explores how elements of eco-smart packaging—specifically, material sustainability, recyclability, minimalism, technological features, functional benefits, and data transparency, shape consumer attitudes and influence their intention to purchase organic food. Attitude is examined as a mediating factor in these relationships. A structured survey using a multistage random sampling method was conducted across selected districts, and data were analyzed using Exploratory and Confirmatory Factor Analysis along with Structural Equation Modeling. The results highlight that recyclability and data transparency are the most influential factors driving positive consumer attitudes and purchase intentions. While minimalism also showed a strong effect, material sustainability had a relatively weak impact, indicating limited consumer awareness. The findings underscore the growing importance of interactive, informative, and environmentally responsible packaging in shaping consumer behavior in the organic food market.

Keywords: *Organic food, eco- friendly packaging, smart packaging, purchase intention, attitude.*

1. Introduction

The rising awareness of environmental sustainability and health consciousness has significantly reshaped consumer preferences in the food market. Among these shifts, organic food has emerged as a prominent choice, appealing to consumers who prioritize natural, eco-friendly, and ethically sourced products (Paul & Rana, 2012). However, in an increasingly competitive market, the packaging of organic food plays a pivotal role in influencing consumer perceptions and purchase decisions. Packaging serves not only as a functional necessity but also as a critical medium for conveying product quality, brand values, and environmental commitment (Magnier & Schoormans, 2015). For organic food, packaging that aligns with sustainability values is crucial to attract eco-conscious consumers who are willing to pay a premium for environmentally responsible products (Yadav & Pathak, 2016).

Eco-smart packaging, an emerging concept that integrates eco-friendly and technologically advanced elements, has gained attention as a strategic tool in the organic food industry. Eco-packaging emphasizes the use of sustainable materials, recyclability, and minimalist designs to reduce environmental impact, thereby aligning with consumer preferences for sustainable practices (Steenis et al., 2017). Simultaneously, smart packaging leverages technological

features, such as QR codes and freshness indicators, to enhance product transparency, functionality, and engagement (García-Arca et al., 2021). This combination of eco-friendly and technological advancements addresses the dual demand for sustainability and innovation, making eco-smart packaging an integral factor in shaping consumer purchase intentions.

The importance of packaging is further underscored by the growing body of literature suggesting its influence on consumer behavior. Research indicates that packaging can significantly impact consumer attitudes, which mediate the relationship between packaging attributes and purchase intentions (Ajzen, 1991; Chen & Chang, 2013). For instance, sustainable materials not only improve perceptions of environmental responsibility but also enhance product authenticity (Lindh et al., 2016). Similarly, smart features such as data transparency tools have been shown to foster trust and mitigate perceived risks, particularly in organic food markets where product origin and quality are essential (Aung & Chang, 2014).

Despite the recognized importance of eco-smart packaging, there remains a need for a comprehensive understanding of its multidimensional impact on consumer behavior. This study aims to fill this gap by examining the influence of eco-smart packaging on the purchase intention of organic food, with a focus on factors such as material sustainability, recyclability, minimalism, technological features, functional benefits, and data transparency. By offering insights into the interplay between packaging attributes and consumer behavior, this study seeks to provide actionable recommendations for businesses and policymakers aiming to enhance sustainable practices in the organic food industry.

2. Literature Review

2.1 Purchase Intention of Organic Food

Purchase intention, defined as the likelihood of a consumer buying a product, is a central concept in consumer behavior studies, particularly in the organic food market. Paul and Rana (2012) argue that health consciousness and environmental concerns are significant motivators influencing organic food purchase behavior. Yadav and Pathak (2016) observed that eco-conscious packaging improves consumer attitudes toward organic products, enhancing their likelihood of purchase. Magnusson et al. (2001) found that trust in organic certifications plays a vital role in shaping purchase intentions. Similarly, Shafie and Rennie (2012) highlighted the role of packaging in justifying the price premiums often associated with organic products. Visual appeal, combined with sustainability cues, has been shown to positively influence consumer attitudes toward organic food, as suggested by Van Loo et al. (2013). These findings establish that both product and packaging attributes significantly impact consumer purchase decisions.

2.2 Eco-Packaging: Dimensions and Consumer Impact

Material Sustainability

Material sustainability is a critical component of eco-packaging, reflecting the use of biodegradable, compostable, or renewable materials. Lindh et al. (2016) demonstrated that consumers perceive brands utilizing sustainable materials as more credible and environmentally responsible. Steenis et al. (2017) found that sustainable materials improve product quality perceptions, which directly influence purchase intentions. Pattnaik and Mathiyazhagan (2018) explored the supply chain implications of adopting sustainable materials, finding that such practices foster greater consumer trust and satisfaction. Similarly, Van Sluisveld and Worrell (2013) highlighted that bioplastics not only reduce environmental impact but also align with consumer expectations for sustainable innovation. Magnier and Schoormans (2015) further argued that consumers form an emotional connection with products packaged using sustainable materials, increasing their likelihood of purchase. These studies collectively underscore the importance of material sustainability in shaping consumer attitudes and behaviors.

Recyclability

Recyclability addresses the post-consumption phase of packaging, emphasizing its role in promoting a circular economy. Wang et al. (2020) demonstrated that clear instructions on recyclability increase consumer trust and positively impact purchase decisions. Gómez and Martín-Consuegra (2018) found that recyclable packaging appeals to environmentally conscious consumers who prioritize waste reduction. Verghese and Lewis (2007) highlighted that recyclable materials are crucial for meeting the growing demand for sustainable packaging solutions. Abraham and Gill (2017) observed that clear labeling of recyclable materials enhances consumer understanding, reducing confusion and fostering positive attitudes. Singh et al. (2018) added that products with recyclable packaging are perceived as more environmentally friendly, directly influencing purchase intentions. These findings suggest that incorporating recyclability into packaging design enhances both consumer perception and environmental impact.

Minimalism

Minimalist packaging design, characterized by reduced material usage and simplicity, has gained traction among eco-conscious consumers. White et al. (2019) found that minimalist packaging designs are perceived as more eco-friendly, fostering favorable consumer attitudes. Rokka and Uusitalo (2008) noted that minimalist designs align with consumers' desire for simplicity and sustainability, enhancing product appeal. Pinto et al. (2014) emphasized that reduced material usage in packaging not only minimizes waste but also enhances perceptions of product value. Magnier and Schoormans (2015) argued that minimalist packaging evokes an emotional connection with consumers by reflecting their values of environmental responsibility. Prakash and Pathak (2017) found that minimalist designs effectively reduce

perceptions of waste, positively influencing consumer purchase intentions. These studies collectively establish that minimalist packaging is a key driver of sustainable consumer behavior.

2.3 Smart Packaging: Enhancing Consumer Engagement

Technological Features

Smart packaging technologies, such as QR codes, augmented reality, and freshness indicators, have revolutionized consumer engagement. García-Arca et al. (2021) demonstrated that these innovations enhance transparency and foster trust, positively influencing purchase behavior. Oliveira et al. (2020) found that freshness indicators are particularly effective in the organic food sector, where product quality is a primary concern. Ting et al. (2018) argued that interactive features like QR codes improve consumer satisfaction and brand recall. Aday and Yener (2015) observed that temperature-sensitive packaging increases trust in product safety, further supporting purchase decisions. Balaji and Arshad (2020) emphasized that tech-enabled packaging reduces perceived risks associated with product authenticity and quality, increasing consumer confidence. These findings highlight the significant impact of technological features in enhancing consumer trust and engagement.

Functional Benefits

Functional benefits, such as resealability, tamper-evidence, and freshness preservation, add substantial value to packaging. Yam et al. (2005) found that resealable packaging aligns with eco-conscious values by reducing food wastage, appealing to environmentally aware consumers. Koutsimanis et al. (2012) observed that tamper-evident features increase perceptions of safety and quality, particularly in organic food products. Manalili et al. (2014) demonstrated that freshness-preserving packaging significantly impacts consumer purchase decisions by ensuring product quality. Ahmed and Ahmed (2021) highlighted that functional benefits like resealability improve product convenience and overall satisfaction. Poyatos-Racionero et al. (2018) argued that functional innovations differentiate products in the competitive organic food market, enhancing their appeal. These studies emphasize the importance of functional benefits in shaping consumer preferences.

Data Transparency

Data transparency, facilitated by tools like Radio Frequency Identification (RFID) and blockchain, has emerged as a pivotal factor in modern packaging. Aung and Chang (2014) found that traceability tools improve trust in product authenticity, a critical concern for organic food consumers. Beulens et al. (2005) highlighted that transparency in food supply chains mitigates perceived risks, positively influencing consumer attitudes. Zhou et al. (2020) demonstrated that RFID-enabled packaging enhances trust in product authenticity, increasing consumer purchase intention. Tseng et al. (2021) argued that consumers are willing to pay a premium for transparent and traceable organic food products. Wognum et al. (2011) found that blockchain technology improves transparency and trust, which are key drivers of purchase

decisions. These findings underscore the role of data transparency in fostering consumer trust and enhancing purchase intention.

2.4 Conceptual Framework

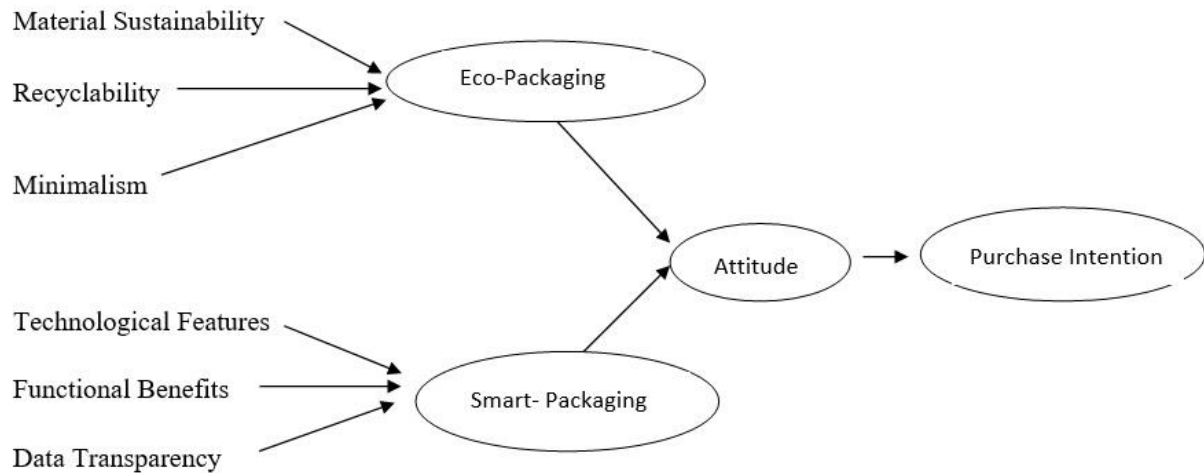


Figure 1: Conceptual Framework

Figure1: The conceptual framework of this study explores how packaging attributes impact consumer attitudes and purchase intentions. The model combines eco-packaging and smart packaging as two key concepts, each consisting of specific factors that influence consumer behavior.

Eco-Packaging

Eco-Packaging focuses on sustainability and environmental responsibility. It is represented by three dimensions:

- Material Sustainability – The use of eco-friendly materials that reduce environmental harm.
- Recyclability – Packaging that can be easily recycled or reused, promoting a circular economy.
- Minimalism– Simple, clean, and less resource-intensive packaging designs that appeal to consumers seeking sustainable products.

These elements collectively shape consumer attitudes by highlighting the brand's commitment to sustainability, which can positively influence purchase decisions.

Smart-Packaging

Smart-Packaging incorporates advanced features that enhance functionality and user experience. It consists of:

- Technological Features– Innovations like sensors, QR codes, or interactive elements that provide additional product information.

- Data Transparency– Clear and accessible product information, such as traceability of origin or production processes.
- Functional Benefits –Practical features that improve convenience, such as temperature control or product freshness indicators.

These attributes impact consumer attitudes by offering convenience, transparency, and added value. However, the study examines whether these features positively or negatively affect consumer perceptions.

Attitude and Purchase Intention

Consumer attitude acts as a mediator between packaging attributes and purchase intention. A positive attitude increases the likelihood of purchasing the product, while a negative attitude may discourage buying decisions. This framework provides a comprehensive understanding of how sustainability, functionality, and transparency in packaging design influence consumer choices, offering valuable insights for businesses seeking to align their products with consumer preferences.

3. Hypotheses Development

The hypotheses in this study are derived from the dimensions and their influence on consumer attitudes and behavior.

- **H1:** Material sustainability under eco-packaging positively affects attitudes toward packaging.
- **H2:** Recyclability under eco-packaging positively affects attitudes toward packaging.
- **H3:** Minimalism under eco-packaging positively affects attitudes toward packaging.
- **H4:** Technological features under smart packaging positively affect attitudes toward packaging.
- **H5:** Functional benefits under smart packaging positively affect attitudes toward packaging.
- **H6:** Data transparency under smart packaging positively affects attitudes toward packaging.
- **H7:** Attitude toward packaging positively affects purchase intention of organic food.

4. Materials and Methods

4.1. Sampling design and sample size

A multistage sample design, comprising four distinct stages has been implemented for this study. The data collection process involves the distribution of structured questionnaires through primary data collection method.

STAGE 1: Selection of Districts/Divisions based on the Scope of the Study: The scope of this study is centered to the geographical expanse of South Bengal within the state of West Bengal, India. Our investigation is specifically directed towards the Presidency Division, a

pivotal administrative unit comprising five distinctive districts: Howrah, Kolkata, Nadia, North 24-Parganas, and South 24-Parganas.

STAGE 2: Selection of Subdivision/Blocks based on Literacy Rate: Within each district, there are multiple subdivisions, which are further divided into **Community Development (CD) Blocks**. According to the official records from 2011 census, the districts under consideration—Howrah, Kolkata, Nadia, North 24-Parganas, and South 24-Parganas—comprise 14, 1, 17, 22, and 29 CD Blocks, respectively. Recognizing the emerging trend of utilizing environment friendly products, it is evident that literacy rates are becoming increasingly significant. In alignment with this perspective, the present study ranks CD Blocks within each subdivision based on literacy rates. The CD Blocks, such as Bally Jagachha (located in Howrah Southern subdivision, Howrah district) with an 87.75% literacy rate, Kolkata (within Kolkata district) with a 94.00% literacy rate, Haringhata (in Kalyani subdivision, Nadia district) with a 92.15% literacy rate, Barrackpore 1 (in Barrackpore subdivision, North 24 Parganas district) boasting an 85.91% literacy rate, and Namkhana (within Kakdwip subdivision, South 24 Parganas district) exhibiting an 85.72% literacy rate, have been identified in each respective subdivision. In conclusion, data have been gathered across these five subdivisions, revealing a consistent literacy rate exceeding 80% in each.

Determination of Sample Size

To determine the optimum sample size, we have employed Cochran formula, as follows:

$$n = z^2 \times p(1-p) / e^2$$

where, e: Margin of error ($\pm 5\%$)

$$n = 1.96^2 \times 0.5(1-0.5) / 0.05^2 = 384.16$$

Z: Z-score (1.96 for 95% confidence).

p: Proportion of success (0.5).

n: sample size

Therefore, minimum respondents required (n) = 384

STAGE 3: Randomization of Sample Using Simple Random Sampling Technique

To ensure an unbiased selection process, our study employs a method of randomization through a lottery without replacement. This approach involves drawing sample from the identified CD Blocks within each subdivision without replacement. By utilizing randomization method, we aim to achieve a representative and diverse sample that accurately reflects the multistage probability sampling for the present study.

STAGE 4: Finalization of Sample through Scrutiny of Inconsistencies

Collected data was carefully reviewed to identify and exclude incomplete, inconsistent, or illogical responses.

4.2. Research Instrument

The primary data has been collected with the help of a self-designed questionnaire. The first section contains questions on socio-demographic variables (age, gender, education level, etc).The second section comprises statements related to factors affecting the consumer purchase intention. The statements are designed on a 5-point Likert scale ranging from strongly disagree to strongly agree.

4.3. Analytical Tools and Techniques

Data analysis was conducted in three phases to ensure robust validation of the measurement and structural models. Exploratory Factor Analysis (EFA) was used to identify the underlying factors. . Confirmatory Factor Analysis (CFA) was performed validated the measurement model. Structural Equation Modelling (SEM), tested hypothesized relationships and mediation effects among the constructs. Maximum likelihood estimation was used to estimate path coefficients (Kline, 2015).All the analysis was conducted in R (version 4.3.1) (lavaan package).

5. DATA ANALYSIS

5.1 Exploratory Factor Analysis (EFA)

5.1.1

KMO and Barlett's test:

Test	Result
Kaiser-Meyer-Olkin (KMO)	0.93
Bartlett's Test of Sphericity Approx. Chi square Df Sig.	$\chi^2=6488.4$ df=496 $p < 0.001$

Table 1: KMO and Bartlett's Test

Table 1: The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was found to be 0.93, indicating that the dataset is excellent for factor analysis. Additionally, Bartlett's test of sphericity was significant ($p < 0.001$), confirming that the correlations among variables are sufficient for principal component analysis.

5.1.2 Total Variance Explained

Factor	SS Loadings	Proportion of Variance	Cumulative Variance
ML1	2.655	0.083	0.083
ML7	2.116	0.066	0.149
ML4	2.199	0.069	0.218
ML6	2.071	0.065	0.283
ML3	2.047	0.064	0.346
ML5	2.031	0.063	0.410
ML2	2.027	0.063	0.473
ML8	1.461	0.046	0.519

Table 2: Total Variance Explained

Based on the criterion of retaining factors with eigenvalues greater than 1.0, a total of eight components were extracted. In table 2 the components collectively explain 51.9% of the total variance, demonstrating that a substantial proportion of the data's variability is captured by the identified factors. Factor loadings were satisfactory, with all items loading above 1.46 indicating good convergent validity for each factor.

5.1.3 Rotated Component Matrix

Item	ML1	ML7	ML4	ML6	ML3	ML5	ML2	ML8
MS1						0.621		
MS2						0.684		
MS3						0.714		
MS4						0.763		
DT1							0.769	
DT2							0.562	
DT3							0.714	
DT4							0.734	
MIN1				0.630				
MIN2				0.700				
MIN3				0.779				
MIN4				0.715				
TECH1					0.841			
TECH2					0.642			
TECH3					0.575			

Item	ML1	ML7	ML4	ML6	ML3	ML5	ML2	ML8
TECH4					0.736			
FB1								0.499
FB2								0.479
FB3								0.503
FB4								0.811
REC1			0.758					
REC2			0.779					
REC3			0.683					
REC4			0.713					
ATT1		0.658						
ATT2		0.649						
ATT3		0.730						
ATT4		0.745						
PI1	0.830							
PI2	0.773							
PI3	0.826							
PI4	0.761							

Table 3: Rotated Component Matrix

Table 3: Presents the rotated component matrix, showing clean item-to-factor associations to facilitate interpretation. Each factor revealed loadings (> 0.47) on a unique set of variables, indicating a well-defined, orthogonal structure. Here, the constructs are represented as MS (Material Sustainability), DT (Data Transparency), REC (Recyclability), ATT (Attitude), TF (Technological Features), PI (Purchase Intention), FB (Functional Benefits) and MIN (Minimalism).

5.2 Confirmatory Factor Analysis (CFA)

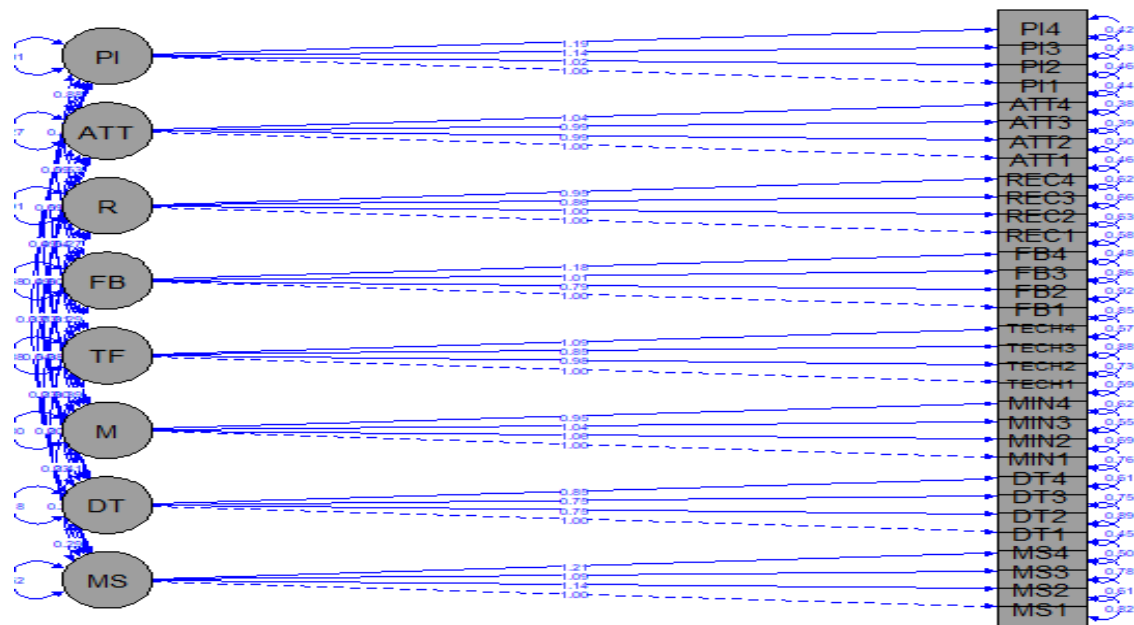


Figure 2: CFA Path Diagram Interpretation

The Confirmatory Factor Analysis (CFA) results, demonstrate the relationships between latent constructs and their corresponding observed variables. The latent constructs—MS (Material Sustainability), DT (Data Transparency), R (Recyclability), ATT (Attitude), TF (Technological Features), PI (Purchase Intention), FB (Functional Benefits) and M (Minimalism)—are represented as circles, while the observed variables are shown as squares. The arrows connecting these elements illustrate factor loadings, with thicker arrows indicating stronger relationships. The model was evaluated for goodness-of-fit, and the results indicate statistical significance ($p = 0.000$), confirming the adequacy of the factor structure.

Figure 2: Model fit was assessed using multiple indicators. All standardized factor loadings are above 0.6, indicating strong convergent validity. The chi-square value was significant ($\chi^2 = 504.379$, $df = 436$, $p = 0.013$), a result commonly observed with larger samples. Despite the significant chi-square, supplementary fit statistics supported the adequacy of the model. The Comparative Fit Index (CFI) reached 0.989, and the Tucker–Lewis Index (TLI) was 0.987—both surpassing the 0.95 criterion indicative of excellent model fit (Hu & Bentler, 1999). Additionally, the Root Mean Square Error of Approximation (RMSEA) was 0.021, suggesting a close fit to the data. The Standardized Root Mean Square Residual (SRMR) stood at 0.034, comfortably below the 0.08 benchmark. Taken together, these results provide strong evidence that the measurement model demonstrates excellent overall fit (Hair et al., 2019)

5.3 STRUCTURAL MODEL

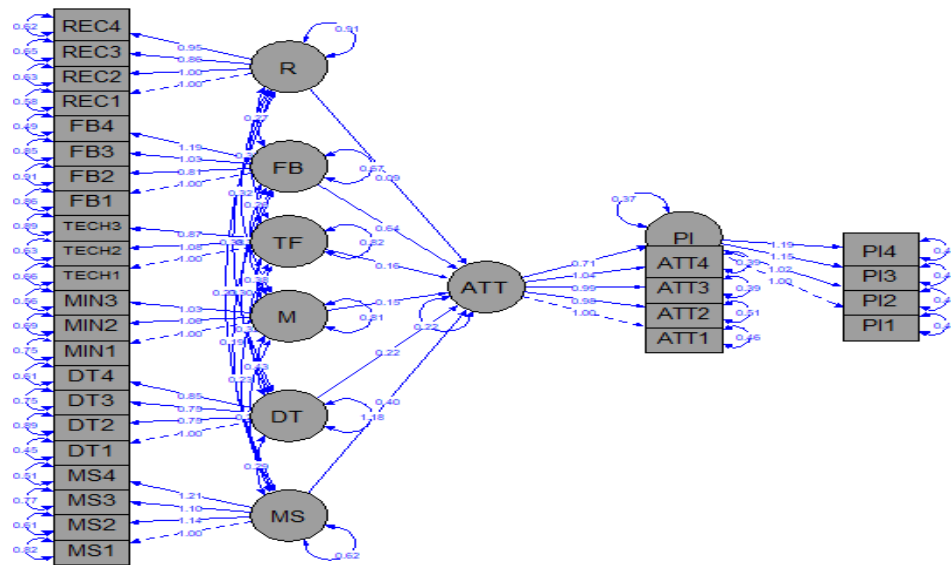


Figure 3: SEM Path Diagram Interpretation

Figure 3: The model fit indices presented demonstrate strong evidence of an excellent overall model fit. The chi-square statistic was significant ($\chi^2 = 486.006$, $df = 383$, $p < 0.001$). The Comparative Fit Index (CFI) was 0.982, and the Tucker–Lewis Index (TLI) was 0.980—both exceeding the 0.95 benchmark typically associated with excellent model fit (Hu & Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA) was 0.027, ≤ 0.05 , indicating a very close fit to the data. Additionally, the Standardized Root Mean Square Residual (SRMR) was 0.040, which is well below the 0.08 threshold. Altogether, these indices suggest the model aligns very well with the observed data (Hair et al., 2019).

5.4 RESULTS OF HYPOTHESIS TESTING

Hypothesis	Path	Std. Estimate	Std. Error	p-value	Std. Coeff.	Result
H1	MS → ATT	0.402	0.063	<0.001	0.281	Supported
H2	DT → ATT	0.225	0.043	<0.001	0.217	Supported
H3	M → ATT	0.148	0.059	0.012	0.119	Supported
H4	TF → ATT	0.160	0.055	0.004	0.129	Supported
H5	FB → ATT	0.641	0.071	<0.001	0.468	Supported
H6	R → ATT	0.091	0.048	0.057	0.077	Marginal

Hypothesis	Path	Std. Estimate	Std. Error	p-value	Std. Coeff.	Result
H7	ATT → PI	0.712	0.047	<0.001	0.796	Supported

Table 4: Hypothesis Testing

Table 4: The structural model results indicate that most of the proposed hypotheses are supported, reflecting significant relationships among the examined constructs. Material Sustainability (MS) significantly influenced Attitude (ATT), with a standardized coefficient of 0.281 ($p < 0.001$), suggesting a moderate positive effect. Similarly, Data Transparency (DT) also had a significant positive impact on Attitude ($\beta = 0.217$, $p < 0.001$). Minimalism (M) showed a smaller yet meaningful influence on Attitude ($\beta = 0.119$, $p = 0.012$), while Technological Features (TF) contributed moderately to Attitude as well ($\beta = 0.129$, $p = 0.004$). Among all predictors, Functional Benefits (FB) had the strongest effect on Attitude, with a standardized coefficient of 0.468 ($p < 0.001$), indicating a substantial role in shaping consumer perception. The path from Recyclability (R) to Attitude approached significance ($\beta = 0.077$, $p = 0.057$), suggesting a marginal effect that warrants cautious interpretation. Finally, Attitude had a highly significant and strong impact on Purchase Intention (PI), with a standardized coefficient of 0.796 ($p < 0.001$). These findings emphasize the importance of both functional and ethical product features in influencing consumers' attitudes and behavioral intentions (Hair et al., 2019).

Findings

The structural model indicates several statistically significant and positive relationships between the predictor variables and consumer attitude. Specifically, strong associations were found for MS → ATT ($\beta = 0.281$), DT → ATT ($\beta = 0.217$), M → ATT ($\beta = 0.119$), TF → ATT ($\beta = 0.129$), and FB → ATT ($\beta = 0.468$). These results suggest that when products emphasize material sustainability, provide clear and transparent data, adopt minimalist design principles, incorporate useful technological features, and offer tangible functional benefits, they are more likely to elicit favorable attitudes from consumers. Among all predictors, FB → ATT ($\beta = 0.468$) emerged as the strongest, highlighting the dominant role that perceived usefulness and performance play in shaping consumer evaluations. Meanwhile, the path from R → ATT ($\beta = 0.077$) was marginally significant ($p = 0.057$), implying that recyclability, while environmentally important, may not independently have a major effect on consumer attitudes within this context. Finally, the relationship ATT → PI ($\beta = 0.796$) demonstrated a very strong and significant influence, showing that a positive attitude significantly enhances the intention to purchase. Overall, these findings reinforce the importance of strategically aligning product features with consumer values to foster favorable perceptions and drive purchasing behavior.

Conclusion

These results highlight the interplay between ethical, functional, and design-related product features in shaping consumer attitudes. Functional Benefits, Material Sustainability, and Data Transparency emerged as the most influential predictors of a positive attitude, underlining the importance of aligning product offerings with consumer values. Although Minimalism and Technological Features were also positively related to Attitude, their effects were comparatively less pronounced. Recyclability, while conceptually relevant, did not reach conventional levels of significance, suggesting that it may be less decisive in shaping immediate perceptions.

Importantly, Attitude served as a strong determinant of Purchase Intention, underscoring its mediating role in the consumer decision-making process. These insights suggest that companies aiming to enhance consumer engagement and conversion should prioritize strategies that enhance functional value while embedding sustainability and transparency into their product narratives.

Recommendation

Given the increasing relevance of sustainable consumption and packaging in influencing consumer behavior—particularly in sectors like organic food. This study offers several practical recommendations. These insights aim to guide brands, policymakers, and packaging designers in aligning sustainability goals with consumer expectations. The findings highlight the need for strategic integration of environmental, functional, and informational elements within packaging, ensuring both ecological responsibility and consumer satisfaction. Accordingly, the following recommendations are proposed:

- **Emphasize Recyclable and Minimalist Packaging**
Companies should prioritize the development of packaging that is both easily recyclable and visually minimalist. Such designs not only support environmental sustainability but also foster consumer trust and are associated with stronger purchase intentions, particularly among environmentally conscious consumers.
- **Improve Transparency through Informative Labelling**
The inclusion of digital tools such as QR codes, and labels displaying detailed supply chain and origin information, can significantly enhance product transparency. This is especially critical in the organic food market, where consumers seek traceability as part of their ethical and health-conscious decision-making.
- **Optimize Functional Attributes without Overcomplication**
While features like resalability, ease of opening, and tamper-proofing are valued, excessive complexity can diminish usability. Packaging should deliver practical functionality in an intuitive manner, with benefits clearly communicated to the end user.
- **Raise Awareness about Material Sustainability**
The relatively modest impact of material sustainability on consumer purchase behavior indicates a knowledge gap. To address this, awareness campaigns led by both public and

private entities should educate consumers on the environmental advantages of biodegradable, compostable, and renewable materials.

- **Integrate Technology with Purpose and Simplicity**

The adoption of smart packaging technologies should be guided by usability and relevance. When integrated meaningfully—such as for indicating freshness or ensuring traceability—technology can enhance consumer perception. However, poorly implemented or overly complex features may lead to consumer skepticism or disengagement.

- **Encourage Future Research on Sociocultural Moderators**

Future studies should delve deeper into how demographic factors (e.g., age, education, income level) and behavioral attributes (e.g., environmental concern, digital literacy, technology anxiety) influence packaging perceptions. Understanding these moderating variables can enable more tailored and effective sustainable packaging strategies across diverse consumer segments.

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IMPACT OF SPIRITUAL ETHICS ON EMPLOYEES' CREATIVITY

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Abstract

The purpose of the current study is to examine the influence of spiritual ethics on employee's creativity. This study reveals that spiritual ethics has a significant and positive impact on the administrative decisions being taken by the various stakeholders of an organisation on daily basis. Furthermore, the results of the study showed that spiritual ethics has a pervasively significant and positive impact on the self-esteem of the employees. Additionally, the current study also showed that the self-esteem of the employees has a significant and positive impact on employees' creativity. Finally, it has been found that there is a mediation impact on the relationship between the self-esteem of the employees and employees' creativity. These findings may help the Universities to focus heavily on self-esteem of the employees by introducing sustainable innovative programmes to foster the relationship between spiritual ethics and employees' creativity.

Keywords: *spiritual ethics, employees' creativity, sustainable innovation, artificial intelligence, AI.*

Introduction

In today's rapidly evolving and competitive business environment, organizations are increasingly seeking innovative solutions to stay ahead. Employee creativity plays a pivotal role in driving organizational growth, competitive advantage, and overall productivity. Creativity among employees is shaped by numerous internal and external factors, including their work environment, leadership styles, and personal values. One factor that has gained growing attention in recent years is spiritual ethics, which refers to the moral principles derived from spiritual beliefs that guide an individual's thoughts, behaviours, and decisions. "Spirituality" was mostly a Roman Catholic term until the late 19th century and "Ethics" refers to the "second-order" reflection that probes their rational supports and systematic interconnections (Spohn, 1994a).

Spirituality has begun to hold an increasingly significant place in organizational studies. The term spirituality was first generally examined with a view to "the self" and then with its effects in the workplace within the studies of "workplace spirituality." Due to increasing interest toward the job activities, spirituality has been examined in relation to organizational effectiveness, performance, resilience and leadership, and more recently with an emphasis to ethics at work and they have since appeared throughout history in different forms; some lost forever, and others lasting into the present day, making an undeniable impact on world events (Ayoun et al., 2015a).

However, the relationship between spiritual ethics and creativity in organizational settings remains underexplored and underdeveloped in scholarly research. The interplay between our spiritual yearnings and our capabilities to learn are all deeply interwoven (Howard, 2002). However, mainstream paradigms of ethics including business ethics are devoid of any reference to spirituality or religion. They employ a materialistic and individualistic conception of human nature in which humans are materialistic beings having only materialistic desires and motivations (Zsolnai, 2022). There is ample evidence that workplace spirituality assists individual goals like peace, serenity, job satisfaction, and meaningful work, as well as organizational positives like increased loyalty, commitment, reduced absenteeism and turnover (Bandsuch & Cavanagh, 2005a). Previous studies have defined spirituality using terms that reach for a level of being that is beyond the purely physical, emotional or even cognitive (Ayoum et al., 2015b). Authors have used the term “spirituality”, “spiritual”, and “spirit” in different ways rather than interchangeably (Tischler et al., 2002). We often hear people say that “I’m not a religious person, but I am very spiritual.” This may mean that they have found resources for inner strength in practices that are not burdened by the doctrinal and historical baggage of institutional religion (Spohn, 1994). "Morality/Spirituality" refers to "first-order" descriptive accounts of the lived experience of human values and obligations on the other hand "Ethics" refers to the "second-order" reflection that probes their rational supports and systematic interconnections (Spohn, 1994).

While creativity is a crucial driver of innovation and organizational success, many organizations struggle with unlocking the full creative potential of their employees. Existing research has primarily focused on external factors such as organizational culture, leadership, and environment, while less attention has been given to the internal, personal values that may influence an individual’s creative capacity.

Spiritual ethics, as an internal motivator, could serve as an important but overlooked determinant of creativity. Employees’ spiritual beliefs, ethical values, and the sense of purpose derived from spirituality may enhance their ability to think creatively, solve complex problems, and contribute novel ideas within the workplace. However, the exact nature of this relationship remains unclear, and few studies have systematically examined the role of spiritual ethics in fostering or hindering creativity.

Although the litany of benefits associated with workplace spirituality is quite impressive (and still growing), certain potential threats also exist, including divisiveness, discrimination, misuse and superficiality (Bandsuch & Cavanagh, 2005a). Further, the recent upsurge in the usage of Artificial Intelligence) is also contributing to dehumanisation of various institutions (K, 2023).

Differentiating between religiosity and spirituality has been established in literature. Religiosity has been described in terms of organized system of beliefs, practices, rituals and symbols. The difference between religiosity and spirituality has been established in literature. Religiosity has been described in terms of organized system of beliefs, practices, rituals and symbols whereas spirituality is highly individual and intensely personal, and not necessarily tied to denomination (Ayoum et al., 2015b). Spirituality is another important factor in the workplace that requires comprehensive empirical and theoretical studies (Aftab et al., 2023).

This paper aims to explore how spiritual ethics influence employees' creativity. By examining existing literature, identifying research gaps, and proposing a conceptual framework, this study contributes to understanding the intersection of spiritual ethics and creative behaviours in the workplace. The paper will provide an overview of the theoretical foundations surrounding both spirituality and creativity, followed by a review of literature that highlights key research gaps and concepts relevant to this topic. The goal is to shed light on how spiritual ethics could foster a work culture conducive to creativity, innovation, and sustainable organizational performance.

This research seeks to address the following questions: How do spiritual ethics impact employees' creativity? What are the mechanisms through which spiritual ethics influence creative thinking, problem-solving, and innovation in the workplace? By answering these questions, this paper aims to fill an important gap in the literature and offer insights for managers and organizational leaders who aim to cultivate a creative and ethical work environment.

Literature Review

Spirituality has begun to hold an increasingly significant place in organizational studies. The term spirituality was first generally examined with a view to "the self" and then with its effects in the workplace within the studies of "workplace spirituality." Due to increasing interest toward the job activities, spirituality has been examined in relation to organizational effectiveness, performance, resilience and leadership, and more recently with an emphasis to ethics at work (Hanapiyah et al., n.d.). Despite the growing interest in spirituality within the workplace, the concept of spiritual ethics as a factor influencing creativity is still an under-researched area. The majority of studies on workplace spirituality have focused on broader themes such as employee well-being, job satisfaction, work-life balance, and organizational commitment. While these studies acknowledge the importance of spirituality in employees' professional lives, they do not specifically examine how spiritual values and ethical frameworks can influence creativity, which is a more nuanced and specific aspect of work behaviour.

Moreover, most of the existing literature on creativity in organizations tends to emphasize external factors such as leadership, team dynamics, or the physical work environment. Only a limited number of studies have explored the role of individual traits and personal values in fostering creativity. The intersection between spiritual ethics and creativity remains largely unexplored, with little research investigating how employees' personal spiritual beliefs might shape their creative outputs in the context of their work.

The benefits associated with workplace spirituality is quite impressive, certain potential threats also exist, including divisiveness, discrimination, misuse, superficiality and favouring one religious or spiritual perspective which can lead to illegal discrimination, harassment, and criminal violence at the work place (Bandsuch & Cavanagh, 2005b).

The research gap becomes evident in the limited exploration of how personal ethics, grounded in spiritual beliefs, might inspire creative thinking, ethical decision-making, or innovative problem-solving at work. Although scholars have studied the ethical dimensions of creativity

in business, the concept of "spiritual ethics" as a unique force in the creative process has not been adequately addressed in academic discourse. As a result, there is a need for empirical studies that systematically examine how spiritual ethics influence employees' creativity in diverse organizational contexts.

The most significant and frequently mentioned benefits associated with workplace spirituality (and thus the primary arguments for an organization to adopt it) include the following (Bandsuch & Cavanagh, 2005a):

1. Loyalty, commitment, and greater retention.
2. Connection to work and others.
3. Superior ethics and virtue development.
4. Performance, productivity and creativity.

To effectively manage workplace spirituality and achieve its benefits, all three dimensions of spirituality (beliefs, rituals and community) should be employed in a clear, coordinated, comprehensive and continuous manner which was proposed as the four C's (Bandsuch & Cavanagh, 2005a).

Conclusion

In conclusion, this paper has highlighted the importance of exploring the influence of spiritual ethics on employee creativity. The existing literature reveals a significant research gap regarding the impact of personal values and spiritual ethics on creative behaviours in organizational settings. By proposing a conceptual framework that links spiritual ethics to creativity, this paper provides a foundation for future research on the subject. Understanding how spiritual ethics influence creativity can offer valuable insights for organizations looking to cultivate a work culture that nurtures innovation, ethical behaviour, and personal fulfilment. Further empirical studies are needed to test the proposed framework and explore the practical implications of fostering spiritual ethics in the workplace to enhance employee creativity.

This research not only fills an important gap in the literature but also provides actionable knowledge for managers, HR practitioners, and organizational leaders striving to build creative, ethical, and productive workplaces. As organizations increasingly prioritize creativity in the face of global challenges, spiritual ethics may offer a novel and valuable approach to unlocking the full potential of their employees.

In an effort to foster spiritual significance, three dimensions of workplace spirituality (fundamental beliefs, sacred rituals, and community relationships) were presented as part of a framework designed to help business organizations manage their workplace spirituality. The clear, coordinated, comprehensive and continuous implementation of these essential dimensions (beliefs, rituals and community) cultivates workplace spirituality, as well as individual and organizational spiritual growth, which together contribute to and help maximize the many related personal and professional benefits (Bandsuch & Cavanagh, 2005a).

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THE INFLUENCE OF CORPORATE GOVERNANCE ON THE PERFORMANCE OF FAMILY AND NON-FAMILY FIRMS: AN INDIAN PERSPECTIVE

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Abstract

In recent years, scholars have extensively examined various facets of corporate governance (CG) across diverse contexts. While CG has made substantial strides in developed economies, its influence in emerging markets such as India has emerged more recently. Concurrently, there has been a growing scholarly focus on family firms, a prevailing ownership structure worldwide. This research momentum has been steadily increasing. This study seeks to contribute to the expanding body of knowledge in this realm by directing attention to India's listed companies. By analyzing data from the Nifty 100 index over ten financial years, we present a comparative overview between Indian family and non-family firms on selected CG parameters, while utilising certain statistical measures to comprehend this relationship better. The data for the study has been collected from CMIE Prowess as available for NSE 100 companies.

In particular, we have looked into the dimensions of board structure variables through board size, percentage of non-executive directors and percentage of independent directors. Apart from the selected CG variables as identified from pertinent literature, selected ownership variables and control variables have been incorporated to make the study more robust. Firm performance, the dependent variable of our study, has been captured through two measures, Return on Total Assets (ROTA) and Market value to Book Value (MV/BV). While ROTA serves as an accounting-based performance measure, MV/BV provides a market-based perspective on the same. To complement our correlation analysis and gain a deeper understanding of the relationship between the variables under study, a regression analysis was also undertaken to further enhance the validity of research findings. Overall, the findings underscore the importance of governance structures and ownership dynamics in driving firm performance. Our research endeavour aspires to augment the scholarly discourse in this domain by providing valuable insights into the CG landscape within the Indian context.

Keywords: *Board structure; Corporate Governance; Family firms; Firm Performance; India.*

Introduction

Commonly, Corporate Governance (CG) may be understood as “a set of relationships between a company's board, its shareholders, and other stakeholders”. This understanding is a simplified essence of the meaning of CG as envisioned by The Organisation for Economic Co-operation and Development (OECD). This helps us comprehend a corporation as a structure through which stakeholders may distribute rights and responsibilities. A more compact definition has

been given by The Institute of Company Secretaries of India upholding CG as “the application of best management practices, compliance of law in true letter and spirit and adherence to ethical standards for effective management and distribution of wealth and discharge of social responsibility for sustainable development of all stakeholders.” Over the years, not only has the meaning of CG evolved and increased in usage, but also, it has gained more prominence in the academic and corporate arena alike.

Since CG as a term may be subjected to both narrow and broader interpretations, the accurate control and management structures required to uplift transparency in a company are debatable issues. A strong CG structure ushers in various benefits to an organisation- better access to external capital, reduced vulnerability in times of financial crisis, decreased cost of capital, enhanced company performance and sustainability, to name a few.

The ‘Agency Theory’, proposed by Jensen and Meckling (1976), suggested that in modern corporations, ownership and management is divided, leading to a gap between the principals and agents of the organisation. This separation has resulted in (vertical) agency problems in such organisations through time immemorial. As a probable measure of reducing the impact of such conflicts, Fama and Jensen (1983) opined that management could be kept separate from control aspects of decision making.

In India, the business landscape is prominent with the presence of ‘family firms’; the companies that are run by business families. In most of such firms, ownership is noted to be concentrated in the hands of promoters, which gives rise to horizontal agency problem in these contexts (Roe, 2005). Conflicts of interest are not uncommon in such a setting, whereby, the controlling shareholders might try to optimise private benefits at the cost of minority shareholders. In family firm research, it gets difficult to compare findings examining similar subjects because of the use of various family firm definitions (Azila-Gbette et. al. 2018). While extensive literature exists on family firms, there is still no agreed-upon definition of what constitutes a family firm (Chua et. al. 1999).

Complexities in governance may occur in companies due to the possibilities of imperfect product market, rigidity in labour laws, horizontal agency problem, etc. Stakeholders hold a soft corner for such corporations that are able to provide more disclosure and transparency and often do not mind paying a premium for the services of such companies.

History of CG in India began in 1998 with the Confederation of Indian Industry (CII) introducing a voluntary initiative called the ‘Desirable Code of Corporate Governance’. In February 2000, the Securities and Exchange Board of India (SEBI) implemented the first regulatory framework for CG in listed companies. This was through Clause 49 of the Listing Agreements. This initiative was based on the recommendations of the 1999 Kumar Mangalam Birla Committee Report. Regular updates were continued over the original, most noteworthy in 2004, following the Narayana Murthy Committee Report of 2003. In December 2009, the Ministry of Corporate Affairs (MCA) issued voluntary CG guidelines for the corporate sector. Many of these provisions have since been incorporated into the Companies Act, 2013. It is

necessary to put in place a strong regulatory mechanism so that transparency and adherence to governance regulations for listed firms can be kept in check.

A strong body of literature is present that has examined the association among CG mechanisms, ownership structure and firm performance. Most of the studies have focussed on developed countries. Diverse results were noted, mostly due to the nature of the governance system prevalent in such economies. The subject matter of the current paper aims to contribute to the diversity of the associated research domain. Using Nifty 100 index over ten financial years, the current study examines the relationship between CG practices, ownership structure and firm performance. To be more specific, the paper tries to examine the impact of CG on firm performance and whether family firms showcase better performance as compared to non-family firms.

The overall findings of the study throw light on the relevance of governance structures and ownership mechanisms in uplifting firm performance. It is seen that independent directors have a role to play in improving firm's assets. Smaller board size is noted to be helpful in improving firm performance, lower debt-equity ratios correspond to enhanced market confidence and family firms do exhibit better performance in the light of the current research endeavour.

The paper has been structured in the following manner: the first section introduces the topic of the research, followed by a brief literature review on a similar research domain. The objective and methodology of the study is explained next. The most crucial part of this paper is the fourth section- analysis; which details the interpretations of the research findings. The last section, concludes the study with summary observations and future research directions.

Literature Review

A concise review of related literature clarified the research motivations, objectives and interpretations of noted academicians, scholars and researchers in the field of CG. Their insights significantly enhanced the scope of the current study and helped in the selection of research variables.

Research findings on the impact of CG mechanisms on firm performance has been diverse. While some authors highlight the positive association between the two, some authors stress on a negative association. Also, interestingly, some authors note finding no significant relationship between the variables of study.

Bhagat and Black (2001) observed in their study that firms with more independent boards don't necessarily achieve improved profitability. Thus, the findings of their study were not in support of the conventional wisdom that greater board independence improves firm performance.

Bhagat and Bolton (2008) through their research observations on American public companies opined that better governance, stock ownership of board members and CEO-Chair separation is significantly and positively correlated with better financial and subsequently higher operating performance. However, it was also duly observed that board independence is negatively correlated with operating performance. Bauer et al. (2004), in their study of

European public companies, found that in the long-run, the excess returns to corporate governance should translate in a higher firm valuation for better governed firms. This observation rightly highlights the relevance of strong governance systems for corporations.

In their study on the developing market of Pakistan, Abbasi et. al. (2020), observed that CG factors do not impact firm performance. In a similar observation, Rose, Casper (2016) also noted that quality of corporate governance among listed firms does not impact firm performance. This was further seconded by the study conducted by Buallay et al. (2017), where their results of the study test indicated that there is no significant impact for corporate governance adoption on firm's operational and financial performance in the listed companies in Saudi stock exchange. In the Indian context, Arora and Sharma, (2016) observed that profitability is not related to corporate governance and doesn't impact future viability of a firm.

The findings of Saha and Kabra (2019) reveal a significant positive impact of board size, ownership concentration and audit committee independence on market-based measure of firm performance, whereas, board independence is found to have a significant negative impact on accounting-based measure of firm performance. Othman et. al. (2020) studied that it is only certain CG mechanisms which do have a significant impact on firm performance.

One of the most classical studies conducted on performance difference between family and non-family firms was by Anderson and Reeb (2003), who observed that family firms perform better than non-family firms. In a similar study conducted by Reyna and Encalada (2012), based on Mexican listed firms, family-owned firms on the Mexican Stock Exchange were seen to perform better than their non-family counterparts. Even Koji and Tram (2020) supported the viewpoint that family firms outperform non-family counterparts in their study based on Japanese manufacturing industry.

However, non-family firms out performing family firms are also not unheard of. In a study based on the emerging market of Turkey, Wood et. al. (2019), stated that non family firms are seen to perform better than family firms.

It was also noted that some studies indicate no significant differences in performance between family and non-family firms. For instance, Vieira (2017) conducted a study on publicly listed companies in Portugal and found that, when measured by profitability, there were no notable variations between the two types of firms. This observation challenges the assumption that family ownership inherently affects a firm's financial prospects. The study highlights that other factors beyond ownership structure may play an important role in determining profitability.

Such diverse observations bring to prominence the complexity of the relationship between corporate governance and firm performance. This underscores the necessity of further exploration to uncover nuanced patterns.

Research Objective and Methodology

The primary objective of this study is to analyse the impact of CG on firm performance and subsequently, whether family firms showcase better performance, in terms of profitability as

compared to non-family firms. Further, in trying to fulfil the main focus of the study, understanding whether the selected control variables of the research are influenced by the chosen CG variables, have also been examined.

The CMIE Prowess database has been used to collect data on the Nifty 100 companies over ten financial years from 2013-2014 to 2022-2023. Being a rich repository for data on Indian companies, it is used at large for research and academic purposes, worldwide. This paper doesn't include banks and financial institutions within its scope to avoid complexities owing to difference in accounting methods. It could have otherwise led to deceiving variations in calculation of accounting ratios used for the analysis.

Table 1: Classification of Sampled Firms

Total number of firms	100
Banks and financial institutions (excluded)	21
Sampled firms	79
Family firms	24
Non-Family firms	55

The two measures of firm performance used in the study as dependent variables are- Return on Total Assets (ROTA) and Market value to Book Value (MV/BV). While one measure (ROTA) helps capture the accounting-based dimension of firm performance, the other (MV/BV) is a popular measure for ascertaining the market based financial performance of a firm.

As observed by Saha and Kabra (2019), in situations of econometric testing, the results of ROTA are expected to be more resilient, if the sample might include worst performing firms. This helps the study become robust. Also, in recent years, a lot of studies such as Casper and Gasse (2017), Buallay et. al. (2017), Koji et. al. (2020), to name a few, have used a market based financial measure in their studies to better reflect investor perceptions. It is believed that owing to lesser accounting variations (as the firm has lesser control over it) will enhance the quality of the study.

The explanatory variables are-

- (i) Board size (B_Size)
- (ii) Percentage of Independent Directors (IND)
- (iii) Percentage of Non-Executive Directors (NED)
- (iv) Percentage of Promoter Group Holding of share capital (PGH)
- (v) Family firm (FF)
- (vi) Total Assets (TA)
- (vii) Debt-Equity Ratio (DE)
- (viii) Firm Age (F_Age)

The first three variables help capture CG practice. As noted by Varshney et. al. (2013), board practices of a firm are pivotal to its CG mechanisms. The total number of directors on board, the proportion of non-executive directors to the total number of directors on the board and the proportion of independent directors on the board help gain insightful observations towards the current research endeavour.

PGH helps capture information on the percentage of promoters as equity shareholders. Mishra and Mohanty (2016), stated in their study that this metric serves as a crucial indicator of ownership concentration. Analysing the extent of influence of promoters on decision-making processes, which can significantly impact corporate governance practices and firm performance, can enrich a research manifold.

The study uses a dummy variable- 'Family Firm'. If a sampled firm can be categorised as a 'family firm', it is assigned "1" otherwise, "0". Despite a rich literature available in the domain of family firm research, there is no consensus yet on the exact definition of family firms (Chua, J. H., Chrisman, J. J., & Sharma, P. 1999). This study takes into consideration one of the most used understandings of a family firm, i.e. "a firm is categorized as a family firm when the family/promoter exercises a minimum of 20 percent control in terms of voting rights" (Anderson & Reeb, (2003); Villalonga et al. (2015); Boubker & Sadok, (2021); Sarkar & Selarka (2021)).

Arora and Sharma (2016) had emphasized in their study that certain variables may indirectly impact the outcome of a study. Such selected variables were used as control variables. Debt/Equity was taken as a representative measure for the firms' capital structure (Pavic et. al. 2016). Total assets was used as firm size proxy (Anderson & Reeb (2003); Bauer et. al. (2004); Bhagat & Bolton (2019)). Firm age has also been incorporated so that any potential influence of the same on firm performance can be duly interpreted (Bauer et. al. (2004)).

This study uses descriptive statistics, correlation, and multiple regression analysis. Descriptive statistics provide a summary of the key variables. Correlation analysis examines the relationships between variables. Multiple regression analysis is employed to enable a deeper understanding of their predictive power and interdependencies within the study's context.

As mentioned above, a multiple linear regression model has been used in the study. The empirical model has the following functional form:

$$FP = \alpha_1 + \alpha_2 B\_Size + \alpha_3 IND + \alpha_4 NED + \alpha_5 PGH + \alpha_6 FF + \alpha_7 TA + \alpha_8 DE + \alpha_9 F\_Age + \text{error}$$

Where, FP = Firm Performance characterised by:

- (i) Return on total assets (ROTA)
- (ii) Market value to Book value (MV/BV).

B_Size = Board size

IND = Percentage of Independent Directors

NED = Percentage of Non-Executive Directors

PGH = Percentage of Promoter Group Holding of share capital

FF = Family firm

TA = Total Assets

DE = Debt-Equity Ratio

F_Age = Firm Age

Observation and Analysis

The descriptive statistics of the variables under study has been tabulated and the observations presented in Table 2 below. The findings were helpful in providing an overview of the data distribution and in identifying the outliers of the data set. Overall, it helped enhance data interpretation.

Table 2: Descriptive Statistics

Variable Description	Unit	Family Firm					Non-family Firm				
		Mean	Median	Max	Min	Std Deviation	Mean	Median	Max	Min	Std Deviation
ROTA	Percentage	0.13	0.12	0.62	-0.03	0.13	0.10	0.09	0.46	-0.04	0.08
MV/BV	Ratio	4.82	4.02	23.97	1.71	2.37	3.90	3.22	11.72	0.97	2.66
B_Size	Persons	12.00	13.00	17.00	5.00	2.12	14.00	13.00	22.00	8.00	2.24
IND	Percentage	0.54	0.53	0.80	0.35	0.10	0.44	0.44	0.66	0.17	0.11
NED	Percentage	0.70	0.72	0.91	0.20	0.15	0.59	0.57	0.85	0.19	0.16
PGH	Percentage	0.49	0.50	0.80	0.25	0.16	0.55	0.55	0.90	0.00	0.19
TA	Rs. Million	2,86,969.67	1,25,256.64	23,54,943.96	19,124.32	2,82,622.57	3,66,492.75	2,65,612.85	15,45,291.36	35,783.62	2,86,258.18
DE	Ratio	0.49	0.37	1.69	0.11	0.36	0.41	0.32	1.23	0.08	0.39
F_Age	Years	45.00	43.00	110.00	5.00	22.00	42.00	40.00	102.00	6.00	23.00

Table 3: Correlation Matrix

		ROTA	MV/B V	B_Size	IND	NED	PGH	FF	TA	DE	F_Age
ROTA	Pearson Correlation	1.000	0.256*	- 0.285**	0.277*	0.120	- 0.090	0.652*	0.050	- 0.311*	0.070
	Sig. (2-tailed)		0.029	0.000	0.045	0.152	0.245	0.000	0.374	0.000	0.289
MV/B V	Pearson Correlation		1.000	- 0.608**	0.620*	0.140	- 0.110	0.776*	0.080	- 0.580*	0.100
	Sig. (2-tailed)			0.001	0.037	0.112	0.190	0.000	0.310	0.042	0.201
B_Size	Pearson Correlation			1.000	- 0.040	-0.060	0.090	-0.080	- 0.030	0.040	0.110
	Sig. (2-tailed)				0.412	0.337	0.284	0.315	0.450	0.398	0.178
IND	Pearson Correlation				1.000	0.050	- 0.070	-0.020	0.130	- 0.010	0.150
	Sig. (2-tailed)					0.357	0.328	0.490	0.135	0.532	0.162
NED	Pearson Correlation					1.000	- 0.290*	-0.060	0.050	- 0.150	0.100

	Sig. (2- tail ed)						0.04 8	0.376	0.2 59	0.1 16	0.160
PGH	Pea rso n Cor rela tion						1.00 0	0.080	- 0.1 50	0.0 30	0.090
	Sig. (2- tail ed)							0.256	0.2 14	0.4 16	0.315
FF	Pea rso n Cor rela tion							1.000	0.1 50	0.1 00	0.070
	Sig. (2- tail ed)								0.1 32	0.1 89	0.325
TA	Pea rso n Cor rela tion								1.0 00	0.2 31	0.033
	Sig. (2- tail ed)									0.1 03	0.816
DE	Pea rso n Cor rela tion									1.0 00	0.131
	Sig. (2- tail ed)										0.359
F_Age	Pea rso n Cor rela tion										1.000

	Sig. (2- tail ed)										

Table 4: Correlation Matrix

		ROT A	MV/B V	B_Si ze	IN D	NED	PGH	FF	TA	DE	F_Ag e
ROTA	Pea rso n Cor rela tion	1.00 0	0.256*	- 0.28 5**	0. 27 7*	0.120	- 0.09 0	0.652*	0.0 50	- 0.3 11* *	0.070
	Sig. (2- tail ed)		0.029	0.00 0	0. 04 5	0.152	0.24 5	0.000	0.3 74	0.0 00	0.289
MV/B V	Pea rso n Cor rela tion		1.000	- 0.60 8**	0. 62 0*	0.140	- 0.11 0	0.776*	0.0 80	- 0.5 80*	0.100
	Sig. (2- tail ed)			0.00 1	0. 03 7	0.112	0.19 0	0.000	0.3 10	0.0 42	0.201
B_Size	Pea rso n Cor rela tion			1.00 0	- 0. 04 0	-0.060	0.09 0	-0.080	- 0.0 30	0.0 40	0.110
	Sig. (2- tail ed)				0. 41 2	0.337	0.28 4	0.315	0.4 50	0.3 98	0.178
IND	Pea rso n Cor rela tion				1. 00 0	0.050	- 0.07 0	-0.020	0.1 30	- 0.0 10	0.150
	Sig. (2- tail ed)					0.357	0.32 8	0.490	0.1 35	0.5 32	0.162

NED	Pea rso n Cor rela tion					1.000	- 0.29 0*	-0.060	0.0 50	- 0.1 50	0.100
	Sig. (2- tail ed)						0.04 8	0.376	0.2 59	0.1 16	0.160
PGH	Pea rso n Cor rela tion						1.00 0	0.080	- 0.1 50	0.0 30	0.090
	Sig. (2- tail ed)							0.256	0.2 14	0.4 16	0.315
FF	Pea rso n Cor rela tion							1.000	0.1 50	0.1 00	0.070
	Sig. (2- tail ed)								0.1 32	0.1 89	0.325
TA	Pea rso n Cor rela tion								1.0 00	0.2 31	0.033
	Sig. (2- tail ed)									0.1 03	0.816
DE	Pea rso n Cor rela tion									1.0 00	0.131
	Sig. (2- tail ed)										0.359

	tail ed)										
F_Age	Pea rso n Cor rela tion										1.000
	Sig. (2- tail ed)										

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

Firm performance, in terms of ROTA, shows a significant negative relationship with both board size (-0.285, $p=0$) and the debt-equity ratio (-0.026, $p=0$). Contrastingly, it is significantly positively associated with the percentage of independent directors (0.277, $p=0.045$) and family firm status (0.652, $p=0$). Our findings are indicative of the fact that larger boards and increased debt levels lead to lower ROTA values. On the other hand, companies with a greater proportion of independent directors tend to exhibit higher ROTA values. Our analysis also strengthens the perception that family firms demonstrate better profitability in terms of ROTA.

Firm performance, in terms of MV/BV ratio, is significantly negatively correlated with board size (-0.608, $p=0.001$) and the debt-equity ratio (-0.580, $p=0.042$). Conversely, it shows a significant positive correlation with the proportion of independent directors (0.620, $p=0.037$) and family firm status (0.776, $p=0$). These results indicate that larger boards and higher debt levels are linked to lower MV/BV ratios, while companies with a greater percentage of independent directors showcase better MV/BV scores. Even in the case of firm performance measured through MV/BV, family firms outshine their non-family counterparts.

If the two measures of firm performance are associated together, a positive relation is observed (0.256, $p=0.029$), which suggests that a firm with high returns on total assets would also reflect higher market to book values. Also, a negative correlation is observed between PGH and number of non-executive directors on board (-0.29, $p=0.048$). This gives an indication that firms with higher promoter ownership tend to have fewer non-executive directors. This possibly can further suggest a potential preference for tighter board control by promoters.

Overall, the results highlight the critical role of governance frameworks and ownership structures in influencing firm performance.

A regression analysis was helpful in gaining a better understanding of the variables under study. It helped strengthen the validity of research findings.

When it is ROTA that was considered to examine firm performance, it was seen that the coefficient of percentage of independent directors are showcasing a positive relationship that

stands out to be statistically significant ($\beta = .607, p=0$). This provides an indication that as per the findings on our sample companies, higher the number of independent directors on board, higher would be the return on firm's assets. In a similar manner, the family firm coefficient indicates a positive and significant association ($\beta = .093, p=.004$), highlighting the observation that if a firm is a family firm, their return on assets is enhanced.

The remaining variables showed no statistically significant effect on firm performance, as measured by ROTA.

In the light of MV/ BV, the coefficient of board size reflects a negative, statistically significant relationship ($\beta = -0.232, p=0.001$), indicating that a larger sized board may lead to lower market to book values for a firm. The observation is in line with prior literature reviewed, which emphasizes that smaller boards improve efficiency of a firm due to better communication and coordination prospects. Even the debt-equity ratio coefficient is statistically significant to MV/ BV in a negative manner ($\beta = -0.006, p=0$). This suggests that in terms of investor perception, higher the debt-equity ratio of a firm, lower is the market confidence (Rashid & Kabir 2024).

However, it is to be noted that the coefficient of family firm, has a positive and significant relationship with MV/BV ($\beta = 2.478, p=0$). This helps observe that family firms tend to exhibit higher MV/ BV than non- family firms.

Again, the remaining variables showed no statistically significant effect on firm performance, as measured by MV/ BV.

Table 5: Result of regression analysis

Variables	ROTA	MV/BV	VIF
B_Size	-0.076 (0.512)	-0.232 (0.001)	1.338
IND	0.607 (0)	0.088(0.742)	1.358
NED	0.039 (0.541)	0.154 (0.548)	1.344
PGH	-0.400 (0.681)	-0.163(0.345)	2.688
FF	0.093 (0.004)	2.478 (0)	2.247
TA	0.004 (0.872)	0.225(0.143)	2.986
DE	-0.165 (0.864)	-0.006 (0)	1.106
F_Age	1.653 (0.109)	0.148(0.156)	1.258
R ²	0.569	0.662	
Constant	0.627	0.543	

Conclusion

In this paper, the influence of governance structures and ownership dynamics on firm performance has been investigated using two key metrics- ROTA and MV/ BV. The analysis throws light on distinct patterns in how board composition, debt levels or ownership affiliation affect performance.

Many directors on board and high debt levels are seen to diminish asset returns. However, improved governance through better independent oversight and family involvement were seen

to improve profitability in terms of ROTA. In similar lines, larger boards and higher debt levels were seen to adversely impact market confidence and valuation. But higher proportion of independent directors and family firm status was seen to further improve firm performance in terms of market confidence. The regression results further confirm this trend and reinforce the insights obtained.

Overall, the analysis underscores the critical role of governance structures in shaping firm performance. Firms with effective board governance, particularly through independent directors and family ownership, tend to perform better both in terms of profitability and market valuation, reinforcing the importance of sound corporate governance in driving long-term success.

Future research in a similar domain could explore several related areas. Longitudinal studies examining evolution of governance structures could be undertaken to adjudicate their long-term impact on performance. Sector-specific research can be used to reveal industry-based variations in governance effectiveness. This may offer a deeper understanding of sectoral needs. Cross-cultural comparisons could highlight how different legal, economic, and cultural environments influence governance practices, particularly in developed economies. Additionally, the role of gender diversity on boards could be assessed to understand its impact on decision-making and firm performance in both family and non-family firms. Finally, future studies could investigate how technological advancements, such as artificial intelligence, reshape governance practices and their impact on firm performance. Exploring such research dimensions would surely help develop current research findings. This in turn will help build better comprehension between corporate governance and firm success across various contexts.

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THE EVOLVING DIGITAL MARKETING LANDSCAPE IN INDIA: GROWTH, TRENDS, AND STRATEGIC IMPERATIVES

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Abstract

The widespread adoption of the internet and information technology has significantly accelerated India's marketing and advertising sector's transformation over the past decade. The dynamics of the market have fundamentally changed as a result of this shift, which has elevated digital marketing from an emerging practice to a core business function and created numerous opportunities for business expansion. At a robust compound annual growth rate (CAGR) of 15.3% from 2025 to 2030, the Indian digital advertising market, which was valued at USD 13,632.3 million in 2024, is anticipated to experience substantial and continuous growth, reaching USD 32,328.8 million by 2030. An increasing number of internet users, widespread smartphone use, a flourishing e-commerce industry, and a large, tech-savvy youth population are the primary drivers of this expansion. The necessity of a mobile-first strategy, the rise of visual and video content, the increasing emphasis on real-time engagement and personalization, and the strategic integration of emerging technologies like AI are key trends that are shaping this evolution.

Despite the fact that these trends present the industry with unparalleled opportunities, significant challenges remain. These include bridging the digital divide, ensuring data privacy, managing intense competition, and addressing skill shortages among marketing professionals, as well as navigating India's linguistic and cultural diversity. Understanding and addressing the perceptions and practical difficulties experienced by marketing professionals, as well as encouraging digital inclusion and responsible technology adoption, remain crucial for sustainable growth in the future. To fully benefit from India's dynamic digital marketing future, businesses must implement localized, data-driven, and mobile-centric strategies, invest in talent development, and collaborate with government initiatives.

1. Introduction: India's Marketing Landscape and the Digital Revolution

The widespread influence of the internet and information technology has fundamentally reshaped India's marketing and advertising industry, which has undergone a massive transformation over the past decade. Digital platforms have replaced traditional marketing channels like print and television as a result of this profound shift, redefining market

engagement strategies across the country. The proliferation of smartphones and widespread internet access, which together have created a vast digital environment with more than half a billion internet users, has significantly fueled the digital advertising boom. Brands now have an unprecedented opportunity to connect with a vast and diverse audience that was previously difficult to reach thanks to this rapid digital penetration.

After the COVID-19 pandemic, the shift from traditional to digital marketing became especially apparent. The post-pandemic landscape necessitated a strategic reorientation, despite the fact that many businesses, particularly small- to medium-sized businesses, had historically shown hesitation in fully embracing technology for marketing. During the crisis, brands that switched to digital marketing saw better results and significant cost savings over traditional methods. This compelling evidence solidified digital strategies as a priority, leading to a sustained commitment to digital channels even after the world reopened. In addition to reshaping business operations, this shift has opened lucrative career paths for newcomers in the field by creating a growing demand for digital marketing professionals.

India's adoption of IT and the internet has a number of fundamental effects. The widespread availability of internet access and the rising popularity of smartphones have been the primary drivers behind the country's significant increase in active internet users. India's ongoing progress in connectivity, a general rise in advertising revenues, and favorable government policies that encourage foreign direct investment in the digital sector all contribute to this digital evolution. As a result, India's digital advertising industry is on a solid path to significant expansion, establishing it as one of the world's largest digital markets.

The shift toward digital marketing that has been observed in India is more than just a trend; it is also a fundamental business obligation. In India, digital marketing is no longer an optional or supplementary activity; rather, it is a fundamental requirement for businesses seeking growth, survival, and competitiveness. Companies that don't fully embrace digital transformation and invest in it run the risk of losing a lot of customers and becoming irrelevant in the market.

2. Trajectory of Digital Marketing Growth in India

India's digital marketing landscape today is the result of a dynamic trajectory marked by distinct phases and significant junctures in its development.

Historical Background and Significant Events

As internet use skyrocketed in the 1990s, global players from Western markets initially influenced and dominated digital marketing in India. According to Munshi (2012), the introduction of the internet was seen as an opportunity to improve business and marketing strategies because of the repetitive nature of traditional marketing strategies. As local Indian players emerged, expanding digital marketing services to a wider domestic audience, this dominance began to shift over time. The Indian digital marketing timeline has been defined by a number of significant developments:

- **The decade of the 2010s: The Mobile Internet Revolution** The emergence of the mobile internet marked a turning point, bringing mobile-first strategies into the mainstream. Businesses were able to effectively utilize mobile-based marketing platforms and capitalize on the potential of the local market as a result of this shift, fundamentally altering how consumers engaged with digital content. By 2016, approximately 371 million people in India were using the internet through mobile devices, expanding digital marketing as companies gained a new source to reach customers.
- **2014: Significant Growth in Digital Marketing** After a slow start, this year saw the most significant growth in digital marketing in India, with content marketing also experiencing growth.
- **2016: Facebook's Ascendancy** In 2016, a significant rise in network users established Facebook as India's primary digital marketing channel. Marketers were able to target and distribute content in a more efficient manner because of this expansion, which provided them with a vast user database. The use of social media platforms such as Twitter and Facebook increased significantly as marketers realized the value of social media marketing in attracting readers and customers.
- **2017: The Rise of Video Content on YouTube** The unique presence of YouTube pointed to a growing demand for video content. This trend catalyzed the adoption of multimedia-intensive marketing strategies, with brands increasingly leveraging video for storytelling and engagement. In 2016, visual marketing made a big comeback, which also led to more people using YouTube channels and auto-play videos on Facebook, Twitter, Instagram, and Pinterest.
- **E-commerce and social commerce boom in the 2020s** The emphasis on e-commerce skyrocketed, largely due to social commerce's rapid expansion. Through direct-to-consumer models, businesses were able to engage potential customers by utilizing social platforms for sales and customer interaction.
- **2021: AI-Powered Platform Integration** Indian businesses began actively incorporating AI-powered platforms into their strategies in 2021. This clearly indicated a shift toward more advanced, data-driven digital marketing strategies by aiming to optimize campaign performance and extract actionable insights from vast datasets.

Current Market Size and Future Projections (2024-2030)

The rapid expansion of the Indian digital advertising market positions the nation as a significant global player. The market made USD 13,632.3 million in revenue in 2024. By 2030, the market is anticipated to be worth USD 32,328.8 million, growing at a CAGR of 15.3% from 2025 to 2030, according to projections. Digital advertising is also predicted to grow at a robust 15.6% CAGR, reaching INR 85,000 crore (approximately USD 10.2 billion) in 2028 from INR 41,000 crore in 2023. Internet advertising now ranks second globally and first in terms of growth rate in the Asia-Pacific region. India held 2.8% of the global market for digital advertising in 2024. By 2028, the overall advertising market in India is expected to expand at a CAGR of 9.4%, reaching INR 1,58,000 crore, which is 1.4 times faster than the global average.

Table 1: India Digital Advertising Market Size & Growth Projections (2024-2030)

Metric	Value
Market Revenue (2024)	USD 13,632.3 million
Market Revenue (2030)	USD 32,328.8 million
CAGR (2025-2030)	15.3%
Largest Segment by Revenue (2024)	Smartphone (53.9% share)
Fastest Growing Segment	Smartphone

This table highlights the significant financial opportunity within the Indian digital advertising landscape by providing a clear, quantitative snapshot of the market's current state and projected trajectory. The mobile-centric nature of this growth, which is essential for strategic planning and resource allocation, is immediately reinforced by the recognition of the smartphone as the largest and fastest-growing segment.

The Driving Forces of Growth

There are a number of significant factors driving the expansion of digital marketing in India:

- **Internet Penetration and Smartphone Adoption:** In 2024, India had 886 million active internet users, and that number is expected to exceed 900 million by 2025. India has one of the largest mobile-first digital communities in the world, with over 900 million mobile subscribers in 2023 and a remarkable 96% of Indians using their phones to access the internet. A large and easily accessible online audience has emerged as a result of this widespread adoption, which has been significantly aided by the availability of inexpensive smartphones and data plans.
- **A shift in consumer behavior:** On average, Indians spend 6 hours and 49 minutes per day online, 3 hours and 57 minutes specifically on smartphones. Digital platforms are now absolutely necessary for businesses that want to connect with their target audience because of this significant behavioral shift. The influence of digital channels on purchasing patterns is also highlighted by the fact that consumers are increasingly relying on social media to make decisions about purchases. Through online activities, digital marketing enables businesses to develop and maintain strong relationships with customers, allowing for the exchange of perceptions, concepts, and requirements regarding new products and services.
- **E-commerce Boom:** India's e-commerce industry is expanding at an exponential rate, making it the fastest-growing retail e-commerce market in Asia-Pacific. Brands are using targeted ads to reach customers at the right times during their online shopping journeys, and digital advertising has emerged as a crucial catalyst for driving online sales.
- **Changes in the Demographics:** India has a large millennial and Gen-Z population of over 91 crore people who have access to some of the lowest data rates in the world.

Digital marketing's steady expansion is significantly fueled by this large, young, and tech-savvy population.

- **Government Initiatives:** Programs like "Digital India" have actively pushed for the widespread adoption of digital technologies in a variety of industries, including marketing, creating a supportive ecosystem for digital expansion.

India clearly has a rapidly expanding and engaged digital consumer base, as evidenced by the sheer number of internet users (886 million in 2024), high mobile penetration (96 percent accessing the internet via mobile), and significant daily internet usage (an average of 6 hours and 49 minutes). India's Digital Banking Maturity (DBM) Index surpasses the global average by 20 percentage points, indicating a broader capability and consumer readiness for advanced digital experiences across various sectors in India. The observation that Indian digital champions have outperformed global digital champions across most digital banking journey steps suggests that Indian marketers cannot afford to provide uncomplicated or basic digital experiences. Instead, they must continually invest in cutting-edge user interfaces, highly personalized content delivery, and seamless digital services across all touchpoints. Additionally, the data strongly suggests the strategic necessity of a mobile-first strategy for complete market access. The most significant shift in the Indian digital marketing landscape is the dominance of mobile devices. As a result, businesses must prioritize mobile-first marketing, especially considering that there will be over 900 million mobile subscribers by 2023. The reach and effectiveness of any digital strategy that is not fundamentally optimized for mobile are inherently limited. As a result, mobile optimization must be given top priority in every facet of a company's digital marketing strategy, including application and website development, ad formats, content creation, and user experience. The vast majority of India's digital audience will be missed if a truly mobile-centric strategy is not implemented, which will significantly impede market expansion and penetration.

Table 2: Key Internet and Social Media User Statistics in India (2024)

Metric	Value (2024)
Internet Usage	
Total Active Internet Users	886 million
Projected Internet Users (2025)	>900 million
Internet Penetration Rate	58% of total population
Rural Internet Users	488 million
Urban Internet Users	397 million
Rural User Growth (YoY)	10% (2x urban growth)
Gender Distribution (Male)	53%
Gender Distribution (Female)	47%
Average Daily Internet Usage (Overall)	90 minutes

Average Daily Internet Usage (Urban)	94 minutes
Average Daily Internet Usage (Rural)	89 minutes
Access via Mobile Phones	96% of internet users
Social Media Usage	
Total Social Media User Identities	491 million
Social Media Penetration Rate	33.7% of total population
Average Daily Social Media Usage	2 hours 28 minutes
Gender Disparity (Male)	65.5%
Gender Disparity (Female)	34.5%
Most Popular Social Media Platforms (by usage)	WhatsApp (80.8%), Instagram (77.9%), Facebook (67.8%), Telegram (58.1%), Snapchat (46.9%)

This table provides a foundational and granular understanding of the digital consumer in India. It offers critical demographic and behavioral insights into who is online, how they are accessing the internet, what activities they prioritize online, and their platform preferences. This detailed user data is indispensable for marketers to effectively segment audiences, tailor content, select appropriate channels, and optimize campaign strategies.

3. Dominant Trends Shaping India's Digital Marketing Future

The Indian digital marketing landscape is characterized by several pervasive and evolving trends that are dictating strategic priorities for businesses.

The Mobile-First Imperative

The most significant paradigm shift in the Indian digital marketing landscape is the undeniable dominance of mobile devices. This has made a mobile-first approach not merely an option but an absolute imperative for businesses operating in India. As of 2023, there will be over 900 million mobile subscribers, so there is a great need for mobile-specific marketing strategies.

This is further supported by the fact that a staggering 96% of Indians use mobile phones to access the internet, making India one of the largest mobile-first digital communities in the world. To ensure effective reach and engagement, comprehensive mobile optimization is required across all digital touchpoints, including user interfaces, content strategies, and advertising formats, due to the fundamental reliance on mobile connectivity. The fact that 96 percent of Indians have access to mobile internet strongly suggests that a significant number of people are "mobile-only" or "mobile-primary" users, especially in rural areas. The mobile screen is the primary, if not the only, way for this large portion of the population to interact

with the internet. This suggests that digital advertising and content cannot simply be "adapted" for mobile devices; rather, they must be conceived and designed from the ground up to be natively mobile-focused. This includes taking into account smaller screen sizes, touch interactions, and on-the-go consumption patterns. Therefore, marketers must prioritize highly digestible, visually rich, and frequently short-form content that performs optimally on mobile devices, moving beyond straightforward responsive design to a deeper comprehension of mobile user behavior.

Ascendancy of Visual and Video Content

The rise of visual and video content marks another major milestone in Indian digital marketing. This trend is driven by the increasingly shorter attention spans of consumers and the widespread proliferation of social media platforms like Instagram and YouTube. Video advertisements have become ubiquitous, providing businesses with a powerful medium to convey complex narratives through dynamic storytelling. A significant portion of Indian internet users, approximately 50.4%, watch videos, TV shows, or movies online. The most prevalent types of online video content consumed include music videos (55.4%), comedy, meme, or viral videos (44.1%), and educational videos (37.2%). Platforms like YouTube, with its Shorts feature, and local equivalents like MX Player and ShareChat, have capitalized on the short-form video trend, reflecting a strong preference for easily digestible and entertaining content.

Real-time Engagement and Personalization

Indian digital marketing has reached a critical turning point as a result of the growing significance of real-time engagement. Businesses are increasingly interacting directly with customers in real time thanks to the rise of social media and messaging platforms. This necessitates a highly responsive strategy that enables businesses to promptly respond to customer inquiries and establish long-term relationships. This process is further optimized by AI-powered chatbots and personalized content, allowing for relevant, immediate interactions. Personalization as a core marketing strategy is closely linked to real-time engagement. Businesses are now using individual user preferences and actions to tailor messages across various digital marketing channels. The availability of robust data analytics and AI technologies, which enable brands to provide individualized recommendations, diverse content offerings, and bespoke experiences, is inextricably linked to this trend. For instance, leading e-commerce platform Myntra excels in email marketing by sending personalized reminders to customers who have abandoned their carts and suggesting comparable products based on previous purchases, demonstrating a strong focus on individual customer journeys.

Integration of Emerging Technologies

A significant epoch in India's digital evolution is the incorporation of emerging technologies into digital marketing strategies. The Internet of Things (IoT), Virtual Reality (VR), and Artificial Intelligence (AI) are rewriting the rules and opening up new opportunities for engagement and productivity. Businesses that have successfully integrated these innovations

have gained a competitive edge. By processing and interpreting large datasets to provide actionable insights, AI, in particular, is revolutionizing digital marketing by facilitating effective personalization and enhancing predictive analytics capabilities. According to Deloitte's reports, AI is reshaping enterprise architecture for greater adaptability and automation, and Indian businesses are increasingly adopting small, multimodal AI models for faster, more effective, and targeted solutions. By 2025, over 70% of global businesses are anticipated to adopt Generative AI (GenAI), which is also anticipated to transform content creation, personalization, and monetization.

Leveraging Social Media and Influencer Marketing

Indian digital marketing is moving forward thanks to social media platforms. Facebook (67.8%), Instagram (77.9%), and WhatsApp (80.8%) are the most popular platforms, making them important channels for brand promotion, customer engagement, and lead generation. Businesses can use user personas to create targeted, audience-focused marketing strategies thanks to these platforms' popularity. For instance, Dove has mastered social media marketing by launching campaigns like "The Dove Self Esteem Project" and "#letschangebeauty" that are original, relatable, and engaging. These campaigns promote inclusivity and self-acceptance and have a profound impact on users and generate a significant amount of positive feedback. Brands are increasingly turning to content creators to engage with a wide range of audiences, which has led to the rise of influencer marketing. To connect with customers on a very personal level, this strategy makes use of the huge amount of influence that social media personalities have. India's investment in influencer marketing increased by 16% (or \$40 million) to \$290 million in 2024, demonstrating its effectiveness.

Growth of E-commerce and Social Commerce

Digital advertising has benefited greatly from India's booming e-commerce industry. Brands are making use of targeted digital ads to effectively reach the growing number of online shoppers. E-commerce sales in India are expected to rise significantly, from \$14 billion in 2015 to \$71.94 billion in 2022, making it the Asia-Pacific region's fastest-growing retail e-commerce market. This expansion has been further fueled by social commerce, which enables seamless purchasing experiences and direct-to-consumer models by integrating e-commerce directly within social media platforms.

Localization of Content

Businesses have realized how important it is to localize content because of India's unique fragmented market with numerous regional languages and cultural differences. Because it works well with a wide range of demographics, this strategy makes sure that marketing messages are culturally and linguistically appropriate. In 2024, 870 million internet users—98% of all internet users—accessed content in Indic languages, with 57% of urban users preferring Indic languages, highlighting the significance of local language content. By adapting campaigns to local languages and cultures, this strategy enables brands to reach previously unreachable audiences in semi- and rural areas.

4. Challenges and Considerations for Sustainable Development

For sustained growth and development, the Indian digital marketing landscape has a number of obstacles that must be navigated strategically, despite the abundance of opportunities. The need for additional research into sustainable development is emphasized in the abstract. It is of the utmost significance to comprehend the perceptions held by marketing professionals.

Challenges Faced by Digital Marketing Companies and Professionals

Digital marketing companies and professionals in India face a unique set of hurdles stemming from the country's diverse market, rapid technological advancements, and cultural intricacies.

- **Barriers to Language and Culture:** India's linguistic diversity, which includes a number of regional languages and dialects, makes it hard to make content that everyone can understand. Effective digital marketing campaigns require an understanding of and consideration for the cultural sensibilities of various regions, as a one-size-fits-all approach frequently fails.
- **Penetration of the Internet and the Digital Divide (especially in rural areas):** Although internet access is improving, many rural areas still lack it, limiting the reach of digital marketing campaigns. Due to the persistence of infrastructure deficiencies in remote areas, such as unreliable electricity and limited internet connectivity, bridging the digital divide between urban and rural areas remains a significant challenge.
- **Evolving Technology Landscape and Algorithm Updates:** The rapid pace of technological advancements and ongoing algorithm updates for search engines and social media platforms necessitate constant adaptation and can have a significant impact on campaign performance. Continuous investment in agile strategies and skill development is required to keep up with these changes.
- **Data Security and Privacy Concerns:** As digital advertising becomes increasingly data-driven, there are growing concerns about consumer privacy and data security. Companies in India are required to adhere to stringent data privacy laws like the Personal Data Protection Bill. To effectively utilize personalization, it is necessary to establish and maintain consumer trust in the face of these concerns.
- **Competition and Market Saturation:** There are a lot of agencies competing for clients in the Indian digital marketing landscape. It is more difficult for smaller businesses to compete effectively because of this intense competition, which frequently results in price pressures and reduced profit margins.
- **Measurement and Attribution Complexity:** India's complex digital ecosystem can make it difficult to accurately attribute conversions to various marketing channels. Data quality can be inconsistent, making it essential for effective campaign measurement and optimization to ensure its accuracy and dependability.
- **Talent Acquisition and Retention:** Due to intense competition and a current talent shortage, it is challenging to locate and retain skilled digital marketing professionals in India. Companies can't afford to lose ground if they don't invest in employee training and development on a regular basis.

- **The Art of Persuasion and Strategic Cultivation of Prospective Customers:** Marketing professionals face a primary obstacle in mastering the art of persuasion and strategically cultivating prospective customers. Digital media can be used to increase customer engagement and conversation, addressing this issue.
- **Online product reviews have a smaller impact:** It's interesting to note that online product reviews have a smaller impact on people's purchasing decisions in India. Because personal recommendations from friends and family are frequently regarded as having greater weight than online reviews, this suggests that businesses may need to investigate a variety of different strategies in order to influence consumer decision-making.

The literature lacks a comprehensive understanding of business and marketing managers' perspectives on the significance or benefits of digital marketing for businesses. There are insufficient qualitative and quantitative studies to comprehend managers' perceptions and the effects of shifting trends. Marketing professionals can be both enthusiastic and skeptical about the significance of digital marketing, according to studies. As a result, there is a lack of research on including marketing professionals' perspectives on the development of digital marketing.

Sustainable Digital Transformation in India

Achieving sustainable development in India's digital marketing sphere requires addressing fundamental obstacles, particularly in rural areas, and aligning with consumer perceptions of sustainability.

Obstacles to Sustainable Digital Transformation:

- **Deficits in the Infrastructure:** The absence of solid infrastructure remains a significant obstacle, particularly in rural and remote areas. Digital inequality is exacerbated by the fact that many regions still lack access to affordable cellphones and high-speed internet.
- **Digital Literacy:** Many people in rural India are unable to use digital platforms, financial instruments, or e-commerce effectively due to a lack of fundamental digital literacy. According to a NASSCOM study, nearly 90% of rural workers lack digital literacy, highlighting a significant gap that necessitates focused efforts.
- **Affordability:** Although the price of technology is falling, many rural households below the poverty line still cannot afford it.
- **Cultural Resistance:** There is a degree of resistance to change in many rural areas, particularly when it comes to unfamiliar technology.
- **Problems with Connectivity:** In remote and difficult-to-reach areas, poor connectivity restricts access to mobile networks and the internet.

Consumer Perceptions of Sustainability and Challenges in Sustainable Shopping:

In contrast to global consumers, Indian consumers emphasize that "one size does not fit all" when it comes to sustainability. Despite the fact that environmental concerns are widespread

and growing (64 percent of Indian consumers raised their concerns over the past two years), rather than relying solely on news articles or documentaries, their motivations are frequently influenced by personal experiences with environmental issues and social media. When it comes to sustainable shopping, consumers face a number of obstacles, such as difficulty locating information regarding sustainability, labels that are ambiguous, the prevalence of products that are only partially sustainable, a lack of availability, and concerns regarding affordability. If they were readily available and affordable, they would purchase more sustainable goods.

Strategic Imperatives for Brands and Government for Sustainability:

- **Personalize Products and Messages:** Brands must recognize that Indian consumers place a high value on health, quality, and affordability. These fundamental principles should guide the development of sustainable products and messages.
- **Deal with recycling and collection:** Indian consumers frequently repurpose packaging and have a stronger preference for environmentally friendly packaging, particularly paper. Brands should make it clear and simple to dispose of products, increase reusability and recycleability, and reduce waste.
- **Work with the government:** In India, government programs have successfully influenced public attitudes and actions toward sustainability. Brands have a greater chance of influencing change than they do through private-public partnerships because the government is working on policies governing carbon credits and promoting sustainability reports.
- **Establish Channel Partnerships:** By ensuring the widespread availability, accessibility, and prominent display of sustainable products, partnerships between retailers and brands can nudge consumers toward sustainable choices.

5. Conclusion and Recommendations

The digital marketing landscape in India is undergoing a transformation that has never been seen before. It is marked by rapid expansion and significant shifts in consumer behavior. Market dynamics have fundamentally changed as a result of the widespread adoption of smartphones and the internet, shifting marketing from traditional platforms to digital ones. A sign of this development is the digital advertising market, which is expected to expand at a CAGR of 15.3% to 15.6% through 2030. India's vast and increasingly digitally savvy consumer base, the pervasive mobile-first environment, the boom in e-commerce and social commerce, and the strategic integration of cutting-edge technologies like AI are the primary drivers of this expansion. However, a nuanced comprehension of both the opportunities and the inherent challenges is necessary for sustained development in this dynamic environment. In addition to overcoming language and cultural barriers, bridging the persistent digital divide in rural areas, adapting to a rapidly evolving technological landscape, ensuring stringent compliance with data privacy regulations, navigating intense market competition, and addressing critical talent shortages, the industry faces significant challenges. From the point of view of professionals in marketing, it is difficult to successfully persuade and cultivate potential customers in a market where personal recommendations still hold a significant advantage over online reviews.

Several concrete recommendations emerge for businesses and policymakers to implement in India to encourage the sustainable growth of digital marketing:

- **Give Mobile-Centric Strategies Priority:** Since nearly all Indian internet users access content through their mobile devices, all digital marketing efforts need to be designed and optimized for mobile-first consumption.
- **Make an Investment in Content that is Localized and Culturally Relevant:** For brands to successfully penetrate India's diverse market, particularly the untapped rural and semi-urban areas, content localization must be a top priority. This means coming up with campaigns that are not only linguistically correct but also deeply resonate with cultural nuances and sensitivities specific to the region.
- **Make use of AI and data analytics for hyper-personalization:** Indian customers' increasing digital maturity necessitates highly personalized experiences. To gain useful insights from consumer behavior, businesses should make significant investments in AI-powered platforms and advanced data analytics. This makes it possible to provide individual recommendations, individual content, and responsive real-time engagement.
- **Close the Digital Divide and Increase Digital Literacy:** In order to achieve truly inclusive and long-term growth, it is necessary to intensify efforts to close the digital divide, particularly in rural India. Businesses, the government, and educational establishments must work together to improve internet connectivity, digital literacy programs that address affordability and cultural resistance, and digital infrastructure.
- **Support Talent Development and Retention:** Strategic investments in training and development programs are necessary due to the rising demand for skilled digital marketing professionals. In order to cultivate a talent pipeline with the most recent digital marketing skills, businesses should collaborate with educational institutions.
- **Integrate Sustainability as a Core Value Proposition:** Instead of treating sustainability as merely a marketing ploy, brands must incorporate it authentically into their core value propositions, in line with the health, quality, and cost priorities of Indian consumers. This requires eco-friendly product and packaging solutions and open communication about sustainable practices.
- **Strengthen Public-Private Partnerships:** For systemic challenges to be addressed and sustainable practices to be promoted, brands, retailers, and government agencies must work together. A more robust and trustworthy digital ecosystem can be created through joint initiatives in infrastructure development, digital literacy campaigns, policy advocacy for data privacy, and ethical advertising, driving collective progress toward a digital India that is developed sustainably.

Businesses can take advantage of the enormous growth potential of India's digital marketing landscape while also contributing to its long-term equitable and sustainable development by strategically addressing these requirements.

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ADOPTION WISE VARIATIONS IN TECHNICAL EFFICIENCY OF POND AQUACULTURE IN WEST BENGAL

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Abstract

Despite constant effort to augment pond aquaculture in West Bengal through improved technologies, training and extension activities, low level of technology adoption clearly indicates that fish farmers were either not adopting laboratory-generated technologies or modifying such technologies to suit their existing resource position. Reasons behind farmer's tendency not to adopt or partially adopt the improved technologies can help to increase adoption intensity of pond aquaculture technologies in West Bengal. Current study, based on primary survey, has revealed that level of adoption was as low as 76 per cent and there was ample variations in intensity of adoption. In order to explore the effect of adoption intensity upon technical efficiency score of farmers, data envelopment analysis has been undertaken. Applying meta-frontier technique, grand and group technical efficiency score has been calculated. Results indicate that technical efficiency score was increasing directly with the increase in the intensity of adoption of improved technologies. For intensive farmers, such intensity was found as high as 0.834, whereas traditional farmers could score adoption intensity as low as 0.362. In order to investigate the impact of socio-economic characteristics, pond size and extension contacts upon technical efficiency score, multiple regression analysis using the ordinary least squares (OLS) method was followed. It is found that size and income of fish farms; educational level of farmers and extension contact were directly correlated with adoption of the fish production technologies, while age of fish farmers was negatively associated. Since extension activities has been found positive impact on adoption intensity, more farmers group visit system and field school approach should followed by the government. Financial assistance like interest free loans should be facilitated so that fish farmers can able to adopt costly innovations of scientific aquaculture technologies.

Keywords: *Modern culture practices, Technical efficiency, Meta-frontier analysis, Determinants of adoption.*

JEL Classification: Q22, C61.

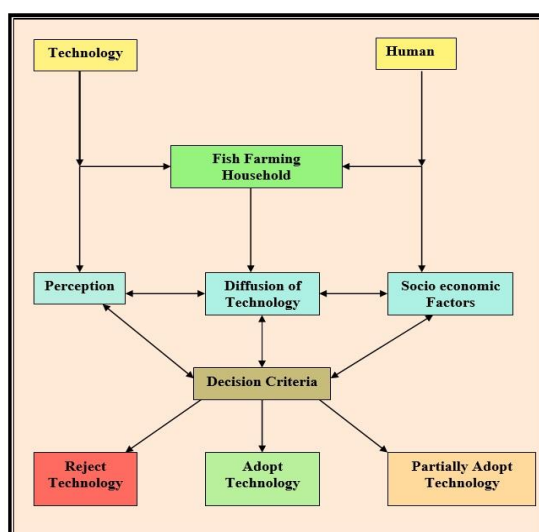
1. Introduction

West Bengal is the leader of producing fish in India, contributing 1.17 million tonnes of fish each year. Though pond aquaculture shares considerable portion of fish production in the state, the productivity of the sector is slowing down over the years. The sector contributes to the livelihood of over 14 million people, most of whom falls under economically underprivileged category of population. No doubt, among the major states in India, West Bengal has been extending several facilities for expansion of culture fisheries, such as fish seed supply at

cheaper rate, training programme for farmers, subsidies for renovation of tanks as also some welfare measures. Along with these, Fish Farmers Development Agencies (FFDAs) had been established to help the fish farmers with necessary technical, financial as well as extension support in order to augment pond aquaculture through improved modern scientific culture practices. Different studies on the performance of FFDAs amply demonstrate that the productivity in water bodies under FFDA programmes is sufficiently higher (10-15 mt/ha/yr) than that in non-FFDA ponds (Srivastava et al, 2005), which results the mean pond productivity at about two and half tonnes per hectare yearly. It has also been debated in many research that proper percolation of extension services could enhance pond productivity up to four tonnes per hectare. Considering the availability of technological strength and resource potentiality of the Indian farmers, it is feasible to enhance the mean pond productivity to 4 tonnes/ha/yr in the next ten years is feasible (Ayyappan et al, 2009). Hence, it is evident that the adoption level of modern culture practice is tardy and arbitrary in the state.

Arbitrary technology adoption and the resultant less fish productivity clearly indicates that laboratory-induced production technologies and extension services provided by the institutional personnel were either not fabricating the anticipated result or not being accepted by the farmers. In any case, these two facts are mutually correlated. Because, rejection of a particular technology, after being practised would help the extension personnel to understand the basic difficulties with the existing technologies and thereby modify technology for farmer's interest. Hence, fish farmer's decision to adopt improved technologies is elementary as well as apparent as farmer's perception regarding new technology not only depends on whether technology is economically or environmentally sound; rather the technology is capable to serve their best interest. Diagram 1 demonstrates the basic factors involved in the farmer's decision making process towards adoption of new technology. Usually, fish farmer's decision to reject new technology may occur either from their inability or from unwillingness or both, based upon their utility consideration of income and food security (Batz *et al.*, 1999). Therefore, socio economic background of the farmers also highly influences the rate of adoption of modern aquaculture practices.

Diagram 1: Framework for Farmers Decision Regarding Adoption of New Technology



Another important observation regarding technology adoption by the fish farmers is that improved aquaculture technology may not produce desired positive results because of the selectiveness on the part of the farmers to adopt only a part of the recommended package of the technology. Sometimes, farmers select, reject, modify or re-innovate recommended package to suit their resource position, their acquired knowledge from aquaculture practices, their socio-economic background or financial capability. Sometimes, “the farmer’s decision for or against the adoption of any science-based production technology was described as a mental process, consisting of several stages” (Ofuoku et al., 2005). The educational level, size of the fish farm, income from pond aquaculture business, and extension activities - all are tangled in this process and thereby inter-related with adoption of the fish production technologies. Whether farmers are tradition-bound or progressive depends closely on their socio-economic background. Hence, decision regarding diffusion of new technology by the fish farmers is usually decided upon interaction between perception on this introduced technology and socio-economic characteristics of the farming households (diagram 1). As a result, adoption of new aquaculture technology and the problems and challenges they faced has heterogeneous success rate in terms of efficiency and productivity of their business (Wetengere, 2010). The objective of this paper, therefore, is to examine the nature of adoption of fish farming technologies to determine how technology adoption by the fish farmers affects their technical efficiency (ability to produce optimal output with the use of existing inputs) in fish production and then to identify the variables which govern the adoption of a acclaimed package of pond aquaculture technology.

2. Materials and Methods

2.1 Sample size selection

This study is based on primary source of information obtained through field survey from representative respondents of 4 districts, each from four major out of six agro climatic zones of West Bengal, purposively selected due to their proximity to modern aquaculture practices. Now, block wise full details of fish farming in these 4 districts comprising water area (ponds) available, fish production, nature of technology adoption and culture details have been collected for drawing representative sample of blocks. In the next stage, 3 blocks was randomly selected from each district. Finally, from comprehensive list of pond operators of each block, farmers are categorized into three sub-groups, namely, small (having pond size less than 0.5 acre), medium (pond size between 0.5 to 5 acre) and large pond owner (holding pond of size more than 5 acre). From each village, 10 fish farmers from each size group (that is, small, medium and large) have been randomly selected. In this way, 30 respondents from each block were chosen. Thus total number of respondents from each district is 90 and final sample size for the state as a whole became 360. The study was carried out in July-August of 2024 on the basis of simple random sampling survey with the help of pre-designed semi-structured questionnaire to all the respondents selected. The data pertaining to yield during the period, type and extent adoption behaviour, information on fish seed, feed, labour as also some other inputs, information on fish outputs produced and some other micro-details are culled for one production year.

2.2. Analytical Framework

The descriptive variables were analysed using different measurements like number, percentage distribution, mean and standard deviation and data were collated in tabular form using version 20 of SPSS. The impact of adoption intensity on technical efficiency score of fish farmers were investigated using meta-frontier production function approach of Data envelopment analysis (DEA). The said methodology examines systematic difference, if any, in the efficiency score of fish farmers due to different levels of technology adoption (Hayami, 1969; Hayami and Ruttan, 1970).

In this analysis, individual fish firm's performance in the sample is calculated against two different frontiers. One frontier is based on fish firms from all the different groups in the sample and the other frontier is based only on firms from the group to which it belongs. The first can be regarded as the *grand* frontier and the other as the *group* frontier. The grand and the group frontiers can be defined as follows. Let us define the index set $I = \{1, 2, \dots, N\}$ where each experiential data point is an element of I . Now, let us consider a partition $I = \bigcup I_r$ where I_r comprises only observations from group r . if the standard assumptions of convexity and free disposability of inputs (x) and outputs (y) holds true, then the empirically constructed group and grand production possibility sets are respectively. Since each S^r is a subset of S^G , the latter is bigger than the union of the individual group production possibility sets. For the overall or grand efficiency of the fish farms in the sample, we solve the following LP problem, including all 360 farms from observation as –

$$S^r = \{(x, y) : x \geq \sum_{j \in I_r} \lambda_j x^j; y \leq \sum_{j \in I_r} \lambda_j y^j; \sum_{j \in I_r} \lambda_j = 1; \lambda_j \geq 0 (j \in I_r)\} \text{ (for group } r\text{)}$$

And

$$S^G = \{(x, y) : x \geq \sum_{j \in \bigcup I_r} \lambda_j x^j; y \leq \sum_{j \in \bigcup I_r} \lambda_j y^j; \sum_{j \in \bigcup I_r} \lambda_j = 1; \lambda_j \geq 0; (j \in \bigcup I_r)\}$$

$$\underset{\lambda^j, \theta^j}{\text{Minimize}} \theta_G^j$$

Subject to –

$$\sum_{j=1}^{360} \lambda^j Y^j \geq Y_0^j \text{ (output constraints)}$$

$$\sum_{j=1}^{360} \lambda^j X_k^j \leq \theta_G^j X_k^0 \text{ (inputs constraints, } k\text{)}$$

$$\sum_{j=1}^{360} \lambda^j = 1$$

$$\lambda^j \geq 0, j = 1, 2, \dots, 360$$

Where, θ_G^j is the dual of the variable indicating proportional increase in output possible by firm j; or Grand technical efficiency, TE_G^j .

λ^j = shadow price (weight or intensity variable) used to originate all likely linear combinations of the sample observations.

Y_0^j = Actual output produced by firm j.

X_k^0 = Actual input use by firm j

Similarly, the relevant DEA model for group r with N_r fish farms in the sample is –

$$\underset{\lambda^j, \theta_r^j}{\text{Minimize}} \quad \theta_r^j$$

Subject to –

$$\sum_j \lambda^j Y^j \geq Y_0^j \quad (\text{output constraints})$$

$$\sum_j \lambda^j X_k^j \leq \theta_r^j X_k^0 \quad (\text{inputs constraints, k})$$

$$\sum_j \lambda^j = 1, \quad \lambda^j \geq 0,$$

Where, θ_r^j specifies proportional increase in output possible by firm j (dual of the variable); or the group technical efficiency, TE_r^j . A point wise measure of technical efficiency of group r relative to the grand frontier evaluated at the input-output data of farm j is –

$$\beta_r^j = \frac{TE_G^j}{TE_r^j}$$

An overall measure of the efficiency of group r is –

$$TE(r) = \left(\prod_{j \in r} \beta_r^j \right)^{1/N_r} \quad \text{where } N_r \text{ is the number of farms in group } r.$$

Clearly, performance for any fish farms j relative to other farms within the same group r is TE_G^j . On the other hand, β is a measure of its performance compared to all groups in the study. Technical efficiency score of fish farm within each group was estimated separately based on their individual frontier and also based on the grand frontier comprising all the observations

taken together. Index of intensification efficiency broadly reflects the effects of adoption behaviour on the technical efficiency of a fish farm.

3. Results and discussions:

3.1 Level of Adoption of Improved Aquaculture Practices:

The adoption level of improved aquaculture practices by the fish farmers has been tabulated in the exhibit 1. In this study, adopter-operators has been defined as those operators (or fish farmers) who adopt the practices like pre-stocking, stocking, input applications like lime, toxicants, manures, fertilizers, application of supplementary fish feeds, harvesting etc. The computation revealed that almost 21 per cent of total farmers had not adopted any modern culture techniques to improve farm productivity. 23 per cent of total sample went for full adoption, but partial adoption of modern culture practices was quite high (more than 55 per cent) among the farmers. Almost 40 per cent of the small farmers had not adopted any scientific culture practice. Adoption of full package of practices is highest (38.33 per cent) among large farmers. Partial implementation of package is highest among medium size of farmers (62.5 per cent). The adoption rate had increased positively with the size of ponds. A total of six different improved aquaculture technologies mostly practiced by respondents was studied, namely formulated use of feed, correct stocking density, TSP use in the pond, polyculture of carp, polyculture with small indigenous fish species and culture of mono-sex tilapia. According to their application by the respondents, an adoption score index was constructed by the number of stages followed by fish farmers. The adoption score was arrived at, by dividing the overall mean adoption score by the number of adoption stages. The results indicate that the level of adoption was low since a total of 76 per cent of the fish farmers fell under the low adoption category. This is confirmed by the adoption score and index that are likewise low.

Exhibit 1: Percentage Distribution of Fish Farmers Adopting Modern Culture Practices

Adoption Intensity	Frequency			
	Small (N=120)	Medium (N=120)	Large (N=120)	All (N=120)
Full Adoption (Intensive)	07 (5.83)	33 (27.5)	46 (38.33)	86 (23.88)
Partial Adoption (Semi-intensive)	66 (55.00)	75 (62.5)	58 (48.33)	199 (55.27)
No adoption (Traditional)	47 (39.17)	12 (10.0)	16 (13.33)	75 (20.83)
Adoption Score	0.27	0.53	0.46	0.42

Source: Field Survey, 2007-08

Note: Figures in parentheses indicate percentage of respective totals

As such, adoption rate had been found highest among medium farmers (0.53), followed by large (0.46) and small (0.27) farmers. This is recognized to the traditional training since farmers were not participating in visit system by the extension agents. The low adoption of innovations is an index of the poor extension approach to improved aquaculture development. One important observation in this regard is that most of the fish farmers, even though they tend to adopt, did not use the inputs in accordance with proportions and schedules recommended by the technical experts. They normally chose only those combinations of inputs that suited their resource position best.

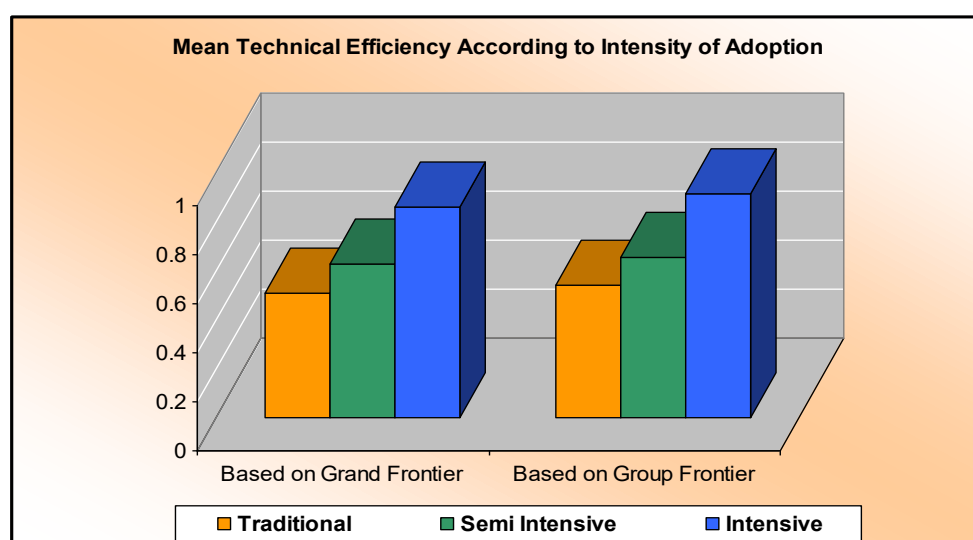
4.2 Adoption Wise Variation in Technical Efficiency

Now, grand (overall) and group (according to intensity of adoption) technical efficiency have been calculated and represented in exhibit 2. From the exhibit, it has been found that, in general, average TE scores were higher among intensive systems. Based on group frontier, the average TE scores of semi-intensive and intensive farms are 0.649 and 0.907 respectively, but that for extensive farms were only 0.537. The trend of results has appeared almost similar when TE was measured based on grand frontier. Clearly, technical efficiency varied directly with the increase in adoption intensity, so also the adoption efficiency. There are considerable differences in adoption efficiency among the different groups. Adoption efficiency was found 0.834 for intensive farmers, whereas the corresponding figure was as low as 0.362 for traditional farmers. Frequency distribution of mean technical efficiency scores for both group and grand frontier is shown in figure 6.2. It is widely stated that the fish farming involves the use of certain 'cultural practices' to obtain the maximum yield. No doubt, intensive composite fish culture involves a high degree of skill. But it is observed that fish culture is practised in a very neglected and arbitrary manner; as a result of which, technical efficiency had been found measurably low. Only a small percentage of the adopter-operators in our sample have been found to follow strictly the uses of inputs in accordance with the schedules and doses. In the sample studied, only 11 per cent of the adopter-operators followed preparatory operations like de-weeding, desilting and eradication of predators and weed fishes. Only 7 percent cultivators used toxicants; 61 per cent of the water had weeds and only 5 per cent of the water units were renovated. The species-mix in seed and the stocking rate – the two major determinants of yield – were not strictly followed. The operators liberated different species of carps without maintaining right proportions. They could not procure quality fish seed. It was also reported that the average survival from spawn to fry stage is about 30 per cent which is very low. Netting and soil testing were seldom done. It is also to be noted that use of fertilizers and supplementary feed, which indicates the inability of the users to bear higher cash expenses for cultivation and their ability to bear risk, was not made properly. Only 10 percent of the adopter-operators were found to follow the suggestions made in this regard. Manures for maintaining healthy atmosphere in tank were seldom given. Organic manures were used by about 70 per cent of the operators (the most common being cow dung). Unfortunately, it is also observed that about 95 percent of the fish farmers in our sample fed their fish irregularly. The most commonly reported fish feed were rice-bran, leftover cooked rice or fresh cow dung, etc. All these findings lend credence to the fact that the level of adoption of technology is insufficient, and the input-mix is sub-optimal.

Exhibit 2: Mean Technical Efficiency of Fish Farms Across Adoption Intensity

Region	No of Fish Farms	Mean Technical Efficiency		Adoption Efficiency
		Based on Grand Frontier	Based on Regional Frontier	
Traditional (No Adoption)	86 (23.88)	0.504	0.537	0.362
Semi Intensive (Partial Adoption)	199 (52.28)	0.623	0.649	0.471
Intensive (Full Adoption)	75 (20.84)	0.854	0.907	0.834
Total	360	0.628	0.694	0.520

Diagram 2: Frequency Distribution of TE Score by Adoption Intensity



4.4 Constraints behind Unsatisfactory Adoption

As to why fish farmers are tardy in adopting package of practices becomes clear from the information given in the following Exhibit 4. Perhaps the most important reason for non-adoption is the financial difficulties. A sizeable percentage of operators (more than 77 percent) have reported this problem. Almost half of the operators are facing problems regarding multiple ownerships. Risk factor and failure to provide extension services to provide information also account for the non-adoption. About 56 per cent of the operators consider risk factor as a deterrent for adoption. To sum up, the data reveal that the major causes for non-adoption are the perception of risk factor, cost factor (or financial difficulties) and lack of information.

Risk involved in adopting intensive practices is greater in the sense that it increases proportionately along with an increase in the cost of cultivation. Again, why some operators perceive higher risk in adopting modern practices entailing high costs may be that, in terms of yield, their performance falls much below expectations for various reasons. Consequently,

while costs mount up, benefits remain low; the apprehensions about risk and loss thus become real.

As regards biological and environmental hazards, it is important to note that though initially unwanted predatory fishes or animals can be removed, they may reappear. This poses serious biological hazards. Another serious problem in regard to algal blooms occurring in the ponds is that it creates ‘super-saturation’ in oxygen levels during day and oxygen ‘depletion’ during night. This sometime leads to mass mortality. The ‘fear psychosis’ of possible occurrence of fish diseases among fish farmers coupled with the lack of fish hospitals is an impediment.

Exhibit 4: Reasons for Non-adoption of package of practices

Questions regarding Nature of Constraints	Yes		No	
	Frequency	%	Frequency	%
Are you facing financial difficulties	280	77.7	80	22.3
Is there lack of availability of quality seed	161	44.7	199	55.3
Is plurality of ownership a problem	178	49.4	182	50.2
Is risk factor acting as fear-psychosis	201	55.8	159	44.2
Is there lack of Proper Extension Services	139	38.6	221	61.4
Is high Price Spread a problem	65	18.1	295	81.9

Source: Field Survey, 2007-08

The operational features of the new technology should be examined against the backdrop of prevailing organizational basis of individual water units and pisci-culture as a whole. The new technology is scale-neutral, no doubt; but two problems arise with the farmers in this context – one, as a proposition involving higher cost per acre and second, as a proposition involving more working capital than usual. In this context, there arises the question of financial support necessary to internalize the external economies. The Government of West Bengal through FFDA schemes has made arrangements for giving loans and subsidies to adopt modern intensive fish culture. But, the success behind such arrangements are not quite satisfactory. There is wide gap between farmers who want to receive assistance and those who actually received it. The following exhibit 5 gives the distribution of fish farmers for whom assistance is needed by type of assistance. It is found that finance is the most important component of assistance needed by the farmers. More than 83 per cent of the sample farmers need financial assistance. Technical advice and services are also important component of assistance, which about 63 percent of the farmers expressed desire to receive. Another important component of assistance, which the fish farmers desired to obtain, is the regular supply of quantity of inputs and arrangements for different infrastructural facilities. 32 per cent of the fish farmers under study need those kinds of facilities. Desire to receive marketing facilities has been expressed by 83 per cent of the sample farmers.

Exhibit 5: Distribution of the Fish Farmers who needed and Received Assistance

Types of Assistance	Number and Percentages of Farmers			
	Needed		Received	
	Number	%	Number	%
Finance	302	83.89	22	6.11
Technical advice/service	227	63.06	140	38.89
Supply of fish feed and other inputs	117	32.5	86	23.89
Others (marketing facilities)	318	83.33	7	1.94

Source: Field Survey, 2006

But unfortunately, it is revealed from the exhibit 5 that only a small proportion of the fish farmers received considerable assistance of any kind. In the case of finance, most of the fish farmers could not able to manage it (77.78 per cent). Technical advice and marketing facilities leave much to be desired. Input supply at cheaper rate has been received by 23.89 per cent of the farmers. 24.17 of the farmers, who want to receive technical advice from extension personnel has been deprived. Only 1.94 per cent of the sample farmers have received marketing facilities. Registered and regulated markets are found to be conspicuous by their absence.

Exhibit 6: Percentage Distribution of the Fish Farmers – Not Receiving Assistance with Reasons thereof

Reasons	Financial Assistance	Extension Services	Quality Seed	Marketing Facilities
Did not know	21.24	12.13	06.38	24.89
Know but did not try	17.34	46.27	17.37	09.38
Tried but failed to receive	56.73	27.23	38.91	27.92
Reluctant due to cumbersome procedure	04.69	14.37	17.34	37.81

Source: Field Survey, 2006

As regards the reasons for the unsatisfactory availability of assistances, it is clear from the following Exhibit 6, for example, that quite a significant proportion of the fish farmers interviewed were not in the know of the financial assistance programmes (21.24 per cent), even though 56.73 per cent of the respondents applied and did not receive financial assistance. 46 per cent of the respondents did not even try for technical assistance or extension services, even though fish seed has been received and used by a significant proportion (20 per cent) of the fish farmers. The rest who did not receive was mainly because of the fact that they did not even try (38.91 per cent of those who did not receive). Marketing facilities through appropriate network have not still developed. Again, cumbersome procedure for applying for receiving assistance also acts as a deterrent factor for the purpose of receiving different assistances from the Government agencies.

5. Conclusion and Policy Formulations

Findings of the study have shown that adoption rates of modern culture practices are measurable low. Household's food and nutritional security was contributed by farmer's allocation of resources to those activities. For that they sometimes adopt only a part of package

of practices and end up with low level of technical efficiency. Though technical efficiency of the farmers under study is positively related with intensity of adoption, diffusion of technology extended by FFDAs has been found to be limited or sometimes absent. Actually, it has not been taken care of that lab generated technology is not readily applicable and appropriate under varied local conditions. These has happened due to lack of adequate skilled staff mainly due to absence of regular capacity building programs for staff. Absence of coordination among DoF and other development agencies like financial institutions, NGOs, PRIs has also been observed.

It should also be mentioned that there is a prospect of FFDAs in facilitating intensive culture practices among the fish farmers and obviously, it created a positive impact. But it is also essential to know the fish farmers, understand their social, economic and cultural disabilities and understand their local settings and institutions under which low productivity is generated and sustained before solutions can be conceived of and set into action. Since farmers had different development potential and constraints in the study area, the programme is essential to be area or community specific rather than through central planning. The FFDAs need to be re-evaluated to ensure proper planning, adequate supervision, better monitoring and effective implementation. In the first place, it should be stated that this programme, if it is to succeed completely, calls for the real identification of the beneficiaries. Also, the cumbersome loaning procedure is normally followed in FFDA program. This causes delays and difficulties in the sanction of loan. The transaction costs of loans, which include informal costs like frequent transportations costs for visiting block and bank officials are quite high. It may be suggested that fishery banks should be established in each block to advance loan well in advance at reasonable rate of interest.

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ROLE OF NURSE IN THE HOSPITAL IN QUALITY PATIENT'S CARE MANAGEMENT

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Introduction

Nursing integrates the art and science of caring and focuses on the protection, promotion, and optimization of health and human functioning; prevention of illness and injury; facilitation of healing; and alleviation of suffering through compassionate presence. Nursing is the diagnosis and treatment of human responses and advocacy in the care of individuals, families, groups, communities, and populations in recognition of the connection of all humanity.

-ANA (2021). Nursing: Scope and Standards of Practice, Fourth Edition, p. 1.

Nursing is a critically important profession within the healthcare sector, often considered the backbone of hospitals and a crucial link between doctors and patients. Nurses are the largest component of most healthcare settings and are essential for providing direct patient care, promoting health, and preventing illness. They play a vital role in managing and navigating a patient's care, ensuring a holistic and person-centred approach. Beyond the time-honoured reputation for compassion and dedication lies a highly specialized profession, which is constantly evolving to address the needs of society. From ensuring the most accurate diagnoses to the ongoing education of the public about critical health issues; nurses are indispensable in safeguarding public health.

Here's a more detailed look at why nursing is so important:

- **Patient-Centred Care:**

Nurses are the primary caregivers, spending significant time with patients, providing support, and advocating for their needs. They assess, record, and monitor patient symptoms, reactions, and progress, working closely with physicians on treatment plans and medication management.

- **Health Promotion and Disease Prevention:**

Nurses play a key role in educating patients and the community about health issues, promoting healthy lifestyles, and preventing illnesses. They also work to address social determinants of health, such as poverty and lack of access to resources, which can significantly impact health outcomes.

- **Advocacy and Support:**

Nurses act as advocates for patients and their families, ensuring their rights are protected and their needs are met. They help patients navigate the healthcare system, access resources, and understand their treatment options.

- **Collaborative Care:**
Nurses work as part of a multidisciplinary team, collaborating with doctors, other healthcare professionals, and patients to provide comprehensive and coordinated care.
- **Frontline Care:**
During emergencies and pandemics, nurses are often on the front lines, providing vital care and managing complex situations. Their resilience and dedication are particularly evident during times of crisis.
- **In-Demand Profession:**
Nursing is a fast-growing and in-demand profession, with a high need for qualified nurses in various healthcare settings.
- **Public Trust:**
Nurses are consistently ranked as one of the most trusted professions, highlighting their commitment to patient care and ethical practice.
- **Scope of Practice:**
Nurses practice in a wide range of specialties, with varying levels of certification and responsibility. They can work in hospitals, clinics, community health centers, and other healthcare settings.
- **Continuous Learning:**
Nurses are lifelong learners, staying up-to-date with the latest advancements in nursing practice and healthcare technology.

Nursing can be described as both an art and a science; a heart and a mind. At its heart, lies a fundamental respect for human dignity and an intuition for a patient's needs. This is supported by the mind, in the form of rigorous core learning. Due to the vast range of specialisms and complex skills in the nursing profession, each nurse will have specific strengths, passions, and expertise.

Nursing is a healthcare profession that focuses on the care of individuals and their families to help them recover from illness and maintain optimal health and quality of life.

Nurses are distinct from other healthcare providers as they have a wide scope of practice and approach to medical care. They play an integral role in promoting health, preventing illness, and caring for all individuals, including those who are disabled or are physically or mentally ill.

Role

They are responsible for the ongoing care of sick individuals and need to assess their health status and help them throughout the process to recovery. The role of a nurse may include to:

- Promote health and prevent illness
- Care for the disabled and physically / mentally ill people
- Engage in healthcare teaching
- Participate in the provision of healthcare alongside other team members

- Supervise training and education of nurses
- Assist in healthcare research

Nurses advocate for the best interests of the patients at all times and focus on holistic health, which encompasses the physical, social, emotional, and spiritual needs of the patient. They are also involved in the treatment decision-making process to represent the patient's situation and make recommendations, if required.

As a profession, nursing has several ethical principles that guide their philosophy of practice throughout all tasks in the workplace. These are to-

- Provide exemplary care at all times
- Prioritize the care of patients with respect to individual dignity
- Cooperate with other health professionals to improve patient outcomes
- Act with integrity and honesty to maintain the profession reputation

In accordance with these principles, nurses are able to care for patients in the best way possible to promote positive health outcomes.

Nurses play a multifaceted role in health education, serving as educators, patient advocates, and communicators. They provide essential information about health conditions, treatments, and self-care, empowering patients to actively participate in their healthcare. Their role extends to educating families and the community on health promotion and disease prevention.

Key Roles of Nurses in Health Education:

- **Patient Educators:** Nurses explain diagnoses, treatment plans, medications, and follow-up care to patients and their families.
- **Health Promoters:** They educate patients about healthy lifestyles, including diet, exercise, and stress management.
- **Disease Prevention:** Nurses inform patients about preventative measures, vaccinations, and screenings.
- **Community Educators:** They conduct health education programs in schools, clinics, and community centres to raise awareness about health issues.
- **Patient Advocates:** They support patients in navigating the healthcare system and accessing necessary resources.
- **Communicators:** They facilitate effective communication between patients, healthcare providers, and other members of the healthcare team.

A patient's quality of care can directly affect their overall satisfaction, safety, and health outcomes. Nurses are the backbone of health care and typically have the most contact with patients. This one-on-one interaction positions nurses to be care providers and advocates for their patients and their loved ones, ensuring their rights, needs, and wishes are respected.

How to Deliver High-Quality Patient Care

Successful nurses know that better patient care involves more than administering treatment. To provide quality care to patients, nurses must offer emotional support and empathy. They also need to be resourceful, innovative, and collaborative with other members of the health care team. Explore practical ways to improve patient care.

Use Evidence-Based Practices

At the heart of quality patient care is clinical competence. Care must be timely, efficient, and built on evidence-based practices. These practices let nurses stay attuned to new protocols and intervention methods so they can make well-informed decisions regarding patient care. Nurse leaders and their teams should review guidelines, best practices, and current research regularly and put them to use daily.

Suppose you have a patient with a complex medical condition. Examine related medical literature, research studies, and clinical guidelines. Use these data to formulate a plan to recommend various nursing treatment options. Then share your findings and recommendations with your supervisor and colleagues to gain support for your strategy.

Facilitate Open Dialogue

Create an environment of open communication among patients, their families, and other caregivers. This collaboration helps build trust, ensures the accuracy of information, and improves patient satisfaction. Actively listen to patients and encourage them to share their concerns.

Put the Patient First

Patient-centred care considers a patient's medical needs, personal and cultural values, and their comfort and emotional health. This holistic approach allows caregivers to develop personalized treatment plans that align with the patient's needs and goals.

Promote Inclusivity and Equality

There must be zero tolerance for discrimination and inequality in any health care environment. Discrimination comes in many forms, from weight stigma to inaccurate diagnoses based on implicit bias. Speaking out against patient inequity and injustice can help your organization create a more inclusive, unbiased culture that prioritizes respect and empathy.

Empower Patients

Patients who feel empowered are likely to be more invested in their treatment. Involving them in decision-making encourages them to speak up, knowing nursing staff hear and respect their opinions. This open communication will also keep them engaged through their aftercare. Consider these four ways that nurses can help patients take an active role in their treatment and care:

- Provide patients with evidence-based information about their conditions and treatments. A well-informed patient is an empowered one.
- Engage patients in their ongoing care by coordinating and sharing relevant information about follow-up appointments, progress monitoring, and treatment assessment.
- Actively involve the patient's loved ones in discussions around care and treatment by educating them and encouraging participation.
- Encourage self-care by demonstrating proper medication administration and wound care, suggesting lifestyle modifications, and teaching self-monitoring techniques.

Make Safety a Priority

Patient safety should always be of the utmost importance. Nurses can help by following proper protocols and identifying and reporting potential risks. Take precautionary measures such as fall prevention, safe medication management, and infection control.

Streamline Efficiencies

Implementing a more efficient medical administration system is one example of how to improve patient care. Consider eliminating manual documentation to reduce errors and save valuable time. Then test out the new system with your team and ask for feedback and how to improve it. Streamlining procedures frees up more time you can allocate toward patient care.

Provide Ongoing Care

Patient care doesn't end after discharge. Work with your organization to provide a seamless transition that promotes patient recovery, prevents complication and improves over all patient's care. Encourage patients to take advantage of support systems, such as transitional care programs, mental health resources, and remote monitoring devices.

Nursing professionals profoundly impact patient care, and their contributions can ensure positive outcomes. By implementing strategies like effective communication, collaboration, and patient advocacy and education, you can enhance the overall health care experience for your patients and their families.

Conclusion

Nurses can be key contributors to making substantial progress toward health care equity Globally the decade ahead by taking on expanded roles, working in new settings in innovative ways, and partnering with communities and other sectors. But the potential for nurses to help people and communities live healthier lives can be realized only if the barriers to their working to the full extent of their education and training are removed. To this end, it will be necessary to revise scope-of-practice laws, public health and health system policies, state laws regarding the use of standing orders, and reimbursement rules for Medicare and other payers. Major shifts occurring both within society at large and within health care will transform the environment in which the next generation of nurses will practice and lead. If health care equity is to be fully achieved, nursing schools will need to focus on ensuring that

all nurses, regardless of their practice setting, can address the social factors that influence health and provide care that meets people where they are.

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INDUSTRIAL MANAGEMENT GROWTH IN INDIA

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Abstract

Industrial management has arisen as a basic driver of monetary development and improvement in India, catalyzing the country's change from an agrarian economy to an industrial force to be reckoned with. Throughout the course of recent many years, India has seen huge development in its industrial base, driven by globalization, mechanical headways, and moderate government strategies, for example, "Make in India" and "Advanced India." These drives have cultivated development, further developed frameworks, and improved efficiency in areas like assembling, data innovation, and administrations. The ascent of industrial management practices has been instrumental in enhancing functional effectiveness, production networks, executives, and asset usage. Through the execution of cutting-edge administration methods like lean assembling, Total Quality Management (TQM), and computerization, ventures have had the option to decrease squander, further develop item quality, and fulfill worldwide guidelines. Besides, the reception of Industry 4.0 advances, including man-made brainpower (artificial intelligence), the Web of Things (WOT), and information investigation, is reshaping the scene of industrial management, taking into consideration continuous checking, prescient upkeep, and more intelligent navigation. Regardless of these progressions, challenges remain, especially in regions like labor force ability improvement, supportability, and administrative consistency. Resolving these issues through powerful approach structures and industry—the scholarly community's joint effort—is fundamental for supported industrial development. This theoretical diagram highlights the critical job of industrial management in India's financial turn of events and underscores the significance of continued advancement, venture, and key changes to further improve the country's industrial capacities and worldwide competitiveness.

Introduction

India's excursion toward turning into a worldwide industrial pioneer is profoundly entwined with the development of industrial management practices. Industrial management incorporates a scope of systems and procedures pointed toward upgrading efficiency, streamlining assets, further developing proficiency, and accomplishing reasonable development. In the Indian setting, industrial management has had a crucial impact on changing the country's economy, working with the shift from a generally agrarian culture to a quickly industrializing economy.

Post-freedom, India's industrialization endeavors were to a great extent driven by open area speculations, with the public authority assuming a focal part in directing monetary turn of events. Be that as it may, with the progression of the Indian economy in 1991, the confidential area arose as a key part, introducing another period of industrial management. The progression strategy opened ways to unfamiliar speculations, cutting-edge innovations, and worldwide

prescribed procedures, all of which added to the development of industrial management in the country.

As of late, government drives, for example, "Make in India," "Expertise India," and "Startup India," have additionally catalyzed the development of ventures, with an emphasis on assembling, advancement, and business. Industrial management practices have developed to satisfy the needs of an exceptionally serious worldwide market, consolidating standards of lean administration, just-in-time (JIT) stock, total quality management (TQM), and Six Sigma, among others. These practices have assisted Indian businesses with accomplishing functional greatness, diminishing costs, and keeping up with excellent guidelines, empowering them to contend on the worldwide stage.

In addition, the coming of Industry 4.0 — described via robotization, man-made consciousness (man-made intelligence, AI), the Web of Things (WOT), and enormous information examination — has changed industrial management. Brilliant processing plants, prescient support, and constant navigation are becoming indispensable to industrial tasks, considering more noteworthy proficiency and advancement.

Be that as it may, the way to supported industrial development isn't without challenges. India actually faces obstacles connected with foundation improvement, workforce ability holes, and natural maintainability. Resolving these issues requires ceaseless interest in innovation, human resources, and strategy changes.

The ascent of industrial management in India addresses an account of development as well as a guide for future industrial change, situating the country as a vital participant in the worldwide economy.

Literature Review

There is much empirical work that shows that industry associations fulfil important developmental roles in developing countries, researchers like Suma Sachin by et.al. (2007) and often compensating for inadequacies in the business environment. The internationalization of human resources, supply chains and technology Momaya, K.S., Bhat, S. and Lalwan et. Al. (2017) management is driving the rise of institutes from Asia. The focus may shift from institutional growth to dynamism for technology-based focal institutes keen to contribute to industrial competitiveness. Bowonder, B., et.al. (1998), The liberalisation and globalisation processes initiated in 1991 are facilitating many changes. Consequently, in developing countries, the government has to devise policies which induce the building-up of technological capability. In economies like Japan, and China globalization has led to inclusive growth through labor intensive industries and creating a competitive business ecosystem of entrepreneurs, like Tiwari, R. and Anjum, B., et. Al. (2012) managers and workers then gradually moving up the value chain. Researchers like Pappas, D. and Chalvatzis, K.J., et. al (2017) India is often referred to as the next development superpower and is widely seen as a potential destination for large scale manufacturing hubs. In this work we draw comparisons

between India, Indonesia and China and find that all countries have a carbon intensive energy sector. Management consulting is one of business' earliest instances of outsourcing Srinivasan, R., et. al (2014). Firms and managers have been seeking external advice and support for issues as critical as strategy to seemingly procedural matters such as accounting and taxation. Other countries of the world have had a head start in managing the problem of e-waste and it would, therefore, be extremely important to learn from their experiences by Johri, R. ed., et. al. (2008). From that point of view, this book provides very valuable knowledge because it covers the subject of e-waste regulation both in India and internationally. The framework reveals that the IT industries in India has unique characteristics, like Hung, S.W., et.al (2009) but also share numerous complementary features. Researcher Mehrotra, S., et.al (2020) It goes on to spell out eight elements of what would constitute a manufacturing strategy for India, which would address the concerns of large corporates and small and medium enterprises, as well as micro-enterprises. The study is important in green management because it examines concurrent relationships between stakeholders' demand, organisations' resources, knowledge, like Khare, V.K, Raghuwanshi, S., Vashisht, A., Verma, P. and Chauhan, R., et. al (2023) environmental uncertainty management, product uniqueness, and sustainability performance. Sustainability performance variables measure financial and non-financial performance in this study. India is a fast-growing economy, that has a majority share in the global information technology industry (IT) by Chawla, Y., Shimpoo, F. and Sokołowski, M.M., et. al (2022). Rapid urbanisation and modernisation in India have strained its energy sector, which is being reformed to cope. While technology management has been accorded considerable importance all along, the dynamics of economic and market environments has led to technology, and consequently its management, like Kumar, V. and Bhat, J.S., et. al (2000) acquiring a far more significant role in recent times.

Research Methodology

This examination on the development of industrial management in India uses a blended strategy approach, consolidating both subjective and quantitative techniques to give an exhaustive comprehension of the point. The technique is intended to survey the effect of industrial management rehearsals on India's monetary turn of events, distinguish key drivers, and assess difficulties and valuable open doors in the area.

Information Assortment

Essential Information: To assemble essential information, organized meetings and reviews will be led with industry experts, administrators, and policymakers across different industrial areas, including assembling, IT, and administrations. The overviews will zero in on regions, for example, functional effectiveness, store network, the board, reception of innovation, and industrial difficulties.

Auxiliary Information

Optional information will be gathered from scholarly diaries, government reports, industry white whitepapers, and pertinent distributions from associations like the Confederation of Indian Industry (CII), NITI Aayog, and the Service of Business and Industry. This information will assist with giving a verifiable setting and tracking the development of industrial management practices in India.

Information Investigation

Subjective Examination: The subjective information from meetings will be dissected utilizing topical examination to recognize key subjects, patterns, and experiences into how industrial management plays developed and its part in forming India's industrial scene.

Quantitative Examination: Quantitative information from studies will be broken down utilizing measurable apparatuses like relapse investigation, connection, and unmistakable measurements to look at the effect of explicit administration practices on efficiency, quality, and productivity in Indian businesses.

Relative Examination: A near investigation will be led to assess how India's industrial management rehearses line up with worldwide guidelines and how arising innovations like simulated intelligence, IoT, and Industry 4.0 are being coordinated.

The blended technique approach guarantees an all-encompassing perspective regarding the matter, considering a nuanced comprehension of industrial management's development and its suggestions for India's future industrial direction.

Importance of Industrial Management: Industrial management assumes an urgent part in driving development and improvement in India's industrial area. As India proceeds with its excursion toward turning into a worldwide assembling center, compelling industrial management has become fundamental to further develop efficiency, enhance assets, and encourage development. Industrial management includes the preparation, sorting out, and managing of creation cycles to upgrade productivity, quality, and benefit. This is especially significant in a nation like India, where ventures range from huge-scope producing plants to little and medium undertakings (SMEs), all contributing essentially to financial development and occupation creation.

One critical part of industrial management is asset streamlining. India faces limitations on different assets, including area, energy, and unrefined substances. Proficient industrial management guarantees that these assets are used successfully, decreasing waste and bringing down creation costs. This, thus, assists organizations with remaining serious in a worldwide market. Moreover, with India's attention on maintainable turn of events, industrial management underscores eco-accommodating works on empowering enterprises to take on green innovations and limit natural effects.

Besides, industrial management upgrades the nature of items through the execution of severe quality control measures and interaction enhancements. By zeroing in on item quality, Indian enterprises can fabricate major areas of strength for a worldwide, prompting expanded commodities and learning experiences in global business sectors. Industrial management likewise advances specialist security andl-being by laying out safe workplaces and sticking to work norms, guaranteeing a persuaded and productive labor force.

In rundown industrial areas, management is imperative for India's industrial area, driving development through proficient asset use, quality confirmation, ecological obligation, and labor force security. As India proceeds with its "Make in India" and "Aatmanirbhar Bharat" drives, the significance of industrial management will just develop, assisting enterprises with accomplishing worldwide seriousness while adding to the country's financial advancement.

Types of Industrial Management:

Industrial management incorporates different sorts and approaches, each custom-made to upgrade various parts of creation, the labor force, the board, and functional proficiency. In India, as businesses fill in variety and scale, the job of powerful industrial management turns out to be much more basic. Here are a portion of the critical sorts of industrial management practices that are forming the Indian industrial scene:

1. Operations Management

Operations management centres around arranging, sorting out, and managing creation processes. This area of industrial management is imperative for guaranteeing that labor and products are delivered proficiently, satisfying the quality guidelines expected by both homegrown and worldwide business sectors. Operations management includes enhancing asset use, decreasing wastage, and keeping up with smoothed-out creation work processes. In India, where asset imperatives and high rivalry are conspicuous, powerful operations management assists organizations with minimizing expenses and keeping up with benefits.

2. Supply Chain Management

Supply Chain Management (SCM) includes planning and dealing with the whole supply chain, from unrefined substances to finished results arriving at the purchaser. Viable SCM in India is fundamental for dealing with a complicated organization of providers, makers, and merchants. Given India's huge topography, various business sectors, and foundational challenges, productive supply chain management guarantees ideal conveyances, limits expenses, and fulfills market needs. Industrial chiefs zeroing in on SCM additionally hope to cut just-in-time (JIT) stock administration to lessen capacity expenses and upgrade adaptability in answering changing purchaser requests.

3. Human Resource Management (HRM)

Human Resource Management in industrial settings is pointed toward enlisting, preparing, and holding talented specialists. The labor force is an essential component in any industry, and viable HRM guarantees that the ideal individuals are set up, thoroughly prepared, and roused. In India, the accessibility of an enormous, youthful labor force offers extraordinary potential; however, challenges like expertise holes and worker turnover require particular administration techniques. Industrial HRM rehearses incorporate establishing helpful workplaces, laying out wellbeing and security conventions, and executing work regulations and representative government assistance projects to further develop work fulfillment and efficiency.

4. Quality Management

Quality management includes laying out and keeping up with item quality norms that meet administrative and client assumptions. Indian businesses are progressively zeroing in on quality management to contend worldwide and increment send-outs. Approaches like Total Quality Management (TQM), Six Sigma, and ISO affirmation are generally utilized across Indian enterprises to guarantee top-notch yield. Quality management likewise decreases abandonments, limits modifications, and upgrades consumer loyalty, which is vital for enterprises planning to extend in both homegrown and global business sectors.

5. Project Management

Project management includes arranging, executing, and shutting down projects inside the business, guaranteeing they meet time, spending plan, and quality prerequisites. In India, where industrial tasks are many times enormous in scope and perplexing, a powerful venture board is basic to stay away from deferrals and cost overruns. Project supervisors apply systems like Lithe, Cascade, and Shelter to oversee assets and handle project changes. In a successful venture, the board assists Indian businesses with finishing projects on time and financial planning, cultivating more noteworthy productivity and partner fulfillment.

6. Financial Management

Financial management in industrial settings is centered around overseeing costs, streamlining spending plans, and guaranteeing a solid income to help with tasks. This sort of management is pivotal in India, where businesses face financial limitations and rivalry. Financial management in ventures centers around planning, cost control, and getting financing for extension. Viable financial management assists ventures with keeping up with benefits, overseeing dangers, and pursuing informed choices on speculations and potential learning experiences.

7. Maintenance Management

Maintenance management guarantees that apparatus and hardware are in ideal working condition to forestall surprising margin times and maintain efficiency. In India, numerous ventures rely upon capital-concentrated hardware, and any margin time can prompt huge monetary misfortunes. Maintenance management includes preventive and prescient support procedures to diminish the probability of hardware disappointments. It likewise incorporates keeping a stock of extra parts and preparing staff for normal maintenance exercises. This management type is fundamental for enterprises hoping to broaden the life expectancy of their resources and guarantee functional progression.

8. Environmental and Sustainability Management

With a developing accentuation on reasonable turn of events, industrial management likewise incorporates practices pointed toward decreasing natural effects. Environmental and sustainability management includes limiting waste, lessening outflows, and monitoring assets, lining up with India's attention on eco-accommodating development. Industrial directors supervise the executives' squander, energy-saving drives, and consistency with environmental regulations. This sort of management diminishes natural effect as well as further develops brand notoriety and assists ventures with lining up with worldwide environmental norms.

Industrial Management Impact in India:

Industrial management in India is imperative for cultivating development and productivity inside the nation's growing industrial area. With drives like "Make in India" and "Aatmanirbhar Bharat" planning to situate India as a worldwide assembling center point, powerful industrial management rehearses have become fundamental. Industrial management includes different teachings, for example, activities of the executives, production network, quality management, and human asset management. These practices are intended to advance assets, further develop efficiency, and upgrade quality norms across businesses.

India's industrial management scene is developing to address the two difficulties and potential open doors. The country's different business sectors, enormous workforce, and bountiful regular assets offer exceptional benefits, yet imperatives like asset restrictions, infrastructural holes, and ecological contemplations require specific management draws near. For example, effective store networks help executives assist businesses with beating strategic obstacles, while quality management practices empower organizations to satisfy global guidelines and lift send-outs.

The significance of supportability and natural management is likewise developing, with Indian ventures progressively taking on eco-accommodating practices to limit natural effects. With more noteworthy accentuation on talented work, cost proficiency, and mechanical mix, industrial management rehearses in India support development and seriousness in a worldwide market.

In rundown, industrial management is urgent for driving development, guaranteeing manageability, and upgrading India's industrial abilities. By embracing powerful management systems, Indian ventures are better situated to contend around the world, create work, and contribute fundamentally to the country's financial turn of events.

Industrial Management Grow in India’s Results and Report

To give a computation report to industrial management growth in India, we'll involve the information for FDI inflow, productivity index, and quality certifications from 2018 to 2024, noticing patterns and working out growth rates where material. Here is a breakdown of the information with computations to give a reasonable perspective on the patterns.

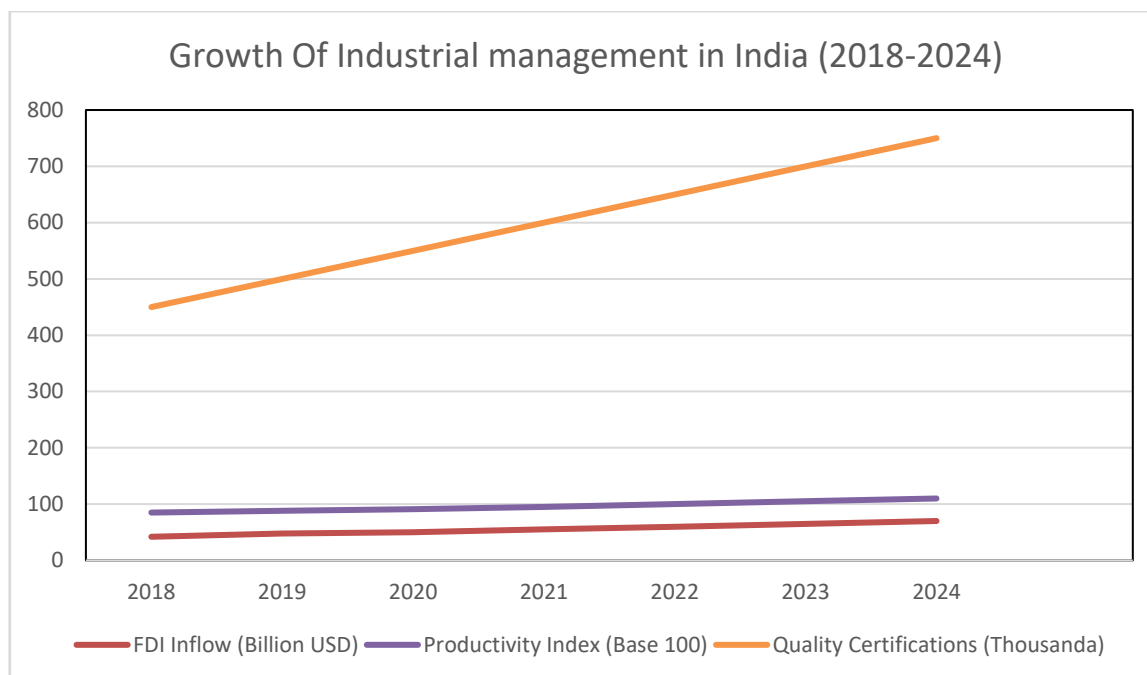
Data Summary (2018-2024)

Year	FDI Inflow (Billion USD)	Productivity Index (Base 100)	Quality Certifications (Thousands)
2018	42	85	450
2019	48	88	500
2020	50	91	550
2021	55	95	600
2022	60	100	650
2023	65	105	700
2024	70	110	750

FDI Inflow Growth Rate

To calculate the annual growth rate for FDI inflow:

$$\text{Growth Rate} = (\text{Current Year FDI} - \text{Previous Year FDI}) / \text{Previous Year FDI} \times 100$$



Here is the refreshed diagram showing the development of industrial management in India from 2018 to 2024, with extended values for 2023 and 2024. This diagram tracks key measurements, for example, FDI inflow, efficiency lists, and quality certificates, featuring progressing development there as India keeps on propelling its industrial abilities.

Conclusion

The growth of industrial management in India denotes an extraordinary excursion toward turning into a worldwide assembling force to be reckoned with. Energized by government drives like "Make in India" and "Aatmanirbhar Bharat," Indian ventures have embraced trendsetting innovations, smoothed out activities, and reasonable practices. This development mirrors a shift from customary techniques to a groundbreaking modern scene where proficiency, quality, and natural obligation are focused on.

Modern industrial management in India isn't just about expanding yield; it's tied in with making tough, versatile frameworks that can flourish in a unique worldwide market. The reception of computerized devices like simulated intelligence, IoT, and huge information examination has upset creation and independent direction, giving Indian organizations an upper hand. Moreover, the emphasis on human asset improvement has made a gifted labor force, prepared to fulfill the needs of a mechanically progressed industrial area.

India's industrial growth story is one of vision, advancement, and tireless quest for greatness. As India keeps on embracing present-day administration practices, it is ready to lead in worldwide assembling, contributing not only to monetary development but also to a maintainable, confident future that rouses businesses around the world.

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A COMPARISON BETWEEN THE SERVQUAL AND HEALTHQUAL MODELS FOR EVALUATING PATIENT SATISFACTION REGARDING SERVICES RECEIVED FROM PUBLIC AND PRIVATE HEALTHCARE INSTITUTIONS IN MALDA UNDER THE GOVERNMENT HEALTH SCHEME

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Abstract

Background: Patient satisfaction and treatment outcomes, along with multiple factors, influence the quality of healthcare. Parasuraman and Crew (1988) [9] developed the SERVQUAL scale, a widely used measure of healthcare service quality is assessed through five dimensions: responsiveness, assurance, tangibility, empathy, and reliability. Conversely, Lee's HEALTHQUAL scale (2017) [11] consist four components: effectiveness, environment, empathy, and efficiency. This study investigated the concurrent validity of the SERVQUAL and HEALTHQUAL models in evaluating patient satisfaction within public and private healthcare organizations operating under a governmental health scheme, accompanied by a comparative analysis.

Methodology: This cross-sectional descriptive study was conducted in the Malda district between August and September 2022, among patients admitted to public and private healthcare organizations under a government health scheme. One public and two private hospitals were randomly selected according to their bed counts. Patients were interviewed using structured questionnaires, and the results were assessed using the SERVQUAL and HEALTHQUAL scales, with paired and independent sample t-tests analyzed using the SPSS software version 23.

Findings: A significant majority of participants (71%) assessed the quality of healthcare services in public hospitals as inadequate ($\bar{x} = 3.50 \pm 0.55$). In contrast, (60%) of participants gave high ratings to private hospitals ($\bar{x} = 4.59 \pm 0.34$) regarding service quality, as assessed by both SERVQUAL and HEALTHQUAL.

Conclusion: Patient satisfaction levels were lower in public hospitals, while private hospitals achieved higher scores on both the SERVQUAL and HEALTHQUAL scales. Hospital administrators and policymakers should prioritize improving staff behavior and cleanliness in public hospitals, while maintaining high standards in private hospitals.

Ethical Compliance: All steps executed in this study involving human participants were in compliance with the ethical norms of the institutional and/or national research committee and the Helsinki Declaration (1964) and its later amendments or comparable ethical norms.

Keywords: *HEALTHQUAL, hospital, patient satisfaction, service quality, SERVQUAL.*

Introduction

Health and illness: Every individual possesses the right to access adequate healthcare services, irrespective of socioeconomic status or geographical location (Gangopadhyay, 2019). For the World Health Organization, “health is more than just the absence of disease; it is a condition of total physical, mental, and social well-being.” Health and disease are inextricably linked and encompass the physical, mental, and social dimensions of an individual, potentially leading to issues in these domains (WHO).

Healthcare delivery system: According to the WHO, access to the top accessible quality of healthcare services is a cardinal right for all individuals, regardless of ethnicity, religious faith, political ideology, economic conditions, or social standing. Hospitals provide comprehensive medical care, including preventive and curative treatments, and extend outpatient care to families in their homes. In addition, they also function as research and teaching institutions (WHO). Owing to increasing demand, numerous private hospitals have emerged, potentially offering more luxurious care compared to public hospitals (Shabbir et al., 2016).

The quality of healthcare services is described as the fulfilment of patients' needs and the assurance of their satisfaction. Research has demonstrated that living conditions in India have improved with increased health awareness and accessible healthcare facilities in both public and private sectors. Quality is paramount in healthcare services owing to a patient-centric market, higher literacy and wealth, and greater public awareness. Consequently, healthcare providers must continuously enhance their service quality (Kumaraswamy, 2012).

Patient Satisfaction - A Metric for Evaluating Health Care Quality: Kotler (2000) asserted that healthcare quality is determined by patient outcomes and satisfaction. Satisfaction refers to an individual's contentment or disappointment resulting from a comparison of actual service performance with expectations. Historically, hospitals have assessed health care quality based on medical personnel, technical staff, and administration; however, this approach has shifted to patient feedback. Patient perspectives are crucial for improving the health care system (Manzoor et al., 2019). Choi et al. (2005) noted that healthcare organizations prioritize patient-oriented issues and strive to enhance patient satisfaction. Although patient satisfaction is essential for evaluating institutional performance, healthcare institutions continue to endeavor to improve their quality of service (Asif et al., 2019).

Instruments for Assessing Patient Satisfaction: Numerous instruments have been developed to measure service quality. The SERVQUAL measure, introduced by Berry et al. (1988), comprises five dimensions derived from 22 items: responsiveness, assurance, tangibility, empathy, and reliability [Table 1]. Cronin and Taylor (1992) adapted SERVQUAL to create SERVPERF, which focuses on service quality rather than satisfaction, positing that perceived service quality leads to satisfaction. HEALTHQUAL, created by Lee (2017), utilizes a framework comprising four dimensions—environment, empathy, efficiency, and effectiveness—to evaluate the quality of healthcare services [Table 2].

Health Scheme: The West Bengal government implemented two health projects. The West Bengal Health Scheme-2008 provides essential free health coverage for highest care of up to Rs. 1.5 lakh annually per family for employees, pensioners, and their families affiliated with governmental and semi-governmental institutions. Sathi-2016, a paperless, cashless, smart card-based initiative, encompasses all residents, offering the highest care of up to Rs. 5 lakhs annually per household, mandating public and private healthcare institutions to provide patient care services.

Objectives

This research seeks to assess the concurrent validity of the SERVQUAL and HEALTHQUAL models in measuring patient satisfaction with services provided by public and private healthcare organizations under governmental health schemes, along with a comparative analysis.

Hypothesis

Null Hypothesis (H^0): On the SERVQUAL and HEALTHQUAL scales, patients admitted to public and private organizations had comparable mean satisfaction ratings.

Alternative Hypothesis (H^1): On the SERVQUAL and HEALTHQUAL scales, patients admitted to public and private organizations have different mean satisfaction ratings.

Review of existing literature

Determinants affecting the quality of healthcare services: Prabhakaran and Satya (2003), identified and highlighting three reasons for customer dissatisfaction: (1) providers' insufficient understanding of essential service dimensions, (2) providers' lack of understanding regarding how customers rank these dimensions, and (3) providers' unawareness of the characteristic that make up these dimensions. Gronroos (2001) ^[15] delineated two dimensions of service quality: the technical dimension, which pertains to essential services, and the process/functional dimension, which highlights the methods of service delivery methods. Parasuraman et al. (1988) identified five criteria along with corresponding metrics to evaluate both expected and perceived service quality: responsiveness, assurance, tangibility, empathy, and reliability.

Rationale for the SERVQUAL model in assessing patient satisfaction: As Sohail (2003) noted, it is the most widely utilized method for evaluating patient satisfaction. Literature analysis indicates that Several studies confirmed the reliability of the SERVQUAL model. Some researchers have validated its five general quality characteristics, whereas others have identified different dimensions including responsiveness, dependability, certainty, tangibility, and empathy. Several researchers have modified it by substituting certain dimensions with new elements but not in the original SERVQUAL model.

Limitations of the SERVQUAL Model: According to Lam (2001), SERVQUAL is considered one of the most reliable instruments for assessing service quality. However, some scholars argue that these aspects of SERVQUAL are insufficient to accurately represent the

healthcare industry (Ramsaran-Fowder, 2005). Previous studies identified only three SERVQUAL dimensions relevant to patient satisfaction (Gonzalez-Valentin et al., 2005). Many studies have investigated patient satisfaction, but component analysis has not confirmed the relationship between the five aspects of SERVQUAL and patient contentment (Yesilada & Direktor, 2010).

Rationale for Employing the HEALTHQUAL Model to Evaluate Patient Satisfaction:

The 30-question, four-domain HEALTHQUAL tool has replaced SERVQUAL to assess healthcare quality. It evaluates the quality of service in healthcare organizations by differentiating patients' predictions and perceptions across attributes, such as environment, empathy, efficiency, and effectiveness (Mosadeghrad AM. 2018). Research by Ipenza et al. (2020) demonstrates that HEALTHQUAL possesses superior psychometric properties for content and construct validity, rendering it a reliable instrument for evaluating patient happiness in public-private partnership (PPP) hospitals.

Methodology

Research design: This investigation employed a descriptive, cross-sectional methodology.

Study population: The study included patients treated with public and private organizations in Malda from July to August 2022.

- a. **Addition norm:** Adults aged 18 and above, covered by the health scheme, stayed at the hospital for a minimum of six hours, and were released alive.
- b. **Elimination norm:** Disinclination to participate, incomplete response, or unavailability for interviews.

Sample size: determined as $\{n = [P \cdot (1 - P)] \cdot Z^2 / e^2\}$, with $P = 0.5$, $Z = 1.96$ at a 0.05 significance level of, and $e = 0.1$.

The sample size (n) is: $n = [0.5 \times (1 - 0.5) \times (1.96)^2] / (0.1)^2 = [0.5 \times 0.5 \times 3.84] / 0.01 = 0.96 / 0.01 = 96$.

The sample for this study consisted of 96 individuals, comprising 48 patients randomly chosen from a public hospital and 48 from a private hospital in the Malda region, ensuring a balanced 1:1 ratio.

Hospital Selection: A lottery mechanism, proportional to bed capacity, was employed to choose one public hospital with a bed capacity of 1120, a private hospital with a bed capacity of 100, and additional private hospital with 60 beds.

Participant Selection: A total of 96 individuals were chosen for the study, comprising 48 participants from public hospitals and 48 from private hospitals. Subsequently, we systematically selected 24 individuals from each of the two private hospital cohorts, resulting in a total of 48 participants.

Study Instruments: Participants underwent interviews utilizing a standardized, predesigned,

and pretested questionnaire that encompassed demographic and socioeconomic information including age, sex, religion, education, occupation, and monthly family income. The questionnaire comprised twenty multiple-choice questions on 'Responsiveness' (3), 'Assurance' (3), 'Tangibles' (6), 'Empathy' (5), and 'Reliability' (3), as well as twenty questions on 'Effectiveness' (3) 'Environment' (6), 'Empathy' (7), and 'Efficiency' (4), assessed using a five-point Likert scale ranging from 1 (bad) to 5 (outstanding).

Statistical Analysis: The evaluation of data was conducted using SPSS (version 23). Quantitative observations were articulated in terms of range, mean (or median), and standard deviation. The interval classes were delineated in the following manner: (i) low, below 3.90; (ii) medium, 3.91 to 4.50; and (iii) high, 4.51 and above. Categorical variables are expressed as proportions or percentages, as illustrated in tables, graphs, and diagrams. The t-test was employed to assess statistical significance for continuous variables, utilizing a significance level of $P < 0.05$.

Findings and Analysis

Socio-demographic characteristics of study participants (See Table 3)

Table 3: Breakdown of research participants based on socio-demographic attributes (n=96)							
Variable	Category	Public Hospital		Private Hospital		Total	
		Count	%	Count	%	Count	%
Sex	Male	25	52%	9	19%	34	35%
	Female	23	48%	39	81%	62	65%
Age	Below 40 Yrs	23	48%	23	48%	46	48%
	41 Yrs & above	25	52%	25	52%	50	52%
Religion	Hindu	28	58%	26	54%	54	56%
	Muslim	20	42%	22	46%	42	44%
Education	No Formal Education	20	42%	15	31%	35	37%
	Primary (Class I-V)	4	8%	8	17%	12	13%
	Secondary (Class VI-XI)	19	40%	18	38%	37	38%
	HS (Class-XII & above)	4	8%	4	8%	4	8%
	Graduate	1	2%	3	6%	4	4%
Occupation	Unemployed	26	54%	35	73%	61	63%
	Farmer/Agriculture	10	21%	5	10%	15	16%
	Labor/Worker	9	19%	3	6%	12	13%
	Business/Shop	2	4%	1	2%	3	3%
	Service /Job	1	2%	4	8%	5	5%
Income	Class-I (Rs.7889 & above)	0	0%	1	2%	1	1%

Class-II (Rs.3944-7888)	0	0%	2	4%	2	2%
Class-III (Rs.2367-3943)	3	6%	4	8%	7	7%
Class-IV (Rs.2366-1183)	20	42%	19	40%	39	41%
Class-V (Rs.1182 & below)	25	52%	22	46%	47	49%

The findings revealed that (56%) identified as Hindus, while (39%) had attained secondary education. Occupational data indicated that (64%) of the respondents were unemployed due to their roles as students or housewives. As per the Prasad scale (January 2022), the (49%) of respondents indicated a monthly income is less than Rs. 1182.

Patient satisfaction with healthcare service quality as measured by the five service quality dimensions (SERVQUAL) (See Table 4):

Table 4: Breakdown of research participants based on independent variables (n=96)					
SERVQUAL	Statistic	Public Hospital	Private Hospital	P Value	Mean Difference
Responsiveness	Mean	3.91	4.60	.089	.68
	Std. Dev	.61	.41		
	Sat. Level	Medium	High		
	Count (%)	16 (33%)	30 (62%)		
Assurance	Mean	4.00	4.60	.002	.59
	Std. Dev	.66	.38		
	Sat. Level	Medium	High		
	Count (%)	16 (33%)	29 (60%)		
Tangibility	Mean	2.68	4.54	.000	1.86
	Std. Dev	.86	.42		
	Sat. Level	Low	High		
	Count (%)	45 (94%)	27 (56%)		
Empathy	Mean	3.83	4.62	.007	.79
	Std. Dev	.59	.37		
	Sat. Level	Low	High		
	Count (%)	30 (63%)	31 (65%)		
Reliability	Mean	3.68	4.61	.030	.93
	Std. Dev	.70	.42		
	Sat. Level	Low	High		
	Count (%)	27 (56%)	29 (60%)		

Overall satisfaction	Mean	3.50	4.59	.000	1.09
	Std. Dev	.55	.34		
	Sat. Level	Low	High		
	Count (%)	34 (71%)	29 (60%)		

Responsiveness: The study indicated that 33% of the Public Hospital participants had a mean score (3.91) and std. dev. (0.61) were moderately satisfied, while 62% of the Private Hospital participants had a mean score (4.60) std. dev. (0.41) was highly satisfied with the responsiveness indices, such as regular patient meetings and detailed briefings on patient conditions and treatments. Clever et al. (2008) reported a negative response, resulting in low patient satisfaction. Rehaman and Husnain (2018) stated that responsiveness did not affect patient satisfaction.

Assurance: 33% of the Public Hospital participants with a mean score (4.00) and std. dev. (0.66) demonstrated moderate satisfaction, while 60% of the Private Hospital participants with a mean score (4.60) and std. dev. (0.38) were extremely satisfied with the physicians' competence and safety measures. Ghosh (2014) found high satisfaction with medical care, and Umeano-Enemuoh et al. (2014) noted satisfaction with healthcare practitioners' competence. Khamis and Njau (2014) reported patient dissatisfaction with assurance.

Tangibility: 94% of the Public Hospital participants with a mean score (2.68) and std. dev. (0.86) were poorly satisfied with cleanliness and amenities, while 56% of Private Hospital participants had a mean score (4.54) std. dev. (0.42), were extremely satisfied. Iloh et al. (2012) linked tangibility to patient satisfaction, whereas Irfan et al. (2012) noted dissatisfaction.

Empathy: 63% of the Public Hospital participants with a mean score (3.83) and std. dev. (0.59) reported low satisfaction, while 65% of the Private Hospital participants with a mean score (4.62) and std. dev. (0.37), were extremely satisfied with the staff's attention and conduct. Amole et al. (2016) emphasized the importance of empathy, while Hutchinson et al. (2011) recorded dissatisfaction.

Reliability: The study revealed that 56% of the Public Hospital participants had a mean score (3.68) and std. dev. (0.70) expressed low satisfaction, whereas 60% of Private Hospital participants had a mean score (4.61) std. dev. (0.42) was extremely satisfied with service timeliness and diagnostic test coverage. Aldana et al. (2001) found that reducing waiting times enhances satisfaction. Uchendu et al. (2013) and El-Nassir and Mohammed (2013) confirmed that reliability does not affect patient satisfaction.

Patient satisfaction with healthcare quality is assessed through the four service quality dimensions (HEALTHQUAL) (See Table 5):

Table 5: Breakdown of research participants based on independent variables (n=96)					
HEALTHQUAL	Statistic	Public Hospital	Private Hospital	P Value	Mean Difference
Environment	Mean	2.68	4.54	.000	1.86
	Std. Dev	.86	.42		
	Sat. Level	Low	High		
	Count (%)	45 (94%)	27 (56%)		
Empathy	Mean	3.90	4.63	.008	.72
	Std. Dev	.57	.36		
	Sat. Level	Low	High		
	Count (%)	29 (60%)	33 (69%)		
Efficiency	Mean	3.67	4.59	.001	.92
	Std. Dev	.65	.40		
	Sat. Level	Low	High		
	Count (%)	27 (56%)	25 (52%)		
Effectiveness	Mean	3.98	4.59	.015	.60
	Std. Dev	.66	.39		
	Sat. Level	Medium	High		
	Count (%)	18 (37%)	26 (54%)		
Overall satisfaction	Mean	3.50	4.59	.000	1.09
	Std. Dev	.55	.34		
	Sat. Level	Low	High		
	Count (%)	34 (71%)	29 (60%)		

Environment: The results indicated that 56% of the private hospital participants had a mean score (4.54) and std. dev. (0.42) expressed high satisfaction with bedsheet cleanliness, toilets, wards, clean drinking water, and food quality. In contrast, 94% of patients in public hospital indicated lower satisfaction with the mean score (2.68) and standard deviation (0.86). Iloh et al. established a notable correlation between physical facilities, cleanliness, and patient satisfaction. Irfan et al. stated as dissatisfaction with hygiene.

Empathy: The study revealed that 69% of the private hospital participants expressed high satisfaction, while 60% of the public hospital participants had a mean score (3.90) and std. dev. (0.57) demonstrated lower satisfaction with healthcare providers, with a mean score (4.63) and std. dev. (0.36) attention, demeanor, attitude, expertise, experience, and timely communication,

respectively. Amole et al. emphasized the importance of empathy, in contrast to Hutchinson et al. who noted dissatisfaction.

Efficiency: The results demonstrated that 52% of the private hospital participants had a mean score (4.59) and std. dev. (0.40) were extremely satisfied, while 56% of the public hospital participants with a mean score (3.67) and std. dev. (0.65) reported lower satisfaction with service promptness, free medicines, and the availability of diagnostic services. Nemati et al. [35] observed patient dissatisfaction with efficiency.

Effectiveness: The study demonstrated that 54% of the public hospital participants had a mean score (4.59) and std. dev. (0.39) expressed high satisfaction, whereas 37% of the public hospital participants with a mean score (3.98) and std. dev. (0.66) reported moderate satisfaction with understanding specific needs, safety precautions, and privacy during medical examinations, medication administration, and tests. Similarly, Nemati et al. reported patient dissatisfaction in terms of efficacy.

Overall Patient Satisfaction: The overall quality of healthcare services at public hospitals is perceived as suboptimal, with 71% of participants indicating poor service quality, resulting ($\bar{x} = 3.50 \pm 0.55$) on both the SERVQUAL and HEALTHQUAL scales.

Among the five SERVQUAL characteristics, participants from the Private Hospital expressed the highest satisfaction with empathy, with a mean score (4.62) and std. dev. (0.37), and lowest satisfaction with responsiveness, with a mean score (4.60) and std. dev. (0.41). Public hospitals demonstrated the highest satisfaction with assurance, with a mean score (4.00) and std. dev. (0.66) and the lowest satisfaction with tangibility, with a mean score (2.68) and std. dev. (0.86). Similarly, Umoke et al. (2020) [36] determined that staff care was the most significant factor in patient evaluations. In a private hospital, 60% of the participants rated service quality as excellent, with ($\bar{x} = 4.59 \pm 0.34$).

Private hospital patients expressed the highest satisfaction with empathy, with a mean score (4.63) and std. dev. (0.36) and lowest satisfaction with the environment, with a mean score (4.64) and std. dev. (0.42) for the HEALTHQUAL aspects. In public hospitals, participants exhibited the highest satisfaction regarding effectiveness, with mean score of (3.98) and a standard deviation of (0.66), while the lowest satisfaction pertained to the environment, with a mean score of (2.68) and standard deviation of (0.86).

Analytical findings: The findings indicate that data was analyzed using t-test statistical techniques, demonstrating a significant overall satisfaction level of 0.000, accompanied by a mean difference of 1.09. The null hypothesis was rejected, thereby supporting the alternative hypothesis that quality of healthcare services influences overall patient satisfaction as measured by both SERVQUAL and HEALTHQUAL scales.

Advantages and disadvantages

Advantage: The study utilizes random sampling to improve the generalizability of its findings across to all public and private hospitals in the Malda region.

Disadvantage: The descriptive research methodology produces qualitative data that may be biased and typically utilizes a smaller sample size, which can restrict the generalizability to the wider population.

Summary

This study sought to identify the factors influencing service quality among health scheme cardholders in both government and private health care institutions. Major findings include:

According to the SERVQUAL scale, perceived healthcare service quality in public hospitals is moderate, with the assurance component ranking the highest, followed by responsiveness, empathy, and tangibility. The remaining service quality dimensions have the lowest scores. Private hospitals rated their service quality as exceptional, with empathy ranking the highest, followed by dependability, responsiveness, assurance, and tangibility. The other dimensions were ranked the lowest.

Based on the HEALTHQUAL scale, public hospitals' service quality practices are suboptimal, with effectiveness ranked highest, followed by empathy, efficiency, and the environment. The other dimensions were ranked the lowest. Private hospitals rated their service quality methods more favorably, with the highest empathy, followed by effectiveness, efficiency, and environment. The other dimensions were ranked the lowest.

Suggestions:

1. Establish regular cleaning protocols for wards and toilet areas, and create a schedule for the replacement of bed linen.
2. Install water filtration systems in each ward to guarantee safe drinking water.
3. Improve dietary quality through the enhancement of nutritional content and palatability.
4. Enhance staff civility, demeanor, and communication competencies.
5. Enhance the capacity of healthcare personnel to deliver provide adequate patient care.
6. Enhance the promptness of the services, encompassing admission, treatment, and surgical procedures.
7. Enhance the responsiveness of healthcare professionals to patient complaints.
8. Enhance protocols for patient privacy and implement precautionary measures during examinations.
9. Provide medications and diagnostic tests at no cost within a specified timeframe.

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TRANSFORMING FINANCIAL EDUCATION THROUGH CONVERSATIONAL AI: A STUDY ON CHATGPT

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Abstract

Financial literacy is essential for all individuals. It allows people to avoid financial risks and take prudent financial decisions and plan for the future through investments. However, a sizable section of the population lacks the essential financial knowledge to make well-informed decisions which frequently leads to debt, insufficient savings and a variety of financial problems. ChatGPT is an artificial intelligence language model which was launched in November 2022. It is supposed to provide responsive and conversational responses when prompted with queries. Rapid technology advances in the twenty-first century have resulted in creative solutions to a variety of problems, including the urgent need for increased financial literacy and education. Subsequently integrating ChatGPT into financial education platforms has the potential to democratize access to financial knowledge, fostering informed decision-making and building financial resilience across a wider range of populations.

This research paper explores the benefits and disadvantages of ChatGPT in the financial arena, as well as how well it can personalize learning. The research will explore the potentiality of ChatGPT as a tool to improve financial education and literacy and giving customized financial guidance. The findings suggest that ChatGPT has the potential to significantly enhance financial education and literacy. However, further study is needed to acquire a thorough knowledge of how it may influence financial education and literacy.

Keyword: *ChatGPT, Education, Financial Literacy, AI.*

Disclaimer: “The authors have written this paper in part with GPT-3.5. Please be advised that the contents of this paper should not be construed as investment advice.”

Introduction

ChatGPT is an advanced artificial intelligence language model that has revolutionized the way humans interact with technology. Developed by OpenAI, ChatGPT is part of the GPT (Generative Pre-trained Transformer) family and it is designed to understand and generate human-like text based on the input it receives. ChatGPT is a powerful tool for natural language processing (NLP), enabling it to comprehend and respond to text-based queries, prompts and conversations. Its ability to understand context, generate coherent responses and adapt to various domains has made it an invaluable asset across a wide range of applications.

In this era of increasing automation and digital transformation, ChatGPT represents a significant leap forward in human-computer interaction, offering exciting possibilities for enhancing productivity and accessibility across various domains.

Review of Literature

Financial well-being on an individual and social level depends on having financial awareness and knowledge. Financial literacy has been linked in studies to higher savings, better financial stability and better financial decision-making. By giving users accurate and pertinent information, ChatGPT, as a big language model, has the potential to improve financial literacy and education. This research study investigates ChatGPT's contribution to improving financial education and literacy. Numerous studies have shown the prevalence of inadequate financial literacy among people and the difficulties they have while navigating complicated financial and credit markets that call for educated decision-making, according to Lusardi and Mitchell (2014). An overview of the state of chatbots in the financial sector today and their potential to boost productivity, lower costs and enhance customer service are given in the paper by Gomber et al., (2019). By giving clients individualized, on-demand information and help, chatbots in the banking industry may improve financial literacy and education.

The capacity of ChatGPT to offer customers personalized and interactive replies is one of its primary advantages in the area of financial literacy. This can be especially helpful for people who are afraid to ask for financial guidance or have little financial literacy. ChatGPT can assist users in comprehending complicated financial concepts and making better-informed decisions by giving them personalized answers to their inquiries.

The researchers discovered that a financial Chabot utilizing natural language processing (NLP) greatly increased users' financial knowledge and decreased their felt financial stress in a study by Chen et al. (2020). The Chabot might respond to users' inquiries and offer tailored advice following their financial position. Similarly, a study by Huang et al. (2020) found that an NLP-based financial Chabot improved users' financial literacy and confidence in making financial decisions. An NLP based financial Chabot also increased users' financial knowledge and confidence in making financial decisions, according to research by Huang et al. (2020). ChatGPT also has the benefit of being able to deliver information in several languages. This is crucial in the context of financial literacy because those who do not speak the national language may have more difficulties in getting access to financial services and information. ChatGPT can assist close this language gap and raise financial literacy across a variety of demographics by offering information in many languages.

Interest in using ChatGPT to improve financial education and literacy is growing. The potential advantages of this technology in enhancing financial education and literacy have been the subject of several studies. Some of the most important conclusions and major takeaways from this research are discussed below.

Objective of the Study

- To present the ChatGPT roadmap and its outlook.
- To identify the limitations of ChatGPT in the context of financial education.
- To examine the ethical concerns in delivering financial guidance through ChatGPT.
- To explore how ChatGPT can impart financial knowledge to non-accredited investors of varying educational backgrounds through simple models.

Methodology of ChatGPT

ChatGPT is a new natural language processing (NLP) technology that combines deep learning, reinforcement learning and transfer learning to create chatbots that can interact with humans in a more natural way. At its core, ChatGPT is a recurrent neural network (RNN) that learns from previous conversations and contextual information. This allows it to make more accurate predictions than rule-based chatbots which are limited by the size of their pre-programmed knowledge bases. The most important part of training ChatGPT is to use reinforcement learning techniques along with supervised machine translation models. Reinforcement learning allows ChatGPT to learn new ideas based on what users say, while supervised machine translation models help it adapt to different situations in each conversation thread. This training method allows ChatGPT to quickly learn new skills and adapt to new situations. It is also scalable, meaning that it can be used in a variety of real-world applications. One of the advantages of ChatGPT is that it can generate useful answers even when given incomplete sentences. This makes it a good fit for applications where users may not always be able to provide all the information, they need upfront.

Background and Foundations of ChatGPT

OpenAI, a pioneer in AI innovation, brought forth revolutionary models like GPT-2, GPT-3 and ultimately ChatGPT.

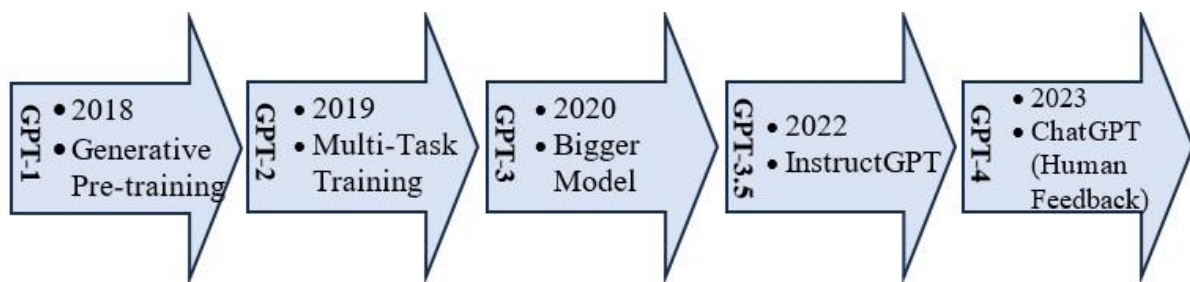


Fig: The Timeline of GPTs from the first version (GPT-1) to the latest version (ChatGPT)

GPT models are engineered to produce coherent, human-like natural language text, spanning phrases, paragraphs and even complete documents. To prepare for subsequent tasks such as text categorization and question answering, GPT models must undergo a crucial pre-training phase, where they ingest vast amounts of text data. This unsupervised pre-training involves exposing the model to extensive textual sources, encompassing everything from textbooks to online content, without any explicit annotations or labels.

During pre-training, the GPT model learns to predict the next word in a sequence by analysing the context provided by the preceding words in the training data. In the realm of Natural Language Processing (NLP), this process is known as language modelling. Through this extensive training on a vast corpus of text, the model becomes adept at recognizing and generalizing linguistic patterns, including syntax, vocabulary and logical structures.

After the pre-training phase, the GPT model can be fine-tuned for specific downstream tasks using a smaller labelled dataset. For instance, if text categorization is the goal, the model can be fine-tuned to determine the most appropriate label for a given input text. Figure 1 illustrates

the chronological progression of GPT models, from the inaugural GPT-1 to the latest iteration, ChatGPT.

GPT-1: GPT-1 is the first version of the GPT language model. It was released in 2018 and is based on the Transformer Neural Network architecture. GPT-1 was first pre-trained on a massive dataset of text data, including documents, papers and online content. The model was taught to predict the next word in a string of text based on the words that came before it. This training allowed GPT-1 to learn word patterns and their relationships. After the initial training, GPT-1 can be fine-tuned to perform specific downstream tasks, such as language translation, emotion analysis and text categorization. For example, to train the model to accurately predict the sentiment of text input, it would need access to a labelled dataset of text data. GPT-1 has a relatively small parameter set of 117 million, compared to later iterations of the GPT model. However, GPT-1 still achieved outstanding results on a broad spectrum of tasks requiring natural language processing (NLP). This shows the effectiveness of pre-training on large volumes of text data for improving language understanding.

GPT-2: GPT-2 was a significant improvement over GPT-1, one of the most powerful language models available at the time. It had around 1.5 billion parameters which is much larger than GPT-1's 117 million parameters. GPT-2 was pre-trained on a large corpus of textual resources, such as books, articles and online content. It was trained to guess what comes next in a text by looking at what came before. This is known as language modelling. GPT-2 was able to generate longer and more cohesive text sequences than GPT-1. It also showed more generalizability across tasks and contexts. This means that it could be used for a wider range of tasks, such as text categorization, emotion analysis and question answering. After initial training, GPT-2 could be fine-tuned for specific tasks. This involved providing the model with additional data and training it on a specific task. For example, GPT-2 could be fine-tuned to generate realistic dialogue for a chatbot or to write news articles.

GPT-3: GPT-3 is a large language model that is more powerful and efficient than its predecessor, GPT-2. It was trained on a massive dataset of text data, including books, articles and online content. This allowed the model to learn the patterns and relationships between words and phrases which enables it to generate text that is both convincing and natural-sounding. GPT-3 is versatile and can be used for a variety of NLP tasks, such as text categorization, sentiment analysis and question answering. This is because the model can learn the specific features of each task from its training data. In addition, GPT-3 has several cutting-edge features, such as multi-task learning and few-shot learning which allow it to learn new tasks with minimal training data. Due to its many advantages, GPT-3 has been used in a variety of domains, including chatbots, language translation, content generation and code generation. ChatGPT is a chatbot that uses GPT-3 to generate natural-sounding conversations. When a user interacts with ChatGPT, the platform first uses natural language understanding (NLU) to understand the user's intent. Then, it fetches the relevant data from a knowledge base and uses natural language generation (NLG) to generate a response. The conversation history is saved so that future interactions can be personalized. Reinforcement learning is used to collect feedback from users and improve the quality of responses over time.

GPT-4: OpenAI recently released GPT-4, a new large language model that has made significant advances in deep learning scalability. GPT-4 is a multimodal model that can take in images and text and produce written outputs. It has exhibited human-level performance on a variety of professional and academic benchmarks, such as scoring in the top 10% of participants in tests on a virtual legal examination. While GPT-4 is still not as proficient as humans in all real-world scenarios, it has the potential to be a powerful tool for a variety of applications. For example, it could be used to generate creative content, translate languages, or write different kinds of creative text formats. There is still room for improvement in GPT-4's factuality, steerability and ability to stay within the provided restrictions.

GPT models have been shown to be state-of-the-art performers on a variety of natural language processing (NLP) tasks, including text generation, question answering, language translation and emotion evaluation.

Some examples of how GPT models have been used in NLP tasks:

- I. **Text generation:** GPT models can be used to generate text, such as news articles, creative writing and code.
- II. **Question answering:** GPT models can be used to answer questions, such as those asked by users of search engines or chatbots.
- III. **Language translation:** GPT models can be used to translate text from one language to another.
- IV. **Emotion evaluation:** GPT models can be used to evaluate the emotional content of text.

Some examples of how GPT models have been used in practical applications:

- I. **Chatbots:** GPT models can be used to power chatbots that can engage in natural language conversations with users.
- II. **Customer service:** GPT models can be used to automate customer service tasks, such as answering questions and resolving issues.
- III. **Content creation:** GPT models can be used to create content, such as blog posts, articles and social media posts.

GPT models are still under development, but they have the potential to revolutionize the way we interact with computers and the way we create and consume content.

ChatGPT in Financial Education

ChatGPT is a powerful language model that can be used for financial education. It can be a cost-effective and scalable alternative to traditional methods such as seminars and workshops. ChatGPT can make financial education more accessible to a wider audience by providing personalized guidance and advice. This can help individuals improve their confidence and decision-making skills. Therefore, organizations and financial educators may find ChatGPT to be a useful tool to improve the financial literacy and education of their audience.

Benefits of using ChatGPT in financial education:

ChatGPT is a promising tool that can be used to improve financial literacy and education. Organizations and financial educators who are looking for a cost-effective, scalable and personalized way to deliver financial education should consider using ChatGPT.

- I. **Cost-effective:** ChatGPT can be used to deliver financial education at a fraction of the cost of traditional methods.
- II. **Scalable:** ChatGPT can be used to reach a large number of people at the same time.
- III. **Personalized:** ChatGPT can provide personalized guidance and advice to each individual learner.
- IV. **Accessible:** ChatGPT can be used by people of all ages and with different levels of financial knowledge.
- V. **Engaging:** ChatGPT can use interactive and engaging activities to keep learners engaged.

Limitations of Using ChatGPT to Explain Financial Concepts

ChatGPT is a powerful tool that makes financial education more accessible to everyone, as learners can seek assistance and receive rapid responses at any time and from any location. It can also save learners time and money, as they no longer need to travel to traditional classroom-based courses or consult with financial experts in person. However, it has some limitations that should be considered.

- I. ChatGPT may not be able to provide the same level of emotional support, empathy and personal interaction as a human teacher or financial expert. This could be a problem for students who are struggling to understand a concept or who need help making a financial decision.
- II. ChatGPT may have difficulty handling complex financial concepts that involve multiple variables, calculations and scenarios. This is because ChatGPT is trained on a massive dataset of text and code, but it does not have the same ability to think critically and reason as a human.
- III. The effectiveness of ChatGPT depends on the dependability and correctness of the data and technology it employs. If there are technical problems or errors, it could negatively impact the learning experience.
- IV. ChatGPT may sometimes generate responses that are factually incorrect or misleading, known as hallucinations. This can lead to misunderstandings or poor financial decisions if the information is not carefully verified.
- V. ChatGPT is an AI language model and does not hold any formal financial certifications or any professional qualifications. Therefore, it cannot replace advice from certified financial advisors or experts who are trained to provide regulated and personalized financial guidance.

Addressing Ethical Concerns in Delivering Financial Guidance through ChatGPT

ChatGPT can be used to provide financial counselling to consumers. However, there are several ethical issues that must be considered when using ChatGPT for this purpose.

- I. **Accuracy and trustworthiness:** ChatGPT's recommendations must be accurate and trustworthy. This means that the financial advice offered must be based on sound financial principles and take the user's financial goals and situation into account. Providing inaccurate or misleading advice can have serious consequences for users.
- II. **Privacy:** When users seek financial assistance through ChatGPT, they may disclose private financial information. This information must be kept private and must not be disclosed to anyone else without the user's express permission. Steps should be taken to safeguard and protect the user's data.
- III. **Conflicts of interest:** When offering financial advice through ChatGPT, it is important to be open and honest about any potential conflicts of interest. For example, the user should be informed if ChatGPT receives payment for recommending specific financial products or services.
- IV. **Appropriateness:** ChatGPT's financial advice must be appropriate for the user's financial situation and goals. Before offering any advice, ChatGPT must consider the user's financial status, investing experience, risk tolerance and investment goals.
- V. **Recognition of AI's limits:** ChatGPT is a machine learning model and, as such, has its limitations. It cannot replace a human financial advisor and may not be able to offer individualized guidance that considers all of the user's specific circumstances.

By adhering to these ethical principles, ChatGPT can be used to provide consumers with helpful financial advice while upholding their interests.

Personalized learning through ChatGPT

ChatGPT can be a valuable tool for improving financial literacy and education by providing personalized learning experiences that meet the unique needs and preferences of each user. ChatGPT can do this by using natural language processing and machine learning techniques to understand the user's financial goals, interests and learning style. With this information, ChatGPT can provide personalized guidance and recommendations on a wide range of financial topics, such as budgeting, saving and investing. For example, if a user is interested in learning about investing, ChatGPT can provide information on different types of investments, how to choose investments and how to manage an investment portfolio. ChatGPT can also adapt the learning experience based on the user's progress and feedback. If the user is struggling with a particular concept, ChatGPT can provide additional explanations and examples to help clarify the concept. Similarly, if the user is demonstrating mastery of a topic, ChatGPT can provide more advanced material to challenge the user and further enhance their learning. Personalized learning through ChatGPT can be a powerful tool for improving financial literacy and education. By providing tailored guidance and support, ChatGPT can help individuals develop the knowledge, skills and confidence they need to manage their finances effectively.

Test with Simple Model

In this study, we test the use of ChatGPT to explain the definition of fundamental financial metrics. ChatGPT has been trained on a large dataset of data and academic literature which gives it the potential to effectively explain complex financial concepts. This is particularly

useful in finance, as understanding fundamental financial metrics is a key step for making informed investment decisions. We investigate the impact of tone and target audience on the language chosen by a language model like ChatGPT. The “mom’s test” posits that the ability to explain complex financial concepts in a manner that is easily understandable by a layperson is an important aspect of effective communication. We aim to explore whether varying the tone and target audience can lead to alternative word choices that may be more suitable for different audiences.

Specifically, we will examine the use of ChatGPT to generate explanations of financial concepts in different tones, such as formal, informal and technical. We will then evaluate the effectiveness of these explanations for different audiences, such as students, financial professionals and laypeople. The tests cover a range of finance concepts, starting with basic ones (alpha, beta) and progressing to more advanced ones (illiquidity, earnings-to-price). The ability of GPT to generate relevant explanations with minimal prompts (i.e., just the factor name, authors, publication year and journal name) is also examined.

Test

A) Alpha:

Prompt: What is alpha in finance?

- **ChatGPT:** In finance, “alpha” is a measure used to evaluate the performance of an investment or portfolio relative to a benchmark index. It is often considered a measure of an investment manager's skill or ability to generate excess returns (or underperformance) compared to what would be expected based on the risk taken.
- Here's how alpha works:
- **Benchmark:** Alpha is typically calculated by comparing the returns of an investment or portfolio to a benchmark index. The benchmark index is chosen to represent a similar asset class or market segment that the investment or portfolio is supposed to track or outperform.
- **Expected Return:** The expected return of the investment or portfolio is estimated based on its level of risk, typically using a financial model like the Capital Asset Pricing Model (CAPM) or other risk-adjusted models. This expected return is what an investor would anticipate based on the risk profile of the investment.
- **Actual Return:** The actual return of the investment or portfolio is the real return that it generates over a specific period, taking into account any capital gains, dividends, or interest income.
- **Alpha Calculation:** Alpha is calculated as the difference between the actual return and the expected return. It is expressed as a percentage or an annualized rate.
- **Alpha = Actual Return - Expected Return**
 - If the investment or portfolio outperforms its expected return, it has a positive alpha, indicating that it generated excess returns relative to the benchmark.
 - If the investment or portfolio underperforms its expected return, it has a negative alpha, suggesting that it didn't generate as much return as expected given its level of risk.

- If the investment or portfolio matches its expected return, it has an alpha of zero, indicating it performed in line with expectations.

Positive alpha is generally considered a sign of skilled management because it suggests that the manager has added value by making investment decisions that resulted in higher returns than would be expected given the level of risk. However, it's essential to consider the investment's risk profile and other factors before concluding that positive alpha is solely due to skill and not due to taking on excessive risk.

Alpha is just one of many performance metrics used in finance and it is often used alongside other measures like beta (which measures the investment's sensitivity to market movements) to provide a more comprehensive assessment of an investment or portfolio's performance.

Prompt: Describe to a high school student what is alpha in finance.

ChatGPT: Imagine you and your friend both decide to invest your allowance money in stocks, like buying shares of different companies. You both want to make money from these investments. Alpha is like a way to measure how well you're doing compared to your friend.

Here's a breakdown:

- **Expectations:** You and your friend choose different stocks to invest in. Each stock comes with its own level of risk. Alpha helps us figure out how much money we might expect to make from these stocks, based on their riskiness. It's like guessing how well you should do.
- **Actual Performance:** After some time, you both check how much money you actually made from your stocks. This is the real profit or loss you've earned.
- **Alpha:** Alpha is like a report card grade. It tells you whether you did better or worse than you expected.
 - If your alpha is positive, it means you did better than you thought you would. You've made more money than expected.
 - If it's negative, you didn't do as well as you thought you would. You've made less money or even lost money.
 - If it's zero, it means you pretty much did exactly as well as you thought you would, given the risks you took.

So, alpha helps you figure out if your stock investments are doing better or worse than you anticipated. It's like a way to measure your investment skills and see if you're making smart choices with your money. Positive alpha is a good sign that you're making wise investments, while negative alpha may mean you need to rethink your strategy.

B) Beta

Prompt: What is beta in finance?

ChatGPT: In finance, "beta" is a measure of a stock's or investment's sensitivity to movements in the overall market or a specific benchmark index. It is a key component of the Capital Asset Pricing Model (CAPM) and is used to assess an investment's level of systematic or market risk.

Here's a simplified explanation of beta:

1. **Benchmark Comparison:** Beta measures how much an investment tends to move in relation to a benchmark index, such as the S&P 500 for U.S. stocks. This benchmark represents the overall market or a specific market segment.
2. **Beta Value:** Every investment has a beta value which is a number. It can be greater than 1, less than 1, or equal to 1.
 - A beta greater than 1 (e.g., 1.2) suggests that the investment tends to be more volatile (moves more) than the benchmark. It's considered more risky.
 - A beta less than 1 (e.g., 0.8) indicates that the investment is less volatile than the benchmark. It's considered less risky.
 - A beta of 1 means the investment tends to move in line with the benchmark.

3. Interpretation:

- ❖ If a stock has a beta of 1.2, it tends to go up by 1.2% when the benchmark goes up by 1% and vice versa.
- ❖ If a stock has a beta of 0.8, it tends to go up by 0.8% when the benchmark goes up by 1% and vice versa.
- ❖ If a stock has a beta of 1, it moves in sync with the benchmark.

4. Risk Assessment: Investors use beta to understand how much market risk is associated with a particular investment. Higher beta stocks are riskier but may offer higher potential returns. Lower beta stocks are considered safer but may have lower return potential.

In essence, beta helps investors gauge how much an investment's price is likely to fluctuate in response to market movements. It's a valuable tool for assessing and managing risk in a portfolio and for making investment decisions based on the level of risk one is comfortable with.

Prompt: Describe to a high school student what is beta in finance.

ChatGPT: Imagine you're playing a game with a group of friends and you want to know how fast each of your friends can run. Beta in finance is a bit like measuring how fast a person can run, but instead of people, we're looking at how fast a stock or an investment can move compared to a special track.

Here's how it works:

1. **Benchmark Track:** Think of the stock market as a track where different stocks and investments are running races. This track is our benchmark. It shows us how the whole market is doing.
2. **Beta Value:** Each stock or investment has a beta value which is like a speed indicator. It tells us how fast or slow that stock moves compared to the track (the market).
 - A beta higher than 1 means the stock is like a fast runner. It tends to go up or down more than the track (market) does.

- A beta lower than 1 means the stock is like a slower runner. It doesn't move as much as the track (market).
- A beta of 1 means the stock moves at the same speed as the track (market).

3. Understanding Risk: Beta helps us understand how risky a stock or investment is. If a stock has a high beta (above 1), it's like a fast and exciting runner but can be riskier. If it has a low beta (below 1), it's like a steadier runner which can be less risky.

So, beta is like a way to measure how much a stock or investment bounces around compared to the overall stock market. It helps us understand how much risk is involved in owning that particular stock. High beta means more excitement (and risk), while low beta means things are calmer (and less risky).

It's an essential concept in finance because it helps people make decisions about which investments are right for them based on how much excitement or risk they're comfortable with.

C) Earnings to Price

Prompt: Factor: EP, Earnings to Price, Sanjoy, 1977, less than 100 words.

ChatGPT: In 1977, Sanjoy developed the Earnings to Price (EP) factor which is a financial metric used in finance. EP is calculated by dividing a company's earnings by its stock price. It provides insight into how much profit a company generates in comparison to its stock's current market value. This factor is valuable for investors and analysts in evaluating investment opportunities.

Prompt: Explain to non-finance professionals.

ChatGPT: Imagine you're thinking about buying a car and you want to know if it's a good deal. One way to do that is by looking at how much the car can earn for you compared to its price.

- Earnings: This is like the money the car can make for you, say by giving rides as a taxi.
- Price: This is the cost of buying the car.

So, Earnings to Price (EP) is just a way to see if the car is a good investment. If the EP is high, it means the car can make a lot of money compared to its cost which is great. But if the EP is low, it might not be such a good deal because it doesn't earn much relative to its price.

In finance, EP works the same way but with stocks instead of cars. It helps people figure out if a stock is a good investment by looking at how much profit it can make compared to its current price. High EP is usually seen as a good sign for investors and low EP might make them think twice about investing in that stock.

Prompt: Explain to my mon.

ChatGPT: Imagine you have a favorite store and you want to know if the things they sell are a good deal or not. You might look at the price tags on the items you want to buy and then think about how much money the store is making from those items.

The EP factor is a bit like doing that for companies that sell stocks to people. Instead of clothes or toys, these companies sell pieces of themselves in the form of stock. EP helps us figure out if these companies are good deals or not.

Here's how it works:

1. **Earnings:** Think of this as the money the company makes. Just like your favorite store earns money from selling stuff, companies earn money from their businesses.
2. **Price:** This is like the price tag on the stock. It tells you how much people are paying to own a piece of that company.
3. **EP Calculation:** EP is calculated by dividing the earnings (money the company makes) by the price (how much people pay for the stock). So, it's like saying, "How much money is the company making for every dollar people spend on its stock?"
 - If the EP is high, it means the company is making a lot of money compared to the stock price which can be a good deal for investors.
 - If the EP is low, it means the company isn't making as much money compared to the stock price which might not be such a good deal.

So, the EP factor helps investors decide if a company's stock is a good buy. If the EP is high, it could mean the stock is a good deal, but if it's low, it might not be the best choice. It's like checking the price tag to see if you're getting your money's worth when you shop at your favorite store.

D) Illiquidity

Prompt: Explain Illiquidity in finance in 100 words.

ChatGPT: Illiquidity in finance refers to the condition where an asset, such as a stock or bond, cannot be quickly and easily sold or converted into cash without a significant loss in value. This lack of liquidity can result from limited trading activity, a small market for the asset, or restrictions on selling. Illiquid assets may require more time and effort to find a buyer and sellers often have to accept a lower price than the asset's intrinsic value. Illiquidity risk can impact investment portfolios, as it may hinder an investor's ability to access funds or react swiftly to changing financial conditions.

Prompt: Explain to non-finance professionals.

ChatGPT: Certainly! Illiquidity in finance is like having something valuable that you can't easily turn into cash when you need it. Imagine you have a rare collectible item; it might be worth a lot, but finding a buyer can take time and you might have to sell it for less than it's worth because not many people want it. In finance, illiquid assets, like certain stocks or investments, can't be sold quickly without losing value. This can be a problem because you might need cash in an emergency or want to take advantage of a better opportunity. So, illiquidity means your money is tied up and not easily accessible.

Prompt: Explain to my mom.

ChatGPT: Imagine you have a valuable item, like a rare antique, but selling it quickly is challenging because there aren't many people interested in buying it and finding the right buyer can take time. In the world of finance, illiquidity is somewhat similar but involves investments instead of physical items.

Illiquidity means having investments that can't be easily converted into cash without losing value or without waiting for a while to find a buyer. Here's why this is important to understand:

1. **Time and Difficulty:** Illiquid investments may take a long time to sell. It's like waiting for the right buyer to come along for your antique. This can be a problem if you need money quickly for an unexpected expense.
2. **Price Impact:** When you sell an illiquid investment quickly, you might not get as much money for it as it's truly worth. It's similar to having to sell your antique at a lower price because you can't find the perfect buyer.
3. **Risk:** Illiquidity can add risk to your investments. If you can't access your money when you need it, you might have to make financial decisions you didn't plan for or miss out on better opportunities.
4. **Examples:** Some investments, like certain stocks, real estate, or private company shares, can be illiquid. They may not have a ready market of buyers and sellers like more common investments (e.g., publicly traded stocks).
5. **Diversification:** Investors often balance illiquid assets with liquid ones (e.g., cash or easily tradable stocks) to ensure they have readily available funds for emergencies or opportunities.

In summary, illiquidity in finance is like having valuable assets that can't be quickly and easily turned into cash. It can impact your financial flexibility and introduce risks, so it's essential to consider liquidity when managing your investments and financial plans.

Discussion

Regarding the simple model, the quality of the output generated by ChatGPT was acceptable. It was able to effectively transform financial knowledge for non-financial professionals, providing explanations of concepts such as alpha and beta to non-finance professionals and even high school students. It is worth mentioning that when the target audience is not specified, ChatGPT tends to provide responses that are more technical in nature and may include terms and concepts that may not be easily understood by non-finance professionals. For instance, without specifying a target audience, ChatGPT may use terms such as “benchmark” that may not be familiar to individuals without a financial background. This highlights the importance of specifying the target audience when utilizing ChatGPT as a tool for disseminating financial information. By clearly defining the target audience, ChatGPT can adjust its language and terminology to be more accessible and easier to understand for individuals with limited financial knowledge, while still providing accurate and technical explanations for more advanced audiences.

By extracting the relevant information from the plot and inputting it into a “prompt” for ChatGPT, we were able to generate a more understandable explanation that could be presented

in a manner similar to that of a financial news outlet such as Financial Times. We also tested the extreme case of generating an explanation to my “mother” without using any professional terms and the results are quite impressive. This approach demonstrates the potential for utilizing natural language generation techniques to improve the accessibility and comprehension of complex financial information for investors.

Conclusion

ChatGPT has the potential to improve financial literacy and education by providing personalized, interactive and multilingual responses to users. However, there are potential drawbacks and constraints that must be addressed to ensure that chatbots are used responsibly and productively. One constraint is the lack of oversight and regulation in the development and use of chatbots. Without adequate supervision, chatbots could provide consumers with inaccurate or misleading information which could have a serious impact on their financial security. Also, chatbots may not be able to offer the same level of empathetic guidance as a human financial counsellor. Despite these drawbacks, ChatGPT has the potential to be a valuable tool for financial counselling and education. It can help to increase access to financial services for underserved groups, provide personalized education and guidance and improve financial literacy. In our study, we tested the capabilities of ChatGPT in interpreting simple model and its ability to explain complex financial concepts in a nontechnical manner. The results show that ChatGPT has great potential as a tool for explaining complex financial concepts to a wide range of target audiences. The ability of ChatGPT to effectively transform financial knowledge into language that can be easily understood by nonfinancial professionals is a key advantage. Although the current free version GPT-3.5 is not perfect in explaining model predictions yet. The use of ChatGPT for financial advice raises a number of ethical issues that must be carefully considered. By addressing these issues, ChatGPT has the potential to democratize investment by giving everyone, regardless of their financial background, the tools and knowledge they need to make informed investment decisions.

Future research should focus on developing standards for using chatbots in financial education and investigating strategies for incorporating chatbots into existing financial education programs. As technology continues to develop, ChatGPT may become an even more important tool for advancing financial literacy and education.

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FOSTERING SUSTAINABLE DEVELOPMENT OF HIGHER EDUCATION INSTITUTIONS THROUGH FACULTY DEVELOPMENT PROGRAMMES

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Abstract

Sustainable development in higher education is increasingly recognized as essential for addressing global challenges. Faculty members play a pivotal role in this process and their professional development is key to fostering innovative human resource management (HRM) practices. HEIs face increasing pressure to adopt sustainable practices and faculty members emerge as crucial agents of change. This research aims to identify how effective faculty development programmes (FDPs) can enhance the capacity of educators of higher education institutions (HEIs) to integrate sustainability into their teaching, research and community engagement. Utilizing primary data collected through surveys and interviews with faculty members across various disciplines, this research investigates the current landscape of faculty development initiatives aimed at sustainability. The findings reveal that well-structured FDPs not only equip educators with the necessary skills and knowledge but also foster a culture of sustainability within HEIs. Furthermore, the study highlights innovative HRM practices, such as collaborative teaching models, interdisciplinary projects and community partnership, that can be integrated into faculty development efforts. The analysis underscores the importance of aligning faculty development with institutional sustainability goals, ensuring that educators are not only recipients in the transformation of HEIs. By adopting innovative HRM practices, such as mentorship, peer support networks and recognition systems, institutions can create an environment conducive to sustainable innovation in teaching and research. Ultimately, this study contributes to the ongoing discourse on sustainable development in higher education by offering actionable insights into the implementation of FDPs. It emphasizes the need for HEIs to prioritize sustainability in their human resource strategies to cultivate a workforce capable of addressing the pressing challenges of the time.

Keywords: *Sustainable Development, Higher Education Institutions (HEIs), Faculty Development Programmes (FDPs), Human Resource Management (HRM), Innovative Practices.*

Introduction

In an era marked by pressing global challenges such as climate change, social inequality, and resource scarcity, the concept of sustainable development has emerged as a critical framework for ensuring a balanced and equitable future (Dauda, 2010; Knowles, Swanson & Holton III, 2011; Pathik et al., 2012). Higher Education Institutions (HEIs) play a pivotal role in advancing this agenda by equipping students, researchers and communities with the knowledge and skills required to address these complex issues. Among the key drivers of this transformation are faculty members whose teaching, research and community engagement significantly influence institutional and societal outcomes (Modebelu & Joseph, 2012).

Faculty Development Programmes (FDPs) have traditionally focused on enhancing pedagogical skills, research capacity and professional competencies. However, their potential to contribute to sustainable development within HEIs is increasingly being recognized. By embedding sustainability principles into curriculum design, research agenda and institutional culture, FDPs can empower faculty members to become change agents for sustainability. This paper explores the evolving role of faculty development programmes in promoting sustainable development in higher education, examining their impact, challenges, and potential to foster long-term institutional change (Castells, 2010).

Sustainable development has emerged as a pivotal concern in global discourse, particularly in the context of HEIs. As centers of learning, research, and societal influence, HEIs bear the responsibility of fostering sustainability across multiple dimensions, including environmental, social and economic aspects (Okevukola, 2002). Faculty members play a crucial role in this endeavour, as they are the primary conduits for knowledge dissemination and the application of sustainable practices within academic settings. This research examines how faculty development programmes can facilitate the integration of sustainability into the educational framework of HEIs, emphasizing innovative practices in human resource management (HRM) (Hartnett & Strassner, 2003).

The challenge of aligning the capabilities of faculty members with institutional sustainability goals necessitates a systematic approach to faculty development. This study seeks to identify effective strategies that HEIs can adopt to enhance faculty engagement in sustainable practices, thereby contributing to the overall mission of sustainable development (Paterson, 2005).

Literature Review

Sustainable development in higher education is increasingly recognized as essential for addressing global challenges, including climate change, inequality and resource depletion (Leal Filho et al., 2018). The United Nations' Sustainable Development Goals (SDGs) underscore the role of education in promoting sustainable societies, highlighting the need for HEIs to integrate sustainability into their curricula and operations (UNESCO, 2019). The global education sector is called to action and HEIs are at the forefront of instilling sustainable values and practices in future generations.

Faculty development programmes are designed to enhance the skills, knowledge and competencies of educators, ultimately improving teaching quality and institutional effectiveness (Ginsberg, 2011). These programmes encompass various initiatives, including workshops, mentoring and collaborative projects, aimed at fostering professional growth and innovation. Research indicates that effective faculty development can lead to improved student outcomes and greater institutional commitment to sustainability (Baker, 2020). The implementation of these programmes is critical, as they not only support faculty members in their professional journeys but also align with broader sustainability goals.

Innovative HRM practices are essential for creating a supportive environment for faculty development. Approaches such as peer support networks, mentorship and recognition systems can enhance faculty engagement and motivation (González et al., 2021). These practices not only foster a culture of collaboration but also align faculty development with the strategic goals of the institution, including sustainability initiatives. As HRM plays a central role in shaping the faculty experience, it is vital to explore how these practices can effectively contribute to a sustainable academic environment.

Faculty members are critical in embedding sustainability into the curriculum and institutional practices. They are responsible for designing courses that reflect sustainability principles and conducting research that addresses pressing societal issues (Tilbury, 2011). Moreover, faculty engagement in community partnerships can amplify the impact of HEIs on local and global sustainability efforts. The dual role of faculty members as educators and researchers allows them to bridge the gap between theory and practice, making sustainability a lived experience for students and the community.

The integration of sustainable development in higher education has gained global momentum, with the United Nations' SDGs serving as a guiding framework (UNESCO, 2017). HEIs are increasingly recognized as key contributors to sustainability through education, research, community engagement and institutional practices (Lozano et al., 2015). However, achieving these outcomes largely depends on the capacity and commitment of faculty members, making faculty development a critical component in this transition.

FDPs are instrumental in enhancing teaching quality, promoting active learning strategies and fostering interdisciplinary thinking (Steinert et al., 2006). Scholars have noted that effective FDPs contribute to improved student learning outcomes and greater faculty engagement in curriculum innovation (Guskey, 2002). When oriented toward sustainability, these programmes can help educators embed sustainability concepts across disciplines and foster critical thinking about social, environmental and economic challenges (Barth & Rieckmann, 2012).

Research indicates that one of the main barriers to integrating sustainability into higher education is the lack of faculty awareness, expertise, or motivation (Rieckmann, 2012). Faculty development can address these gaps by providing training on Education for Sustainable Development (ESD), promoting sustainability literacy and encouraging collaborative and experiential learning approaches (Sterling, 2004). According to Barth et al. (2007), faculty

members who undergo sustainability-focused training are more likely to redesign their courses, conduct sustainability-related research and engage in community partnerships.

The success of FDPs in advancing sustainability also hinges on institutional commitment and support. Studies emphasize that when professional development is aligned with strategic institutional goals, including sustainability, it fosters a culture of shared responsibility and long-term change (Tilbury, 2011). Moreover, interdisciplinary and cross-functional training programmes that involve administrators, researchers and teaching staff have shown to be more effective in embedding sustainability into institutional practices (Lozano & Pérez-Foguet, 2020).

Research Gap

FDPs focus mainly on enhancing teaching skills and research capabilities, however, there is limited research on long term effects of these programmes in fostering sustainability within HEIs. There is insufficient research on how effectively sustainability principles are integrated into FDPs across different disciplines. FDPs are generally discipline-specific, and there is a need for more interdisciplinary programmes focused on sustainability challenges. Despite their potential, FDPs often face challenges such as limited funding, resistance to change and a lack of incentives or recognition for faculty members who engage in sustainability work (Evans et al., 2015). Additionally, many programmes focus narrowly on pedagogical skills without addressing the broader competencies required for sustainability education, such as systems thinking, anticipatory learning and values-based approaches (Wiek et al., 2011).

Objectives of the Study

The objective of this study is to evaluate the perceptions, practices and challenges related to sustainability in higher education institutions from the perspective of faculty members. The study also tries to explore the underlying factors and dimensions in the perceptions of faculty members on the impact of FDPs on sustainable development in HEIs.

Research Methodology

The study is exploratory in nature which tries to explore the underlying dimensions.

The survey instrument used was a self-designed questionnaire covering 20 questions. 5 point Likert scale was used to measure the response, ranging from 1 to 5, with 1 signifying least preferred to 5 most preferred. The questions covered importance of sustainable development in HEIs, preparedness to integrate sustainability in course curricula and teaching it, level of sustainability initiatives in HEIs including communication of sustainability goals to faculty and students, interdepartmental collaboration on sustainability projects and external partnerships for sustainability efforts, role of research in advancing sustainability, role of FDPs in promoting sustainability and impact of faculty members' attitude towards it, role of students in sustainability initiatives, etc.

Sample size is 50 respondents covering faculty members across varied disciplines of HEIs engaged in either government or government-aided colleges in Kolkata region in the state of West Bengal.

The Sampling techniques used is convenient sampling (non-random sampling technique). The Analysis tool used is Principal Component Analysis sampling technique (PCA).

Data Analysis

Principal Component Analysis (PCA) was employed on 18 items related to sustainable development practices in higher education institutions to identify the underlying components. Prior to the analysis, the suitability of data for factor analysis was ensured using Kaiser-Meyer-Olkin (KMO) test for sample adequacy and Bartlett's Test of Sphericity. KMO measure was 0.729 exceeding threshold value of 0.5 substantiating the adequacy of the sample for factor analysis. Bartlett's Test of Sphericity was also significant with χ^2 value of 466 and $p < .001$, indicating that the data were appropriate for PCA. Five components with eigen values greater than one was extracted using Varimax rotation cumulatively explaining 72.7% of the total variance in the data (Table 1). Each component represents a distinctive thematic dimension of sustainability development efforts in higher education institutions. The loading pattern supports the multi-dimensional pattern of sustainability integration capturing both individual faculty development and broader institutional engagement.

First component was identified as *Student Engagement and Institutional Support* including higher loadings from feedback from students on sustainability education (0.806), communication from higher education institutions (0.803), importance of external partnerships (0.704), student engagement in sustainability initiatives (0.697), and importance of sustainable development in higher education (0.536). Second component was defined as *Faculty Development and Academic Practices* with loading from updating best practices (0.852), improving FDP for sustainability (0.790), importance of research in sustainability (0.699), and role of faculty in sustainability (0.652). Third component was extracted as *Curriculum Integration and Participation* with strong contributions from barriers to integration of sustainability (0.859), participation in professional development for sustainability (0.818), and integration of sustainability in curriculum (0.717). Fourth Component was conceptualized as *Faculty Readiness and Attitudes* with loadings from preparedness of faculty for sustainability (0.875), change in faculty attitudes towards sustainability (0.674), and effectiveness of faculty development programmes (0.655). Fifth component was identified as *Institutional Support and Impact Assessment* and encompassing loadings from success of sustainability initiatives (0.892), effectiveness sustainability measures on students (0.732), and helpfulness of resources for implementing sustainability (0.696).

Table 1. Component Loadings						
	Component					
	1	2	3	4	5	Uniqueness
Feedback from students on sustainability education	0.806					0.276
Communication from higher education institutions	0.803					0.259
Importance of external partnerships	0.704					0.377
Student engagement in sustainability initiatives	0.697					0.378
Importance of sustainable development in higher education	0.536					0.449
Updating best practices		0.852				0.257
Improving FDP for sustainability		0.790				0.239
Importance of research in sustainability		0.699				0.243
Role of faculty in sustainability		0.652				0.240
Barriers to integration of sustainability			0.859			0.184
Participation in professional development for sustainability			0.818			0.226
Integration of sustainability in curriculum			0.717			0.240
Preparedness of faculty for sustainability				0.875		0.162
Change in faculty attitudes towards sustainability				0.674		0.385
Effectiveness of faculty development programmes				0.655		0.381
Success of sustainability initiatives					0.892	0.174
Effectiveness sustainability measures on students					0.732	0.212
Helpfulness of resources for implementing sustainability					0.696	0.226
<i>Note.</i> 'varimax' rotation was used						

Discussion

The present study employed Principal Component Analysis (PCA) to explore the underlying dimensions of sustainable development practices within higher education institutions. The statistical preconditions for PCA were met, as evidenced by an acceptable KMO value (0.729) and a highly significant Bartlett's Test of Sphericity ($\chi^2 = 466$, $p < .001$), confirming the adequacy of the dataset for factor analysis.

The analysis revealed a five-component solution, cumulatively explaining 72.7% of the total variance, which is considered robust in social sciences, particularly in exploratory contexts. These components reflect the multi-dimensional nature of sustainability integration, capturing

diverse perspectives from institutional infrastructure to individual faculty behaviour and curriculum-level engagement.

Key Findings

Student Engagement and Institutional Support emerged as the first and most dominant component, suggesting that successful sustainability initiatives are strongly linked to both active student participation and visible institutional commitment. This underscores the importance of strategic communication, partnership-building, and student-centered programming. The second component, Faculty Development and Academic Practices, highlights the critical role of faculty in operationalizing sustainability through teaching and research. High loadings on variables like updating best practices and improving faculty development programmes suggest that institutions must prioritize ongoing professional learning for faculty. Curriculum Integration and Participation, the third component, reflects challenges and opportunities in embedding sustainability into academic curricula. High loading on barriers to integration signals that structural or pedagogical obstacles still exist, but also shows that engagement in professional development is a key facilitator. The fourth component, Faculty Readiness and Attitudes, emphasizes the need for psychological and pedagogical preparedness among educators. Faculty attitudes and perceptions were found to be closely linked with the effectiveness of sustainability integration, supporting the notion that internal motivation and readiness are as crucial as institutional mandates. Finally, Institutional Support and Impact Assessment stresses the importance of evaluating the outcomes of sustainability initiatives. High loadings on success indicators and student impacts suggest that institutions are increasingly focused on evidence-based sustainability efforts and resource allocation.

These components collectively portray a system in which sustainability in higher education is not limited to administrative policy but is a dynamic interplay between institutional structures, faculty engagement, curricular innovation, and student involvement.

Limitations of the Study

Non-random sampling technique was used. The sample size is comparatively smaller. No causal relationship was proposed.

Future Research Directions

Further studies can be conducted to confirm the factor structure using multiple data set. Further regression models can be proposed and empirically tested. Further studies can be conducted to explore other dimensions of sustainable development in HEIs.

Conclusion

This study successfully identified five distinct dimensions underlying sustainable development efforts in higher education through PCA, offering a comprehensive framework for analyzing sustainability integration. The results affirm that sustainability is a multi-level endeavor

involving policy, pedagogy, infrastructure, and community engagement. Institutional support must be coupled with student and faculty engagement to realize meaningful sustainability outcomes. Faculty development and curriculum integration are pivotal for embedding sustainability into core academic practices. Assessment mechanisms and resource availability play an essential role in ensuring that sustainability measures are both impactful and scalable.

These insights provide practical implications for policymakers, academic leaders, and curriculum designers seeking to enhance sustainability efforts within their institutions. Future research could extend this work by applying Confirmatory Factor Analysis (CFA) to validate the identified structure or conducting comparative analyses across different institutional contexts or geographic regions.

This study highlights the critical role of faculty development programmes in promoting sustainable development within HEIs. By equipping faculty with the necessary skills and knowledge, institutions can foster a culture of sustainability that permeates teaching, research, and community engagement. Innovative HRM practices play a vital role in supporting these development programmes, enhancing faculty engagement and aligning institutional goals with sustainability initiatives.

As HEIs continue to navigate the complexities of sustainable development, prioritizing faculty development and innovative HRM practices will be essential. This research contributes to the ongoing discourse on sustainability in higher education, offering actionable insights for institutions seeking to enhance their commitment to sustainable practices.

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