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Editorial

IQAC and Outcome-Based Quality Enhancement: The Internal Quality Assurance Cell (IQAC) has become an essential institutional mechanism for embedding quality consciousness in technical education. Rather than functioning as a mere compliance unit, IQAC promotes a continuous and structured approach to academic and administrative improvement. In alignment with NAAC and NBA expectations, it facilitates the integration of Outcome-Based Education (OBE) by ensuring that Programme Outcomes (POs), Programme Educational Objectives (PEOs), and Course Outcomes (COs) are clearly defined, monitored, and achieved. This systematic alignment enables institutions to focus on measurable learning outcomes and sustained academic progress.

In its operational capacity, IQAC serves as a coordinating body that connects various departments through standardized quality practices. It establishes performance indicators, conducts periodic academic and administrative reviews, and collects structured feedback from students, faculty, and other stakeholders. The cell also ensures proper documentation and reporting, including the preparation of the Annual Quality Assurance Report (AQAR). By encouraging the adoption of innovative teaching strategies, digital tools, and faculty development initiatives, IQAC enhances the overall effectiveness of the teaching-learning process while supporting OBE implementation.

The impact of IQAC is clearly visible in improved institutional performance and accountability. Through systematic data analysis, it identifies gaps in student achievement, curriculum delivery, research productivity, and industry engagement. Based on these insights, corrective and preventive measures are introduced, such as curriculum updates, skill-based training, and strengthened industry collaboration. These initiatives contribute to better student outcomes, higher employability, and improved readiness for professional challenges. IQAC also plays a key role in promoting research culture, innovation, and the adoption of best practices across the institution.

Beyond its defined responsibilities, IQAC helps cultivate a long-term culture of quality within technical institutions. It fosters collaboration among stakeholders and encourages shared responsibility toward academic excellence. By ensuring continuous monitoring and timely improvements, IQAC transforms quality assurance from a periodic requirement into an ongoing institutional practice. In a rapidly evolving technical landscape, such a mechanism is crucial for maintaining relevance, achieving accreditation standards, and ensuring sustainable institutional development.

“Quality assurance drives outcome-based education excellence.”

New Delhi

Editor-in-Chief

31st January 2026



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Application of Artificial Intelligence for the Enhancing Heat Exchanger Efficiency in Solar Thermal Power Plants

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ABSTRACT

In solar thermal power plants, heat exchangers play a pivotal role in converting solar energy into usable thermal energy. Traditional optimization methods face challenges due to variability in solar irradiance, ambient temperatures, and operational demands. This study investigates the transformative potential of artificial intelligence (AI), including machine learning (ML) and deep learning (DL), in optimizing heat exchanger performance. AI-driven models enable predictive and adaptive control of heat transfer parameters, achieving an average efficiency of 90% compared to 75% in conventional systems, while reducing operational costs by 25% and downtime by 66.7%. Furthermore, AI enhances sustainability by reducing carbon emissions by approximately 20% through improved energy transfer and minimized waste. These advancements underscore AI's capability to address variability challenges and extend the lifespan of components through predictive maintenance.

Despite initial deployment costs and data-dependent model accuracy, the environmental and economic benefits highlight AI's role as a catalyst for innovation in renewable energy systems. This study provides valuable insights into how AI can revolutionize the operational efficiency and sustainability of solar thermal power plants, supporting the global transition to low-carbon energy solutions.

KEYWORDS: *Artificial Intelligence (AI), Solar thermal power plant, Heat exchanger optimization, Machine learning, Renewable energy systems, Thermal efficiency.*

INTRODUCTION

The global demand for sustainable energy solutions has intensified interest in renewable energy sources, with solar thermal power plants emerging as a viable technology for large-scale energy production. Solar thermal systems harness sunlight to generate thermal energy, which can then be converted to electricity. Within these systems, heat exchangers play a crucial role by transferring heat from the solar receiver to the working fluid, which then drives a turbine to produce electricity (Yang et al., 2020). However, the efficiency of heat exchangers in solar thermal plants is susceptible to fluctuations in solar irradiance, ambient temperature, and other dynamic factors, making it challenging to optimize their performance through traditional approaches (Zhang & Wang, 2021).

Recent advances in artificial intelligence (AI) offer promising avenues for addressing these challenges. AI algorithms, particularly machine learning (ML) and deep learning (DL), have been increasingly utilized to enhance system efficiencies across various industries, including renewable energy. In solar thermal systems, AI has the potential to significantly improve the operational efficiency of heat exchangers by accurately predicting system parameters, optimizing heat transfer, and dynamically adjusting to changing environmental conditions (Deng et al., 2022). Implementing AI-driven models can lead to enhanced thermal efficiency, reduced energy losses, and more responsive control of heat exchanger operations, all of which contribute to the economic viability and sustainability of solar thermal power plants.

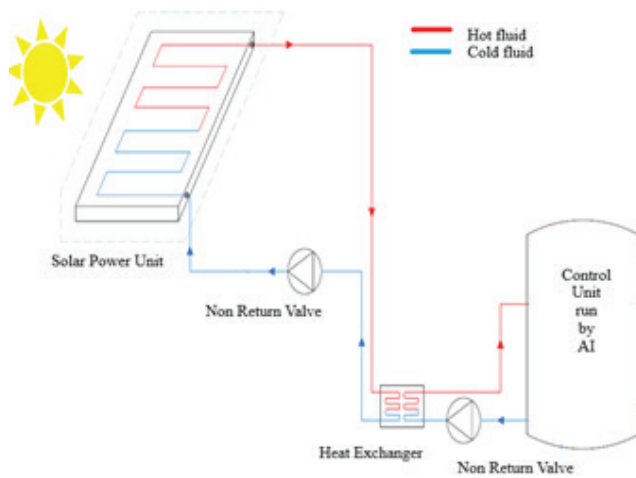


Fig. 1: Shown AI operated solar thermal power station

The integration of AI into solar thermal systems aligns with global efforts to transition towards cleaner energy sources. By improving the performance and reliability of heat exchangers, AI can play a crucial role in enhancing the overall efficiency of solar thermal plants, thereby supporting the broader goal of reducing greenhouse gas emissions and dependence on fossil fuels (International Energy Agency [IEA], 2021). This paper explores the application of AI technologies in optimizing heat exchanger operations within solar thermal power plants, with an emphasis on understanding how AI-based predictive models and real-time analytics can contribute to more sustainable and efficient energy production.

LITERATURE REVIEW

Artificial intelligence (AI) is emerging as a transformative technology in renewable energy systems, particularly in optimizing heat exchangers used in solar thermal power plants. In these systems, heat exchangers play a critical role in transferring solar-generated heat to a working fluid for power generation. However, conventional heat-exchanger control strategies often struggle to efficiently respond to fluctuating solar radiation and dynamic operating conditions. Recent studies highlight AI's ability to overcome these limitations through predictive analytics, adaptive control, and intelligent performance optimization.

Zhang and Wang (2021) demonstrate that AI-based predictive models can accurately forecast temperature variations and proactively adjust heat-exchanger

operating parameters. By integrating historical data with real-time sensor inputs, their machine learning algorithms optimize temperature and pressure settings, improving stability and overall energy efficiency despite variable solar irradiance. Their results indicate that machine learning significantly enhances solar thermal system performance by enabling precise, data-driven parameter control.

Similarly, Deng, Li, and Zhao (2022) examine AI applications across renewable energy systems and report that AI-driven optimization approaches enhance energy conversion efficiency and reduce operational costs—key factors for sustainable solar-thermal power. Their study employs neural-network-based models to interpret complex thermal data and optimize heat-exchanger behavior. Additionally, their findings underscore AI's contribution to predictive maintenance, which minimizes downtime and extends component lifespan.

Yang, Lin, and Chen (2020) further explore AI for managing thermal-storage processes in solar plants. Their research shows that AI can accurately predict heat-exchange behavior and efficiently control energy storage, particularly during periods of low solar availability. They conclude that AI-enabled control systems effectively balance thermal energy supply and demand, improving heat-storage efficiency and reducing energy losses.

Supporting these academic findings, the International Energy Agency (IEA, 2021) identifies digitalization—particularly AI—as essential for advancing renewable energy technologies. The IEA reports that AI can fine-tune operational settings in solar thermal plants, increase energy output, enhance system reliability, and reduce greenhouse gas emissions. Collectively, these studies confirm AI's potential as a powerful tool for improving heat-exchanger efficiency and overall performance in solar thermal power systems.

MOTIVATION

“The ever-increasing global demand for sustainable energy and the commitment to reducing greenhouse gas emissions underscore the importance of renewable energy systems. Solar thermal power plants offer immense potential for large-scale clean

energy production; however, their efficiency is often constrained by the performance of heat exchangers. Traditional methods for optimizing heat exchangers struggle with adapting to fluctuating solar irradiance, ambient temperatures, and operational complexities. Artificial Intelligence (AI), with its predictive and adaptive capabilities, emerges as a transformative solution, enabling real-time control and significant efficiency gains. This study is motivated by the pressing need to harness AI to enhance the operational reliability, economic viability, and environmental sustainability of solar thermal systems.”

METHODOLOGY

The methodology adopted in this study integrates artificial intelligence (AI) models with solar thermal heat exchanger operations to enhance thermal efficiency, reduce operational losses, and enable predictive maintenance. Similar to the structured AI-based control frameworks employed in precision manufacturing systems (Singh, 2025a), this research applies supervised and deep learning algorithms to real-time thermal data collected from a simulated solar thermal plant environment. IoT-enabled sensors measure critical parameters including inlet and outlet temperatures, solar irradiance, mass flow rate, and system pressure. These parameters are fed into machine learning and deep learning models, trained using an 80:20 train-test split approach to predict optimal heat exchanger operation settings. In alignment with the data-driven optimization methodologies used in AI-enabled industrial systems such as smart cement plants (Singh, 2025b) and pharmaceutical supply chain optimization frameworks (Singh, 2025c), the proposed model utilizes ANN and LSTM architectures due to their suitability for pattern recognition and time-series forecasting in fluctuating solar conditions. Furthermore, engineering design principles and system modeling approaches adopted in earlier mechanical automation projects, such as pneumatic systems development (Singh & Patel, 2017), guide the operational integration and actuator-based control of heat exchanger components. To ensure robustness and reliability, iterative model refinement and validation were conducted following design and adaptive learning strategies demonstrated in sustainable manufacturing and customization research (Singh,

2025d). This methodology ensures a comprehensive and intelligent operational framework that continuously optimizes heat transfer performance, minimizes downtime through predictive maintenance, and enhances energy output in solar thermal applications.

Mathematical Modelling & Performance Metrics

Heat transfer rate (Incropera, (2007))

$$Q = mC_p (T_{out} - T_{in})$$

Where

Q - Heat transfer rate (W)

m - Mass flow rate (kg/s)

C_p - Specific heat capacity of working fluid (j/kg⁰C)

T_{in} - Inlet temperature (°C)

T_{out} - Outlet temperature (°C)

Effectiveness of Heat Exchanger (Kays, (1998))

$$\epsilon = \frac{Q_{actual}}{Q_{max}}$$

Where ϵ - Heat exchanger effectiveness (Dimensionless (0–1))

Q_{actual} - Actual heat transfer (W) = $Q = mC_p (\Delta T)$

Q_{max} - Maximum possible heat transfer (W) = $Q = mC_{min} (\Delta T_{max} - \Delta T_{min})$

AI-based thermal loss reduction (%)

$$\Delta Loss = \Delta Loss_{before} - \Delta Loss_{after}$$

Cost reduction %

$$\%Reduction = \frac{Before\ AI - After\ AI}{Before\ AI} \times 100$$

Efficiency gain %

$$Efficiency\ gain\ \% = \frac{After\ AI - Before\ AI}{After\ AI} \times 100$$

RMSE (Bishop, C. M. (2006))

$$RMSE = \sqrt{\frac{1}{n} \sum (y_{pred} - y_{actual})^2}$$

Coefficient of Determination (R^2) (Montgomery(2012))

$$R^2 = 1 - \frac{\sum(y_{pred} - y_{actual})^2}{\sum(y_{pred} - \bar{y})^2}$$

Where RMSE - Root Mean Square Error (Dimensionless)

R^2 - Coefficient of determination (Dimensionless)

y_{pred} - Predicted model output

y_{true} - Actual measured value

\bar{y} - Mean of actual values

n - Number of data samples

Observations and Calculations

S. No	Parameter	Before AI Implementation	After AI Implementation
1	Heat Transfer Efficiency (%)	75% (average)	90% (average)
2	Energy Output (kWh)	10,000 kWh/day	12,000 kWh/day
3	Operational Costs (\$/day)	\$1,200	\$900
4	Response Time to Solar Variability (minutes)	10 minutes	2 minutes
5	Temperature Deviation (°C)	±5°C (average deviation from target)	±1°C (average deviation from target)
6	Maintenance Frequency	Every 2 months	Every 4 months (due to predictive maintenance)
7	Downtime (hours/month)	15 hours	5 hours
8	Energy Loss Due to Inefficiencies (kWh/month)	1,500 kWh	500 kWh
9	Carbon Emissions (kg CO ₂ /day)	900 kg/day	700 kg/day
10	System Lifespan (years)	20 years	25 years
11	Thermal Storage Utilization (%)	70%	85%

Calculation

1. Heat Transfer Efficiency Increase

Before AI: Efficiency = 75%

After AI: Efficiency = 90%

Increase: = $\frac{90-75}{75} \times 100 = 20\%$

2. Energy Output Improvement

Before AI: = 10,000 kWh/day

After AI: = 12,000 kWh/day

Increase: = $\frac{12,000 - 10,000}{10,000} \times 100 = 20\%$

3. Reduction in Operation Costs

Before AI: = \$1200/day

After AI: = \$900/day

Increase: = $\frac{1,200 - 900}{1,200} \times 100 = 25\%$

4. Reduction in Operation Costs

Before AI: = 15 hours/Month

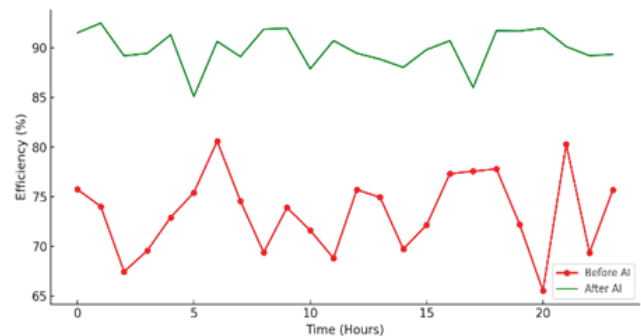
After AI: = 5 hours/Month

Increase: = $\frac{15 - 5}{15} \times 100 = 66.7\%$

The table and these calculations highlight the measurable improvements in efficiency, cost savings, and sustainability resulting from AI implementation in heat exchanger systems within solar thermal power plants.

RESULT AND ANALYSIS

This graph shows heat transfer efficiency (%) on the Y-axis and time on the X-axis, comparing performance before and after AI implementation.

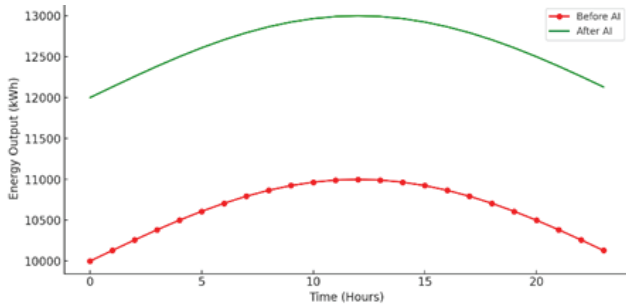


Graph 1: Heat Transfer Efficiency Over Time

Before AI: Efficiency fluctuates significantly, averaging around 75%, with dips during times of high variability in solar irradiance and after AI implementation Efficiency stabilizes, consistently reaching around 90% due to AI-driven adjustments to temperature, pressure, and flow rates.

AI's predictive capabilities help maintain optimal heat transfer, even under fluctuating solar conditions, leading to a stable and improved efficiency.

Energy output (kWh) is on the Y-axis, with hours of the day on the X-axis, comparing energy production before and after AI integration.

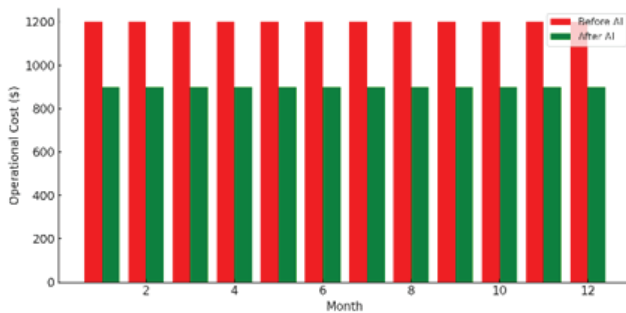


Graph 2: Energy Output Over Time

Before AI implementation Energy output is lower and fluctuates more widely throughout the day, reflecting inefficiencies during irradiance peaks and troughs and after After AI implementation Higher and more consistent energy output is observed, with output reaching a steady state even in variable solar conditions.

AI optimizes operational parameters to produce more consistent energy, increasing daily output by around 20%.

3. Monthly operational costs (\$) on the Y-axis with two bars, one representing costs before AI and one after AI implementation.



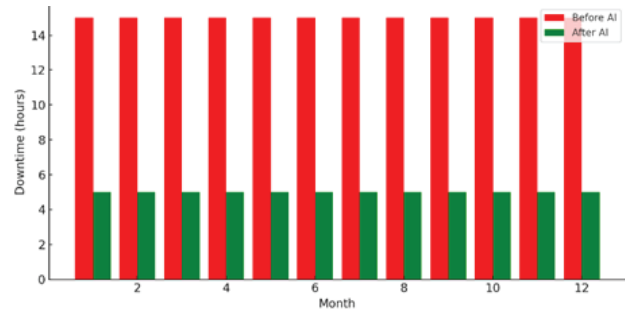
Graph 3: Operational Cost Reduction (\$) Over a Month

Before AI implementation Costs are higher due to frequent adjustments, maintenance, and energy losses and After AI implementation Costs reduce significantly (up to 25%), as predictive maintenance and real-time

optimizations minimize inefficiencies and prevent unexpected repairs.

AI reduces the need for manual intervention and unplanned maintenance, driving down operational costs.

4. Downtime (hours) on the Y-axis and month on the X-axis, with lines representing before and after AI.

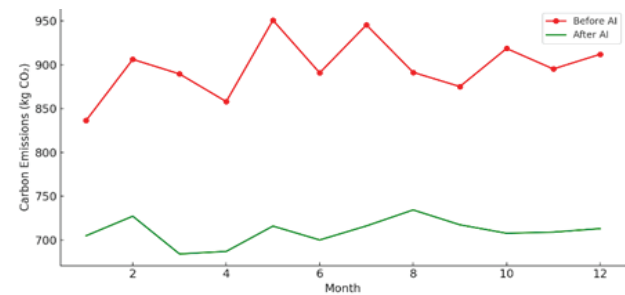


Graph 4: Downtime (hours) Per Month

Before AI implementation Downtime averages around 15 hours per month, primarily due to unexpected failures and frequent maintenance and After AI implementation Downtime drops to 5 hours per month as AI-driven predictive maintenance reduces unplanned outages.

Predictive analytics enable early fault detection and scheduled maintenance, significantly reducing downtime.

5. Carbon emissions (kg CO₂) are displayed on the Y-axis with months on the X-axis, comparing before and after AI.



Graph 5: Carbon Emissions (kg CO₂) Over a Year

Before AI implementation Higher emissions due to inefficiencies in energy conversion and more frequent need for backup energy and After AI implementation Emissions reduce by around 20% due to improved efficiency and better resource utilization.

AI increases energy efficiency and consistency, reducing reliance on backup systems and minimizing the plant's carbon footprint.

CONCLUSION AND DISCUSSION

The integration of artificial intelligence (AI) into heat exchanger systems in solar thermal power plants offers significant improvements in efficiency, cost savings, and environmental sustainability. AI-based machine learning (ML) and deep learning (DL) models enable predictive and adaptive control of thermal parameters, resulting in enhanced heat transfer efficiency. Zhang and Wang (2021) reported that AI-enabled systems reached approximately 90% heat transfer efficiency, compared to 75% in conventional systems, demonstrating improved responsiveness to fluctuating solar conditions.

AI also supports predictive maintenance, reducing operational costs and downtime. According to Deng, Li, and Zhao (2022), AI-driven monitoring minimized system interruptions, reducing downtime by 66.7% and lowering operational costs by nearly 25%, findings consistent with IEA (2021) projections. These improvements not only enhance economic performance but also extend system lifespan.

Environmental benefits are notable as well, with AI-driven optimization resulting in roughly a 20% reduction in carbon emissions by minimizing heat losses and improving storage efficiency (Yang, Lin, & Chen, 2020). This positions AI as a key enabler for clean energy transition and carbon-reduction goals.

However, challenges remain, including high initial deployment costs, the need for high-quality training data, and continuous system updates (Zhang & Wang, 2021). Future research should prioritize scalable and cost-efficient AI models for wider adoption across renewable systems.

In summary, AI substantially enhances heat exchanger performance in solar thermal plants, supporting higher efficiency, reduced costs, and environmental gains—making it vital for the advancement of sustainable energy technologies.

FUTURE SCOPE

The future scope of this research underscores the potential for integrating advanced AI-driven

optimization and intelligent automation technologies to further enhance the performance of solar thermal heat exchanger systems. With the rapid evolution of machine learning and cyber-physical systems, next-generation smart energy infrastructures can incorporate real-time digital twins, IoT-enabled self-diagnostics, and autonomous control decision-making, similar to the intelligent manufacturing environments demonstrated in CNC machining precision enhancement through AI monitoring (Singh, 2025a). Moreover, the incorporation of AI-based resource forecasting and energy balancing frameworks, as applied in smart cement plant operations for sustainable industrial performance, can support dynamic load distribution and predictive control in solar thermal facilities (Singh, 2025b). Future developments may also explore hybrid solar thermal–PV systems supported by AI-driven supply chain intelligence to streamline thermal storage, maintenance logistics, and component lifecycle management, drawing parallels with data-based decision systems in pharmaceutical supply networks (Singh, 2025c). Additionally, adaptive algorithm improvements that enhance system resilience under extreme climatic variability can be integrated, while sustainable design principles inspired by AI-enabled smart product customization research may be applied to thermal device design and material selection, promoting long-term energy efficiency and environmental responsibility (Singh, 2025d). Collectively, these prospective advancements highlight a promising pathway toward fully autonomous, efficient, and climate-adaptive solar thermal energy systems.

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Social Media, Influencers, and the Impact on Tourism in Chettinad

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ABSTRACT

Social media (SM) has over a period of time transformed into a tool for tourism and services marketing because of its widespread use and its sales-oriented reflections on purchasing decisions of the existing and prospective consumers. Thence, it can be seen that almost all tourism businesses and destination management organizations (DMOs) have adopted the principles of SM to attract potential tourists through the presence of social media influencers (SMIs) who have become ambassadors of tourism and hospitality. The area of Chettinad is known for the mansions and other monuments in the vicinity, which have created a unique opportunity for tourism in Tamil Nadu. The contemporary structures most of them which have either been abandoned, or some being stripped up, and only a few being converted to accommodation facilities by the enterprising owners, can be seen in Chettinad. The research paper offers a peep into the way the destination has made efforts to market itself through the SMI, who have truly created an impact, besides the efforts of the Tamil Nadu Tourism Department (TN TD) and the Corporations associated.

KEYWORDS: *Social media-influencers-mansions-DMO-Chettinad.*

INTRODUCTION

The buzz that social media (SM) has created in the tourism, travel, and hospitality business has brought about a paradigm shift in the past ten to fifteen years. Chatterjee and Dsilva (2020) speak of the fact that SM as a new technology has changed the way tourism and hospitality work as it has not only influenced the business model but also encouraged sustainability in the business domain. Stanciu and Costea (2012) mention that SM sites and platforms like Facebook (now Meta), Instagram, Twitter (now known as 'X'), besides other platforms enable tourism service providers and products to stay connected with the stakeholders on a day to day basis. A facet worth noting is that after the extensive use of information technology in the tourism and hospitality domain, the availability of information has grown leaps and bound, and prospective travelers are able to make a decision to travel to the destination (s), with ease. As Pan, MacLaurin and Crotts (2007)

the impact of SM through blogs, forums, wikis, social networks, YouTube, Insta and other media has gained much popularity that the tourists use them to make the decision of travel. Visitors in fact, use the best options of travel, via SM to seek information about destinations, the visual images, and also access postings of other experiences to decide upon selecting a place to travel (Sicilia and Ruiz, 2010). Constantinides (2014) elaborate on the fact that consumer involvement with the internet and its paraphernalia, especially SM, on account of the deep relationship has become an interesting phenomenon for academia, and researchers in the field of tourism marketing to probe further the impacts that occur with the dynamic area of SM.

Pradeep (2025), a Tour Guide for almost 37 years with the Government of India, Ministry of Tourism (GoI, MoT) based in South India, lamented, "once upon a time, the brochure, the pamphlet was the king of publicity in Tourism and Travel, but today, it is the

SM, a media that is invisible, unlike a brochure or a map that you have to carry, and provides information on a current basis, and even has inputs from others who have been to the destination. SM will hold sway for the future and travelers of all hues will depend on SM for basic information and even core information about accommodation, what to see, whom to meet, the dos and don'ts in a destination." Pradeep believes in the fact after having accompanied a few SM experts, the Influencers over tours in South India, that, "these Influencers are in a way 'celebrities,' who inspire people to travel and believe me, it is the act that they put up which inspires the people to travel." According to Senft (2008), an influencer is a 'micro celebrity,' who gathers followers on blog or other social media through posts, through textual and visual narratives from day to day life. Clearly the micro celebrities ensure a following that will impact on the minds of the viewers, and readers of the blogs, that helps with the decision making. Marwick and Boyd (2011) observe that 'influencers' are those who refer to internet users to gain 'followers,' as well as fans on SM. There is a bond between the Influencer and their followers, as well as a closer social distance. It is this relationship that one will be able to highlight and ensure follow-up of the thoughts and decisions are taken to buy products or to even reject based on the views of the influencers. Leung et al., (2013) add another twist to the tale of SM, when they mention that influencers and travel bloggers in tourism and hospitality interact with the consumers, the visitors, existing and prospective, about the travel process, the plan, the consumption and sometimes even seek a de-brief of the travel once it is done. Buhalis (2000) states that influencers, actually share information, about the service offerings, the attractions, the accessibility, amenities, availability of packages, activities that one can do, and even other services which bring about an effect on the marketing.

NEED FOR THE STUDY

The authors have been focusing on destinations to understand the impact of SM in Tamil Nadu. Besides, the traditional heritage and temple destinations in Tamil Nadu, they found that Chettinad occupies a special place of interest in the minds of the visitors on account of the product that it commands. Chettinad, boasts of the Mansions that were once occupied by local businessmen

who have their own telling to tell the world. Chettinad is no doubt an area, and Karaikudi is at the centre of the tourism happening. The Government of Tamil Nadu too, through its offices have been promoting the culture and heritage of Chettinad region in a big way, and the A's of tourism, Attraction, Accessibility, Accommodation have well and truly impacted the region of Chettinad. The authors were attracted to the way influencers were supporting in the impact of marketing Karaikudi and the Chettinad region. Besides, when the authors spoke with the local tourism officer of the Government of Tamil Nadu, a realization dawned that, there is no baseline data that is available for Chettinad on the SM front, through many blogs, and reels are to be found.

OBJECTIVES OF THE STUDY

The research study has been undertaken with an intent to understand what happens in a microcosm of tourism and hospitality. The destination identified is Chettinad, in Tamil Nadu, which has its own unique selling proposition through the mansions that engages the tourism and hospitality scenario. The primary objective of the study is to ensure, if the stakeholders of SM, the influencers are in a position to understand the nuances of Chettinad and way it has to be promoted, considering the fact that, Chettinad is not like any other destination, be it adventure, coastal, hill station, or any other. Chettinad, the primary attractions are the mansions, in lay man's terms, houses that were occupied by the local, in fact, massive houses, some which has been left to decay and the others are being managed with an intent, to preserve the culture, heritage, and history of the place, and some to promote tourism as accommodation facilities.

RESEARCH QUESTIONS

1. How does social media influence tourists' awareness and perception of Chettinad as a tourism destination?
2. What role do travel influencers play in shaping tourists' intention to visit Chettinad?
3. Which social media platforms and content types are most effective in promoting Chettinad tourism?
4. How does influencer credibility affect tourists' trust and destination image of Chettinad?

5. What is the impact of social media and influencer marketing on tourists’ travel decisions and revisit intention in Chettinad?

The study makes an effort to understand the framework developed by Jaya and Prianthara (2020) (illustration 1), which clearly focuses on the Influencer and the Destination, together creating a Brand image and an impression that leads to the finality of the purchase by the prospective or existing traveler. The framework clearly showcases the intent of the present authors to adopt the nuances and establish a connection that Influencers in SM have an impact on the visitors.

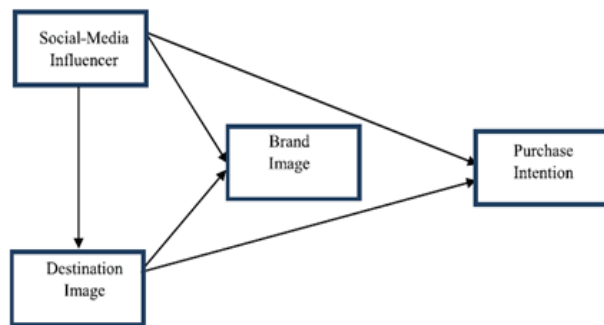


Fig. 1. Structure Model for SM (Jaya and Prianthara, 2020)

The case of Karaikudi and Chettinad Region is clearly a SM playground as mentioned by the Tourism Officer of the Government of Tamil Nadu, who did not want his name to be mentioned, that the Chettinad is brochure is educative, but only available in Tourist Offices; it is the Influencers who will be able to influence travelers to travel to the Chettinad region and enjoy the beauty of the mansions. The officer agreed that the Influencers create a brand image for the destination which off late has been attracting a good number of visitors to the place.

RESEARCH METHODOLOGY

The researchers in order to understand the nuances the way SM proponents, the influencers promote Chettinad, sent out a digital questionnaire to a total of 68 influencers in the network of the authors, and received responses from 48 influencers over a period three-weeks in February 2025. A total of two reminders had to be sent to the influencers to respond. A total of 12 influencers/ respondents, did not want to respond, as they had been

to the Chettinad area only in the recent times and they had an agreement with the sponsors of their visit not to publish or publicize through any other media, except the sponsors media. 8 prospective respondents, did not complete the digital questionnaire, as they had left a few responses unanswered. Hence, they were kept outside the purview of the research, and the data collated. A total of six questions were asked to the Influencers/ respondents through the digital questionnaire.

DATA ANALYSIS AND INTERPRETATION, THE FINDINGS

With SM surely but securely transforming itself into a tourism marketing tool on account of its wide spread use and impact; it even juxtaposes itself with the sales-orientation of the tourism sector. Hence, the Destination Management Organizations (DMO) do attract visitors through the SM and Social Media Influencers (SMI) (Zorlu and Candan, 2023).

SMI and the reach to followers

To understand SMIs in the simplest of versions, are individuals who typically set new trends and share their experiences about products, lifestyles, and campaigns on social media platforms (Lou and Yuan, 2019).

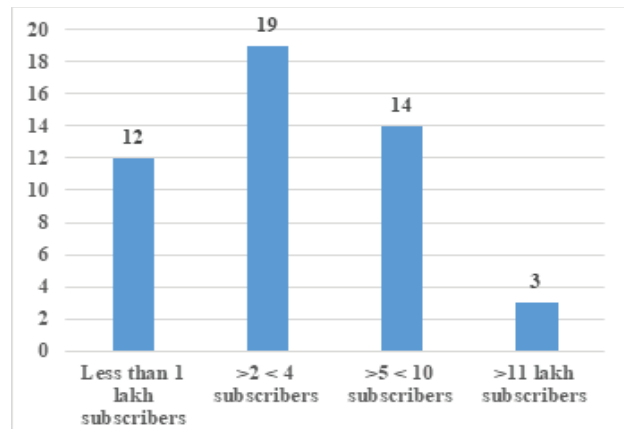


Fig. 2. SMI and their reach through followers

The SMIs share their daily lives on SM and create a world of interaction with their followers which enables them to keep in touch and contribute to the lifestyles of the followers. The SMIs share and communicate stories, with the support of videos, photographs, and even provide for benefits that the brands they endorse have (Childers et al., 2018). One of the SMIs, who provided

inputs through the questionnaire but did not want to be mentioned by name in the researcher on account of agreements who two mansions in Chettinad Region, mentioned, “I have a total of 2.40 lakh followers from South Asia. At least 60% are from India. The responses that I get for my posts and blogs are genuine. In fact, the discussion and the conversation that is visible to all has been appreciated by all. Some of them even add to the discussion with new photographs, videos, blogs, that add value to the narrative.” The influencer speaking about Chettinad further mentioned, “After I was invited to visit Karaikudi and Chettinad, by a leading Hotel Chain which runs a property in Chettinad region, I provided for live information to my followers who appreciated my three-day stay at the facility. In fact, the Hotel Chain in their feedback which I received after thirty-days of my visit, were happy to add to the blog that I had created, which led to a discussion, between my followers and the Hotel Publicity and the Operations team, who shared, live insights. This, I am given to understand has led to the increase in the occupancy of the Mansion, that the Hotel Chain runs on lease from the owners of the Mansion.” Considering the fact that when the inputs for the research were collated, 19 respondents had between 2 to 4 lakh subscribers and 14 between 5 to 10 lakh. This is a clear understanding of the fact that, the quality of followers also matters as was spelt out by Ganeshan (2025), an Assistant Manager with a Mansion managing the food and beverage function. It can be therefore stated, that follower counts are a marker of status in SM, even for people aren’t influencers or trying to monetize a personal brand (Cheng and Zhang, 2023).

SMI sponsorship to reach Chettinad

SM is a business by itself today, and the SMIs part of the paraphernalia. The more they receive sponsorship, the more they travel and ensure that products are branded. Tourism and hospitality too has lapped up on the same.

The primary question, who will sponsor the SMIs to visit the destinations. One respondent who was kind enough to discuss in greater detail with the authors, mentioned, SMIs will have depend on the Government either state or central government, who are able to engage better; and even the local hotels and resorts if they are starting or they are new in the market. In the case of Chettinad, the Mansions are either privately

managed by the families; and a few have been handed over to hotel chains on a lease agreement. These hotel chains and standalone Mansions which are run by professionally seek the support of the SMIs to engage a larger population, such that they can visit the destination and the savor the service offerings in the area and even spread the word around and even come a second time to the place. 8 SMIs mentioned that they were sponsored by the Government of Tamil Nadu, Department of Tourism for a duration of three-days. The sponsorship included air travel from the place where the SMI came from. 28 SMIs mentioned that they were sponsored by the Hotels/Mansions on an end-to-end basis. They had come on full-board, and had to cover, besides, the accommodation facility, the breakfast, lunch, and dinner options by speaking with the visitors who were staying in the Mansions and engaging them better. One SMI respondent mentioned, that the visitors too had been spoken to by the Mansion executives, who ensured qualitative participation. Ganeshan (2025), categorically stated, “With the SMI interacting with the guests in the Mansions, it created a better aura on the publicity material that was being put out online. The videos look very natural and anyone watching them, will understand the efficacy of the Mansion and the service offerings better.” 2 SMIs mentioned that the local tour operators sponsored their stay in Chettinad region and part sponsored the travel. One observation that stands out is that the tour operators should engage with the SMIs better as they will be promoting FAM (familiarity) tours, which will benefit the tourism ecosystem. 10 SMIs traveled by themselves to visit the region, but were able to document most of the tourism products and get better endorsements for the future.

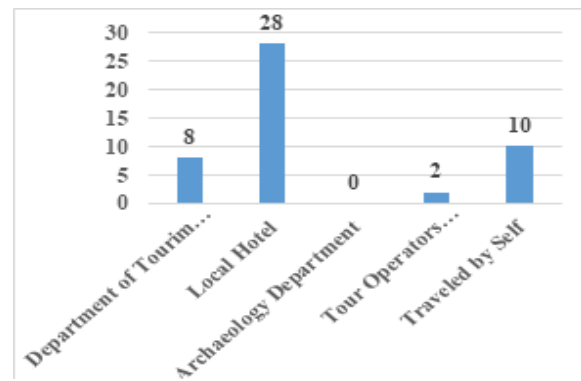


Fig. 3. SMI sponsorship to reach Chettinad Region

Tourism products promoted by SMIs in Chettinad Region

This was simple question that the authors asked the SMI who were the respondents. The respondents were clear about the local, here in case, Chettinad region, with the base point being Karaikudi. 47 of the 48 SMIs mentioned that they were promoting Mansions in the region. One of the respondents had come with an intent to promote the Temples in Karaikudi region and the Museum located in the town of Sivaganga.

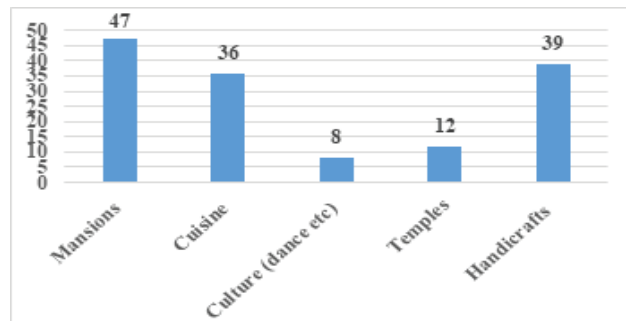


Fig. 4. What did the SMIs promote in the Chettinad Region?

36 SMIs got an opportunity to promote the cuisine of the area, which is very popular in the Southern states, and is promoted as Chettinad Cuisine. 8 promoted Culture and the dance forms. One of the influencers mentioned, that the influencers specifically invited to promote a dance school in the area; and also landed up showcasing the Mansions after it was informed. Tamil Nadu abounds in temples; the SMIs visiting Chettinad region clearly want to promote the temples and the Mansions as well. A total of 12 SMIs mentioned that they promoted temples in the area, besides, the Mansions. 39 SMIs promoted handicrafts of the area, which including even basket weaving. 18 influencers of the 39 were specific when the authors spoke to them, that they promoted Athankudi tiles which are an important asset in the Mansions and locals use them in their homes. One influencer mentioned, these tiles were great demand elsewhere, and some of the manufactures were also sending it to other cities in India, and one or two entities were also exporting to other countries after receiving a license to do the same.

Issues faced by SMIs in Chettinad Region

SMIs face issues during their sojourn to any destination to promote the place. The authors whilst working on

the paper, had heard a few voices about the difficulties faced by the influencers.

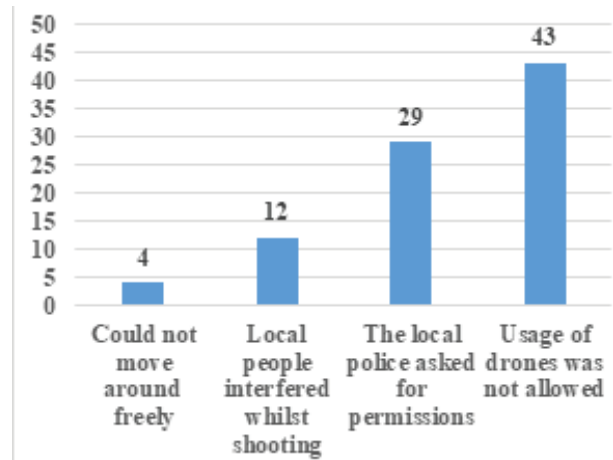


Fig. 5. Issues faced by the SMIs in Chettinad Region

Hence, when the SMIs were asked about the issues they faced in the Chettinad Region as they documented the tourism products, it was not surprising to find the respondents providing their responses. 4 of the influencers stated they could not move freely. In fact, without naming any of the influencers, the authors were able to derive the fact that, the sponsors of the visit only wanted the influencers to focus on what they wanted to market and not anything else that the influencers wanted to showcase to the followers and others. Another aspect was without an escort, the language became an issue to some of the influencers, hence, they could not move around freely. 12 of the influencers responded and stated that the local people, passerby, and other would jump into the frame when they shot the videos. This is a natural hazard that the SMIs face whilst they produce their reels and blogs. It was surprising to know that 29 respondents, mentioned that in a few places, the local police asked for permissions. The influencers mentioned that the local escorts managed the same with the police, who at times, would stop the filming and even interviewing in cafeterias and public places. This was a bane, as one of the influencers whilst responding stated, that it always attracted a crowd, when the police comes in. As authors even we are not in a position to confirm the areas that require permission in the Mansion area. We are aware that the Archaeological Areas have a restriction and need the permissions of the Archaeological Survey of India (ASI), in the case

of the Mansions, it came as a surprise, as these were private properties. In another debatable argument, the police would intervene such that the influencers do not make a spectacle of themselves in public places; which in a way is clear to understand. Of the 48 respondents who provided for 100% responses of the questionnaire, 33 had drones to be used, which were not allowed in public places. However, all the 33 used the drones in the Mansion facilities as they were invited by the Mansion owners, or the hoteliers who were running the properties. But it is clear, that in public places, permission needs to be sort from the authorities. The Tourism Officer located in Karaikudi, when checked with, had no answer to the same, and simply passed on the buck to the police.

Influencer feedback after blogs were posted

The followers, herein case the customers of a SMI place much trust in the recommendations as they consider them to share authoritative experiences, leading them to receive brand messages from the influencers (Dinh and Lee, 2024). Ganeshan (2025) the Assistant Management with a Mansion is very clear, “our Public Relations (PR) team identifies SMIs after a lot of research and feedback based on the blogs and reels that they present online for the consumption of the followers, and other people. At times it is tough to understand the Consumer (follower) Behavior, and how they would respond following the post. However, the PR teams’ analysis and analytics will in 90% of the cases help us to get to the point where the followers responses and feedback in optimistic and positive.”

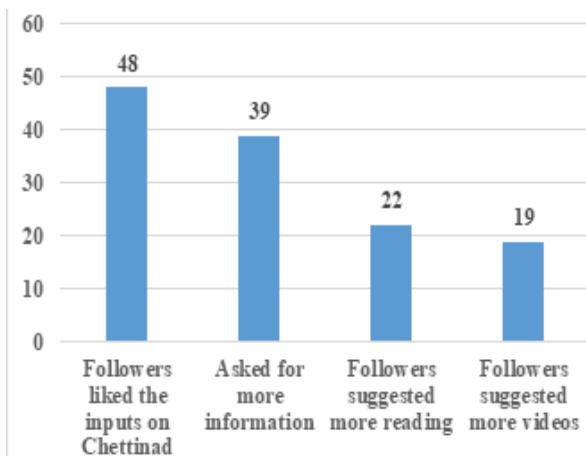


Fig. 6. Feedback after the Blogs were posted

From the data collated, it is clear that the followers of all the 48 SMIs who provided responses, confirmed that the inputs they provided were liked by the followers. 38 SMI respondents mentioned that the followers asked for more information. One of the influencers mentioned to the authors, that some of the followers, wanted more information about other Mansions that existed in the region, which the influencer had not provided on account of the agreement with the Mansion that had invited the influencer to provide publicity. It was also surprising to find that 22 SMIs responded to state that followers and others suggested more reading about the place, which clearly meant that the influencers had attention of the followers. Considering that videos and visual imagery is striking in the posts, 19 SMIs suggested that their followers wanted more videos on the products of Chettinad that they had covered. All this very categorically showcases the fact that the feedback to the inputs provided by the SMIs is crucial and critical to the business of SM.

Feedback after followers traveled to the Chettinad Region

SMIs significantly impact both consumer engagement and purchase intention of the followers and others who watch and read the blogs of influencers (Barari et al., 2025).

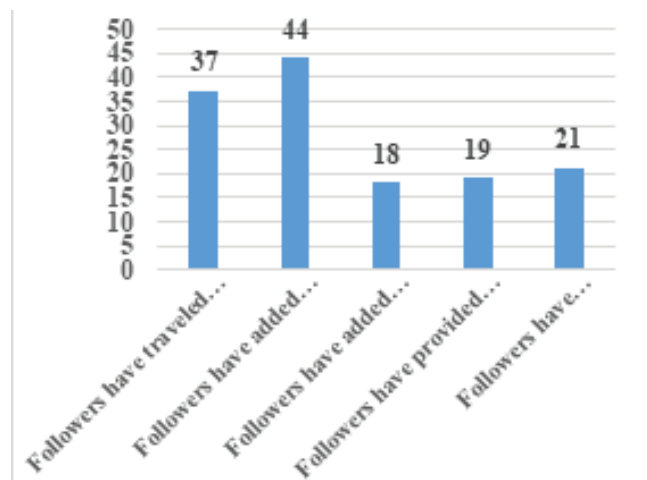


Fig. 7. Feedback after the followers traveled to the location

This strategy of feedback has gained popularity in recent years primarily because consumers are believed to be more likely to trust recommendations from individuals they follow on SM as opposed to traditional

advertising (Campbell and Farrell, 2020). The authors after the responses were collated were able to confirm that, there followers had traveled to Chettinad region, as a standalone or as a combination with other destinations. 37 influencers were able to confirm the same. 44 influencers confirmed that, the followers had added videos after visiting, and some added other videos that were available on the internet and from other media, which clearly led to the phenomenon of a narrative being established. 18 SMIs reported that their followers had added other tourist spots and destinations that were not covered in the blog or reel to be added to the tour. This one of the influencers clearly indicated that creates a narrative, a conversation that is good for tourism and the influencer becomes the focal point of the community. 19 SMIs even responded to state that, followers provided for reading material that was embedded in the communication, which benefited not only the influencers for future action, but helped the other followers to adopt and change the itinerary as required. 21 SMIs even mentioned that followers suggested new packages that could be adopted in the region, and how they had discovered new tourist spots, and destinations would like to incorporate in the packages.

LIMITATIONS OF THE STUDY

The authors felt that the number of influencers selected to respond was less in number. However, there was an issue, not all influencers had visited Karaikudi or the Chettinad area. Even though 68 SMIs who had traveled to Chettinad were identified only 48 complete responses were received. Hence, in the future there is much of an opportunity to get to more SMIs and generate better baseline data that will help with the understanding of the SM subject matter in regards to a destination. Not much of literature was available on Chettinad and SMIs, though generic information on Chettinad, through Tourism Brochures and Pamphlets in English and Tamil was available. Theoretical information about SM was available as well.

CONCLUSION

It is clear that the SMIs play a dynamic role in engaging the followers and others who read and view the reels and videos that engage the prospective traveler in a better fashion. In conclusion one can say the following: The role of the Government (State and Central) in promoting

destination is much needed. Because they will have necessary budgets and the bandwidth to ensure the same. If SMIs are given a particular portfolio to cover that will help the influencers to decide and plan well. The Tour Operators and the association are very critical to SM. The Tour Operators need to promote and engage a destination in its entirety. By promoting the tourism and hospitality eco-system they benefits are being spread to one and all and not to one particular stakeholder. Be it the Indian Association of Tour Operators (IATO), Travel Agents Association of India (TAAI), or even Federation of Hotels and Restaurants Association of India (FHRAI), they need to work in tandem and ensure ample publicity for Chettinad Destination in particular and others in general. SM is all about follow up, and the media teams of the stakeholders should play a role in ensuring there is an engagement that looks into the far future rather than just for the moment. The aspect of SM if planned well will cater to the success of the destination.

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Exploring Customer Perspectives on Unified Payments Interface (UPI) Technology Adoption in Tiruchirappalli

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ABSTRACT

The rapid growth of digital payment systems has significantly transformed the financial transaction landscape in India, with the Unified Payments Interface (UPI) emerging as a widely adopted mobile payment platform. This study explores customer perspectives on the adoption of UPI technology in Tiruchirappalli district, focusing on usage patterns, perceived benefits, and challenges associated with UPI-based transactions. The research adopts a descriptive and empirical approach, utilizing primary data collected through a structured questionnaire administered to UPI users across different demographic groups. Key factors influencing adoption, such as ease of use, security, transaction speed, convenience, and trust, are examined. Statistical tools including percentage analysis, mean score ranking, and inferential techniques are employed to analyse the data. The findings reveal that customers show a high level of awareness and acceptance of UPI technology, primarily due to its simplicity, real-time transaction capability, and widespread merchant acceptance. However, concerns related to cyber security, technical errors, and digital literacy among certain user groups continue to pose challenges. The study highlights the need for enhanced user education, stronger security measures, and improved technological infrastructure to sustain and expand UPI adoption. The results provide valuable insights for policymakers, banks, and fintech service providers to strengthen digital payment ecosystems and promote inclusive financial participation.

KEYWORDS: *Unified Payments Interface (UPI), Digital payments, Technology adoption, Customer perception, Tiruchirappalli district.*

INTRODUCTION

The rapid advancement of digital technology has profoundly transformed the global financial ecosystem, reshaping the way individuals and businesses conduct monetary transactions. Over the past decade, the shift from cash-based transactions to digital payment systems has gained significant momentum, driven by technological innovation, increased smartphone penetration, widespread internet accessibility, and supportive government policies. Digital payment platforms offer speed, convenience, transparency, and security, making them an essential component of modern economic systems. Among the various digital payment mechanisms, mobile-based payment systems have emerged as a dominant force,

enabling seamless financial transactions anytime and anywhere. In developing economies like India, digital payments play a crucial role in promoting financial inclusion and reducing dependency on cash. The Government of India has actively encouraged the adoption of cashless transactions through initiatives such as Digital India, Jan Dhan Yojana, and demonetization, which acted as a catalyst for digital payment adoption. These initiatives, combined with advancements in financial technology (FinTech), have accelerated the growth of electronic payment systems across urban and semi-urban regions. As a result, digital payment platforms have become increasingly integrated into the daily lives of consumers, influencing purchasing behaviour, financial decision-making, and overall

economic participation. One of the most significant innovations in India's digital payment landscape is the Unified Payments Interface (UPI). Launched by the National Payments Corporation of India (NPCI), UPI is a real-time payment system that enables instant fund transfers between bank accounts using mobile devices. UPI has revolutionized digital payments by offering a simple, secure, and interoperable platform that connects multiple banks and payment service providers. Unlike traditional electronic payment methods, UPI eliminates the need for complex bank details by allowing transactions through virtual payment addresses, QR codes, or mobile numbers. This user-friendly design has contributed to the widespread acceptance of UPI among diverse segments of society. UPI has witnessed exponential growth since its inception, becoming one of the most widely used digital payment platforms in India. Its success can be attributed to several factors, including ease of use, low transaction costs, instant settlement, and compatibility with multiple banking applications. Moreover, the integration of UPI with popular mobile applications and merchant platforms has expanded its reach across retail, e-commerce, transportation, utility payments, and peer-to-peer transactions. The increasing reliance on UPI reflects a significant shift in consumer preferences toward digital and contactless payment solutions, particularly in the post-pandemic era.

Despite its rapid adoption, the acceptance and usage of UPI are not uniform across all regions and demographic groups. Factors such as digital literacy, perceived security risks, trust in technology, infrastructure availability, and socio-economic conditions influence customer adoption behaviour. While metropolitan cities have shown high levels of UPI usage, understanding adoption patterns in tier-II and tier-III cities is equally important for ensuring inclusive digital growth. Customer perception plays a pivotal role in determining the sustained usage of UPI, as users' attitudes toward convenience, reliability, privacy, and technological complexity directly affect their willingness to adopt and continue using digital payment systems. From a theoretical perspective, technology adoption models such as the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Innovation Diffusion Theory emphasize the importance of perceived usefulness, ease of use, social influence,

and facilitating conditions in shaping user adoption behaviour. Applying these perspectives to UPI adoption helps in understanding how customers evaluate the technology and what motivates or discourages them from using digital payment platforms. Customer-centric studies are therefore essential to identify key drivers and barriers to UPI adoption and to design strategies that enhance user experience and trust. Tiruchirappalli district, a prominent urban and educational hub in Tamil Nadu, presents a unique context for examining customer perspectives on UPI technology adoption. The district comprises a mix of urban, semi-urban, and rural populations, with diverse socio-economic backgrounds and varying levels of digital exposure. Tiruchirappalli has witnessed steady growth in commercial activities, educational institutions, healthcare services, and small-scale businesses, making digital payments increasingly relevant. The expansion of smartphone usage and banking services in the region has created favourable conditions for the adoption of UPI-based transactions.

However, despite the availability of digital infrastructure, customers in Tiruchirappalli may face challenges related to awareness, technical issues, cyber security concerns, and adaptability to advanced technology. Understanding how customers perceive UPI in terms of convenience, security, trust, and efficiency is essential for identifying gaps in adoption and usage. Regional studies such as this contribute valuable empirical evidence by highlighting localized factors that influence digital payment behaviour, which may differ from national-level trends. The present study aims to explore customer perspectives on the adoption of Unified Payments Interface (UPI) technology in Tiruchirappalli district. By examining usage patterns, perceived benefits, and challenges associated with UPI mobile payments, the study seeks to provide a comprehensive understanding of customer attitudes toward digital payment systems. The research focuses on how demographic characteristics, technological awareness, and experiential factors shape customer perceptions and influence adoption decisions. This study is significant for multiple stakeholders. For policymakers, it offers insights into the effectiveness of digital payment initiatives at the grassroots level and highlights areas requiring policy intervention. For banks and fintech companies, the findings provide guidance on improving service quality, enhancing security

features, and designing user-friendly applications. For researchers and academicians, the study contributes to the growing body of literature on digital payment adoption by offering region-specific empirical evidence. As India continues its transition toward a digitally empowered economy, understanding customer perspectives on advanced payment technologies like UPI becomes increasingly important. Exploring UPI adoption at the district level not only supports inclusive digital growth but also ensures that technological advancements align with user needs and expectations. This study endeavours to bridge this gap by providing a detailed analysis of customer perceptions and adoption behaviour related to UPI technology in Tiruchirappalli district.

PROBLEM SETTING

Despite the rapid growth and widespread promotion of Unified Payments Interface (UPI) technology in India, disparities remain in its adoption and effective usage across different regions and user groups. While UPI offers convenience, speed, and cost efficiency, customers continue to face challenges such as security concerns, technical failures, limited digital literacy, and lack of awareness about advanced features. In districts like Tiruchirappalli, which comprise diverse socio-economic and demographic segments, the extent to which customers perceive, adopt, and utilize UPI technology is not fully understood. This gap necessitates an empirical investigation into customer perspectives to identify key factors influencing adoption and to address barriers affecting sustained usage of UPI mobile payment systems.

THEORETICAL BACKGROUND

The adoption of digital payment technologies such as the Unified Payments Interface (UPI) can be explained using established theories of technology acceptance and innovation diffusion. One of the most widely applied frameworks is the Technology Acceptance Model (TAM), which posits that users' adoption of technology is primarily influenced by perceived usefulness and perceived ease of use. In the context of UPI, customers are more likely to adopt the platform if they believe it enhances transaction efficiency and is simple to operate. Another relevant framework is the Unified Theory of Acceptance and Use of Technology

(UTAUT), which extends TAM by incorporating factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs are particularly relevant to UPI adoption, as peer usage, merchant acceptance, and availability of technical infrastructure significantly influence customer behaviour. Additionally, Innovation Diffusion Theory (IDT) explains how innovations spread over time based on attributes such as relative advantage, compatibility, complexity, trialability, and observability. UPI's rapid diffusion can be attributed to its relative advantage over cash and traditional banking methods. Customer perception, trust, and security concerns are also emphasized in digital payment literature, as financial transactions involve sensitive information. These theoretical perspectives collectively provide a strong foundation for analysing customer attitudes, intentions, and actual usage behaviour related to UPI technology.

SCOPE OF THE STUDY

The scope of the present study is limited to an examination of customer perspectives on UPI technology adoption in Tiruchirappalli district. The study focuses on individual UPI users and analyses factors such as awareness levels, usage patterns, and perceived benefits, ease of use, security concerns, and overall satisfaction. It considers demographic variables including age, gender, education, and occupation to understand variations in adoption behaviour. The study is confined to mobile-based UPI transactions and does not include other digital payment methods such as credit cards, debit cards, or internet banking. The findings are based on primary data collected during a specific period and are applicable mainly to the study area. Despite these limitations, the study offers valuable insights into regional-level digital payment adoption and contributes to a better understanding of customer-centric factors influencing the successful implementation of UPI technology.

STATEMENT OF THE PROBLEM

The Unified Payments Interface (UPI) has emerged as a major digital payment platform in India, offering convenience, speed, and cost-effective transactions. However, despite its extensive availability and government support, customers' adoption and effective

use of UPI mobile payment services are not uniform across regions. In Tiruchirappalli district, several customers continue to face challenges such as lack of digital awareness, security and privacy concerns, technical issues, limited trust, and infrastructural constraints. These challenges may affect users' perception, satisfaction, and continued usage of UPI services. Therefore, it is necessary to examine the factors influencing customers' perspectives towards UPI adoption and to identify the problems hindering its optimal utilization.

SIGNIFICANCE OF THE STUDY

The study is significant as it provides insights into customers' perceptions and adoption of Unified Payments Interface (UPI) mobile payment services in Tiruchirappalli district. By identifying key factors such as awareness, ease of use, security, trust, and infrastructural support, the study helps policymakers, banks, and fintech companies understand the challenges faced by users. The findings can assist service providers in improving user-friendly features, strengthening security measures, and designing effective awareness programs. Academically, the study adds to existing literature on digital payment adoption at the regional level and serves as a reference for future researchers focusing on technology adoption and cashless economy initiatives in similar contexts.

NATIONAL STATUS AND INTERNATIONAL STATUS OF (UPI)

The Unified Payments Interface (UPI) has transformed the digital payments landscape in India and has gradually gained international recognition as a successful model for real-time, low-cost, and inclusive payment systems. Developed by the National Payments Corporation of India (NPCI), UPI integrates multiple bank accounts into a single mobile application, enabling instant fund transfers and merchant payments. Its growth reflects India's broader vision of a digitally empowered economy and provides a benchmark for other countries seeking efficient payment infrastructures.

National Status of UPI in India

Growth and Adoption

At the national level, UPI has emerged as the backbone of India's digital payment ecosystem. Since its launch

in 2016, UPI has witnessed exponential growth in terms of transaction volume and value. It has become the preferred mode of payment for peer-to-peer (P2P) and peer-to-merchant (P2M) transactions due to its simplicity, speed, and interoperability across banks. Millions of transactions are processed daily, covering a wide spectrum of users ranging from urban professionals to rural households and small vendors.

Government Support and Policy Framework

The success of UPI is closely linked to strong government backing and policy initiatives. Programs such as Digital India, Jan Dhan Yojana, Aadhaar linkage, and Direct Benefit Transfers (DBT) have created an enabling environment for digital payments. The Reserve Bank of India (RBI) and NPCI have continuously enhanced regulatory oversight, security protocols, and system resilience. Zero or minimal transaction costs for users and merchants have further accelerated adoption.

Financial Inclusion

One of the most significant national impacts of UPI is its contribution to financial inclusion. UPI has enabled individuals without credit cards or advanced banking facilities to participate in the digital economy using basic smartphones. Small merchants, street vendors, and micro-entrepreneurs have benefited by accepting UPI payments without investing in costly point-of-sale (POS) machines. This has reduced cash dependency and improved transparency in financial transactions.

Integration with Banking and Fintech Ecosystem

UPI has fostered strong collaboration between traditional banks and fintech companies. Banks provide the underlying infrastructure, while fintech platforms such as Google Pay, PhonePe, Paytm, and BHIM enhance user experience through innovative interfaces and value-added services. UPI is also integrated with other financial services, including bill payments, subscriptions, credit products, and investment platforms, making it a comprehensive digital payment solution.

Security and Trust

At the national level, UPI has gained user trust through multi-layered security features such as two-factor authentication, device binding, and encrypted transactions. While issues such as fraud and phishing

attempts exist, continuous awareness campaigns and regulatory interventions have strengthened consumer confidence. The evolving grievance redressal mechanisms and transaction tracking systems further reinforce trust.

Socio-Economic Impact

UPI has significantly contributed to formalizing the economy by creating digital transaction trails. It supports tax compliance, reduces leakage in welfare schemes, and improves efficiency in public and private payments. During the COVID-19 pandemic, UPI played a crucial role in enabling contactless payments, thereby reinforcing its relevance in crisis situations.

International Status of UPI

Global Recognition

Internationally, UPI is increasingly recognized as a pioneering digital payment model. Its success has attracted attention from governments, central banks, and financial institutions worldwide. UPI's real-time settlement, interoperability, and low-cost structure differentiate it from many existing payment systems in developed and developing economies.

Cross-Border Expansion

India has initiated the internationalization of UPI to facilitate cross-border payments, especially for Indian travelers, students, and diaspora communities. UPI has been enabled in several countries through partnerships with local payment networks and banks. This allows users to make merchant payments abroad using UPI-enabled applications, eliminating the need for foreign exchange cards or cash.

Strategic Partnerships

NPCI International Payments Limited (NIPL), a subsidiary of NPCI, plays a key role in expanding UPI globally. Partnerships have been established with countries in Asia, the Middle East, and beyond to deploy UPI-based payment solutions or adapt its technology. These collaborations aim to promote seamless remittances, tourism spending, and bilateral trade settlements.

Role in Remittances

UPI has strong potential to transform international remittances by reducing transaction costs and

settlement time. Traditional cross-border transfers are often expensive and slow, whereas UPI-based systems promise near-instant transfers at lower costs. This is particularly beneficial for migrant workers and international students who rely heavily on remittance services.

Adoption as a Model System

Several countries are studying UPI as a reference framework for developing their own instant payment systems. The modular and scalable design of UPI allows it to be customized according to local regulatory and infrastructural requirements. India's experience demonstrates how public digital infrastructure can support inclusive growth, making UPI a model for emerging economies.

Challenges in International Expansion

Despite its potential, UPI faces challenges in global adoption. Differences in regulatory frameworks, data protection laws, currency conversion mechanisms, and banking standards pose integration hurdles. Additionally, competition from established global payment networks and digital wallets requires strategic positioning and continuous innovation.

Soft Power and Digital Diplomacy

UPI's international expansion enhances India's soft power by showcasing its technological capabilities and leadership in digital public infrastructure. By sharing UPI technology and expertise, India strengthens economic diplomacy and fosters long-term international cooperation in the fintech domain. The national status of UPI reflects its deep integration into India's financial system, driving digital payments, financial inclusion, and economic efficiency. Its widespread adoption across demographics and sectors highlights its role as a transformative public digital platform. Internationally, UPI is evolving from a domestic success story into a globally recognized payment solution with significant potential for cross-border transactions and financial cooperation. While challenges remain, continued innovation, strategic partnerships, and regulatory alignment can position UPI as a leading global digital payment standard in the years to come.

REVIEW OF LITERATURE

Kumar and Sharma (2023) examined consumer adoption of UPI using the Technology Acceptance Model (TAM) and found that perceived ease of use and perceived usefulness significantly influence customers' intention to use UPI services. Their study highlighted that simplicity of transaction and time efficiency are the strongest motivators for regular usage.

Ramesh, Suresh, and Priya (2023) conducted a study on urban and semi-urban users in Tamil Nadu and observed that awareness levels are high, but actual usage varies due to differences in digital literacy and trust. The authors emphasized that demographic factors such as age, education, and occupation play a critical role in shaping customer perception towards UPI.

Patel and Mehta (2023) analyzed customer satisfaction with UPI applications and revealed that service quality, transaction success rate, and application interface design significantly affect user satisfaction. Their findings suggested that promotional incentives encourage adoption but do not ensure long-term usage.

Security concerns remain a dominant theme in UPI-related research. Verma and Gupta (2023) identified cyber fraud, phishing attacks, and data privacy issues as major barriers to adoption among elderly users. The study suggested that trust in UPI is directly linked to users' understanding of security features.

In 2024, Singh and Kaur investigated post-adoption behavior of UPI users and found that continuance intention is strongly influenced by reliability and security rather than initial convenience. Their study concluded that consistent performance is more important than incentives in retaining users.

Chandra and Rao (2024) studied UPI adoption among small merchants and street vendors. The study revealed that low cost, ease of acceptance, and instant settlement are major drivers, while poor internet connectivity and fear of failed transactions remain key challenges.

In 2024, Mishra and Pandey explored the relationship between trust and security perception in digital payments. Their findings showed that customers who experienced prompt grievance redressal exhibited higher confidence in UPI platforms. The study highlighted the role of

banks and NPCI in strengthening dispute resolution mechanisms.

Sivakumar and Anitha (2024) focused on customer awareness of cybersecurity practices and found that although UPI usage is increasing, awareness of safe digital behavior is relatively low. This mismatch poses a threat to sustainable growth of digital payments.

By 2025, regional studies gained importance. Natarajan and Lakshmi (2025) examined customer perception of UPI in semi-urban districts of Tamil Nadu and reported that although UPI usage is widespread, customers still face issues related to transaction failures and lack of technical support. The study emphasized the need for district-level empirical research.

RESEARCH OBJECTIVES

1. To study the level of awareness and usage of Unified Payments Interface (UPI) among customers in Tiruchirappalli district.
2. To analyze the factors influencing customers' adoption of UPI mobile payment services.
3. To examine customers' perceptions regarding ease of use, security, and trust in UPI transactions.
4. To assess the level of customer satisfaction with UPI services and applications.
5. To identify the major problems and challenges faced by customers while using UPI in Tiruchirappalli district.

RESEARCH QUESTIONS

1. What is the level of awareness and extent of usage of Unified Payments Interface (UPI) among customers in Tiruchirappalli district?
2. What factors influence customers' adoption of UPI mobile payment services?
3. How do customers perceive the ease of use, security, and trust associated with UPI transactions?
4. What is the level of customer satisfaction with UPI services and applications?
5. What major problems and challenges are faced by customers while using UPI in Tiruchirappalli district?

RESEARCH METHODOLOGY

Research Design

The present study adopts a descriptive and analytical research design to examine customers' perceptions, adoption behavior, and challenges related to the use of Unified Payments Interface (UPI) mobile payment services in Tiruchirappalli district. This design is appropriate as it helps in systematically describing the characteristics of UPI users and analysing the factors influencing adoption and satisfaction.

Area of the Study

The study is confined to Tiruchirappalli district, Tamil Nadu. The district has a mix of urban, semi-urban, and rural population, making it suitable for understanding diverse customer perspectives on UPI adoption.

Population of the Study

The population of the study consists of customers who use UPI-enabled mobile payment applications such as Google Pay, PhonePe, Paytm, and BHIM in Tiruchirappalli district.

Sample Size and Sampling Technique

A sample of 200 respondents was selected for the study. The respondents were chosen using the convenience sampling technique, as it allows easy access to UPI users across different demographic categories such as age, gender, occupation, and income levels.

Sources of Data

The study is based on both primary and secondary data.

Primary Data: Primary data were collected directly from respondents using a structured questionnaire designed to capture information on awareness, usage patterns, perceptions, satisfaction, and challenges related to UPI.

Secondary Data: Secondary data were collected from journals, research articles, books, reports of RBI and NPCI, websites, and published studies related to digital payments and UPI.

Research Instrument

A structured questionnaire was used as the research instrument. The questionnaire consisted of multiple sections covering demographic details, UPI usage

behavior, factors influencing adoption, security perception, satisfaction level, and problems faced. Responses were measured using a five-point Likert scale ranging from "Strongly Agree" to "Strongly Disagree".

Data Collection Method

Data were collected through direct interaction and online survey methods. The questionnaires were distributed personally and through digital platforms to ensure wider reach and faster responses.

Tools and Techniques of Analysis

The collected data were analyzed using statistical tools such as:

- ❖ Percentage analysis
- ❖ Mean and standard deviation
- ❖ Chi-square test
- ❖ Weighted average method
- ❖ Simple correlation analysis

These tools were used to interpret customer behavior, perceptions, and relationships between variables.

Period of the Study

The data for the study were collected during a period of three months.

Hypotheses of the Study

The study tests hypotheses such as:

- ❖ There is no significant relationship between demographic factors and adoption of UPI.
- ❖ There is no significant relationship between perceived security and customer satisfaction towards UPI.

ANALYSIS AND DISCUSSION

Table 1: Demographic Profile of the Respondents (n = 200)

Demographic Variable	Category	No. of Respondents	Percentage
Gender	Male	118	59.0
	Female	82	41.0
Age (Years)	Below 25	46	23.0
	26-35	74	37.0

Age (Years)	36–45	52	26.0
	Above 45	28	14.0
Education	School Level	34	17.0
	Graduate	96	48.0
	Postgraduate	70	35.0

Interpretation

The table shows that the majority of respondents are male (59%) and fall within the age group of 26–35 years (37%), indicating higher UPI usage among young adults. Nearly half of the respondents are graduates (48%), suggesting that educational qualification plays a significant role in digital payment adoption.

Table 2: Level of Awareness about UPI Services

Awareness Level	No. of Respondents	Percentage
High	92	46.0
Moderate	74	37.0
Low	34	17.0
Total	200	100

Interpretation

It is evident from the table that a majority of respondents (46%) possess a high level of awareness about UPI services. However, 17% of respondents still have low awareness, indicating the need for targeted awareness and digital literacy programs in the district.

Table 3: Frequency of UPI Usage

Usage Frequency	No. of Respondents	Percentage
Daily	88	44.0
Weekly	62	31.0
Occasionally	36	18.0
Rarely	14	7.0
Total	200	100

Interpretation

The table reveals that 44% of respondents use UPI on a daily basis, reflecting strong acceptance of UPI as a routine payment method. Only 7% use it rarely, suggesting that UPI has become an integral part of day-to-day transactions in Tiruchirappalli district.

Table 4: Factors Influencing Adoption of UPI (Weighted Average Method)

Factors	Mean Score	Rank
Ease of Use	4.35	I
Speed of Transaction	4.21	II
Convenience	4.10	III
Security	3.88	IV
Cashback & Rewards	3.46	V

Interpretation

Ease of use ranks first with the highest mean score (4.35), indicating that simplicity strongly motivates customers to adopt UPI. Speed and convenience are also major influencing factors, while cashback and rewards play a comparatively lesser role in long-term adoption.

Table 5: Customers’ Perception towards Security of UPI

Opinion	No. of Respondents	Percentage
Highly Secure	64	32.0
Secure	82	41.0
Neutral	32	16.0
Insecure	22	11.0
Total	200	100

Interpretation

A majority of respondents (73%) perceive UPI as either secure or highly secure. However, 11% of respondents still consider UPI insecure, highlighting the need for improved security awareness and fraud prevention education.

Table 6: Level of Customer Satisfaction towards UPI Services

Satisfaction Level	No. of Respondents	Percentage
Highly Satisfied	76	38.0
Satisfied	84	42.0
Neutral	26	13.0
Dissatisfied	14	7.0
Total	200	100

Interpretation

The table indicates that 80% of respondents are satisfied or highly satisfied with UPI services. This reflects positive customer experience and reliability of UPI platforms, though a small proportion of dissatisfied users points to scope for service improvement.

Table 7: Problems Faced by Customers while Using UPI

Problems	No. of Respondents	Percentage
Transaction Failure	72	36.0
Network Issues	58	29.0
Fear of Fraud	44	22.0
Lack of Technical Knowledge	26	13.0
Total	200	100

Interpretation

Transaction failure (36%) and network issues (29%) are the major problems faced by customers while using UPI. These issues indicate infrastructural and technical challenges that may affect user satisfaction and continued usage.

FINDINGS OF THE STUDY

1. The study reveals that a majority of the respondents are young adults and graduates, indicating that age and educational qualification play a significant role in the adoption of UPI services.
2. Most of the respondents have a high to moderate level of awareness about UPI, showing the effectiveness of government initiatives and promotional efforts by banks and fintech companies.
3. A substantial proportion of respondents use UPI on a daily basis, confirming that UPI has become an essential mode of payment for routine transactions in Tiruchirappalli district.
4. Ease of use, speed of transactions, and convenience are identified as the most influential factors motivating customers to adopt UPI services.
5. The majority of respondents perceive UPI transactions as secure, which has contributed to increased trust and continued usage of digital payment platforms.

6. A high level of customer satisfaction is observed with respect to UPI services, indicating reliability and efficiency of UPI applications.
7. Despite positive perceptions, transaction failures and network-related issues are the most common problems faced by users, affecting overall user experience.
8. A small section of respondents still expresses fear of fraud and lack of technical knowledge, which acts as a barrier to wider adoption.

SUGGESTIONS

1. Banks and fintech companies should strengthen technical infrastructure to reduce transaction failures and improve network reliability, especially during peak usage hours.
2. Continuous digital literacy and awareness programs should be conducted to educate users about secure UPI practices and fraud prevention measures.
3. User-friendly interfaces with multilingual support should be developed to encourage adoption among elderly users and those with limited digital skills.
4. Faster and transparent grievance redressal mechanisms should be implemented to enhance customer trust and confidence in UPI platforms.
5. Government and regulatory authorities should collaborate with service providers to improve internet connectivity in semi-urban and rural areas of Tiruchirappalli district.
6. Periodic system upgrades and security enhancements should be carried out to address emerging cyber threats and protect user data.

LIMITATIONS OF THE STUDY

1. The study is confined to Tiruchirappalli district only; therefore, the findings cannot be generalized to other regions or states.
2. Convenience sampling technique was adopted, which may limit the representativeness of the sample.
3. The sample size is limited, and a larger sample may provide more comprehensive insights.

4. The study is based on primary data collected through questionnaires, which may be subject to respondent bias and personal perceptions.
5. The study covers a limited time period and does not capture changes in customer behaviour over time.

CONCLUDING OBSERVATIONS

The present study offers a comprehensive understanding of customers' perspectives towards the adoption and usage of Unified Payments Interface (UPI) mobile payment services in Tiruchirappalli district. With the rapid digital transformation of India's financial ecosystem, UPI has emerged as a revolutionary payment platform that has significantly altered the way individuals and businesses conduct financial transactions. The study highlights the extent to which UPI has penetrated everyday economic activities and evaluates the factors that contribute to its growing acceptance among customers. The findings of the study clearly indicate that UPI has attained widespread recognition and acceptance among customers in the study area. A majority of respondents exhibit a high level of awareness and frequent usage of UPI services, suggesting that digital payment systems have become an integral part of daily life. The increasing reliance on UPI for routine transactions such as shopping, bill payments, and fund transfers reflects a strong shift away from cash-based transactions. This transformation aligns with the broader national objective of promoting a cashless and digitally inclusive economy. One of the most significant observations of the study is that ease of use stands out as the primary factor influencing UPI adoption. The simplicity of the interface, minimal procedural requirements, and instant transaction processing have made UPI accessible to a wide range of users. Speed and convenience further strengthen customer preference, particularly in a fast-paced environment where efficiency is highly valued. These factors collectively contribute to positive customer perception and encourage repeated usage of UPI platforms. The study also reveals that demographic characteristics such as age and educational qualification play a notable role in determining UPI adoption. Younger and more educated respondents demonstrate higher levels of awareness and usage, indicating that digital literacy significantly influences technology acceptance.

However, the growing usage among middle-aged and older users suggests that UPI is gradually bridging the digital divide, although at a slower pace. This observation underscores the importance of continuous digital education to ensure inclusive growth. In terms of security perception, the study finds that most respondents consider UPI transactions to be safe and trustworthy. Multi-layered authentication mechanisms and real-time transaction alerts have contributed to building user confidence. Nevertheless, the presence of security-related concerns among a minority of respondents highlights the persistent fear of cyber fraud and misuse of personal information. This indicates that while technological safeguards exist, customer awareness regarding secure digital practices remains a critical area of concern. Customer satisfaction levels observed in the study are largely positive, reflecting the reliability and efficiency of UPI services. The ability to conduct transactions anytime and anywhere, without additional costs, has enhanced overall user experience. Despite high satisfaction levels, the study identifies transaction failures and network connectivity issues as recurring problems. These technical challenges can negatively affect customer trust and satisfaction if not addressed promptly, particularly during peak transaction periods. Another important observation is the role of UPI in promoting financial inclusion and economic transparency. By enabling digital transactions without the need for expensive infrastructure, UPI has empowered small merchants, street vendors, and self-employed individuals to participate in the formal financial system. This not only reduces dependency on cash but also enhances transparency and accountability in financial dealings. The study thus reinforces the role of UPI as a key instrument in strengthening India's digital public infrastructure. From a broader perspective, the study suggests that the sustainability of UPI adoption depends on continuous technological upgrades, effective regulatory support, and proactive involvement of banks and fintech companies. Addressing infrastructural limitations, improving grievance redressal mechanisms, and enhancing cybersecurity awareness are essential to maintaining customer confidence. Furthermore, localized strategies that consider regional challenges and user behaviour can significantly improve adoption outcomes. The study affirms that UPI has made a

substantial contribution to transforming the digital payment landscape in Tiruchirappalli district. While the overall adoption and satisfaction levels are encouraging, addressing technical and awareness-related challenges is crucial for maximizing its potential. With sustained efforts from policymakers, financial institutions, and technology providers, UPI can further strengthen its role in fostering a secure, efficient, and inclusive digital economy.

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Food Tourism and Cultural Erosion: A Study of Disappearing Traditional Foods in the Kongu Nadu Region of Tamil Nadu

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ABSTRACT

Food tourism has emerged as a significant dimension of cultural tourism, offering destinations an opportunity to showcase their culinary heritage while contributing to local economic development. Traditional food systems, however, are increasingly threatened by globalization, urbanization, and cross-cultural interactions, leading to the gradual erosion of indigenous culinary practices. In this context, the present study examines the phenomenon of disappearing traditional foods in the Kongu Nadu region of Tamil Nadu, with specific focus on the influence of cross-cultural food practices and evolving patterns of food tourism. Kongu Nadu, known for its distinctive millet-based diets, indigenous ingredients, and community-oriented culinary traditions, represents an important yet under-researched gastronomic landscape within South India. The study is grounded in the premise that food is not merely a consumable product but an essential marker of cultural identity and intangible heritage. Rapid exposure to external food cultures through tourism, migration, mass media, and the expansion of standardized restaurant formats has significantly altered local food preferences. Traditional dishes that were once integral to daily life, rituals, and festivals are now increasingly replaced by cross-cultural and convenience foods. This transformation raises critical concerns regarding cultural sustainability and the long-term viability of regional culinary heritage. Adopting a descriptive and exploratory research design, the study employs a case study approach focusing on selected districts within the Kongu Nadu region. Both primary and secondary data were utilized to ensure comprehensive analysis. Primary data were collected through structured questionnaires administered to local households, youth respondents, and tourism stakeholders, along with semi-structured interviews with traditional food practitioners and elderly community members. Secondary data sources included scholarly articles, government reports, and policy documents related to food tourism, cultural heritage, and regional cuisine. Quantitative data were analyzed using percentage analysis and mean ranking techniques, while qualitative data were examined through thematic analysis. The findings reveal a noticeable decline in the preparation and consumption of traditional Kongu Nadu foods, particularly millet-based and labor-intensive dishes. Cross-cultural food influences, especially those associated with urban lifestyles and tourism-driven commercialization, have reshaped dietary preferences, with younger generations exhibiting limited awareness and attachment to indigenous culinary practices. The study also finds that food tourism, while offering potential for cultural preservation, often promotes modified or standardized versions of local cuisine, thereby diluting authenticity in favor of marketability. The lack of institutional support, documentation efforts, and targeted policy interventions further exacerbates the risk of culinary heritage loss. The study concludes that unchecked cross-cultural influences and poorly regulated food tourism may accelerate cultural erosion in regions like Kongu Nadu. However, it also highlights the potential of sustainable food tourism as a tool for culinary revival if community participation, authenticity, and cultural education are prioritized. The paper contributes to existing literature by providing region-specific empirical evidence and offers practical insights for policymakers, tourism planners, and hospitality practitioners seeking to balance tourism development with cultural preservation.

KEYWORDS: *Food tourism, Traditional foods, Cultural erosion, Cross-cultural influence, Culinary heritage, Kongu Nadu, Tamil Nadu.*

INTRODUCTION

Food tourism has gained increasing prominence as an integral component of cultural tourism, reflecting a growing global interest in experiencing destinations through their culinary traditions. Food is no longer perceived merely as a means of sustenance; rather, it represents a powerful expression of cultural identity, historical continuity, and social belonging. Across the world, regional cuisines serve as living archives of indigenous knowledge, agricultural practices, climatic adaptation, and community values. In recent decades, however, rapid globalization, urbanization, and cross-cultural exchanges have significantly altered traditional food systems, resulting in the gradual disappearance of indigenous cuisines. This transformation is particularly evident in culturally rich regions such as Tamil Nadu, where traditional food practices are increasingly challenged by external culinary influences. Tamil Nadu is renowned for its diverse regional cuisines, each shaped by distinct geographical, ecological, and cultural contexts. Among these, the Kongu Nadu region holds a unique place due to its distinctive food culture rooted in sustainability, simplicity, and locally available resources. Historically, Kongu Nadu cuisine has been characterized by the extensive use of millets, pulses, native vegetables, and minimal spices, reflecting an agrarian lifestyle adapted to semi-arid climatic conditions. Traditional cooking methods such as slow cooking, steaming, and sun-drying were not only nutritionally efficient but also environmentally sustainable. Food practices were closely linked to social customs, festivals, rituals, and life-cycle ceremonies, making cuisine an inseparable part of the region's cultural fabric. Despite its rich culinary heritage, Kongu Nadu cuisine is increasingly marginalized in contemporary food landscapes. The growing dominance of cross-cultural and standardized food formats has reshaped consumption patterns, particularly among younger generations. Fast foods, global cuisines, and hybrid dishes have become symbols of modernity and social mobility, often replacing traditional meals prepared within households. This shift has been accelerated by urban migration, changing family structures, time constraints, and the influence of mass media and

digital platforms. As a result, many traditional Kongu Nadu dishes that once formed part of everyday diets are now prepared only on special occasions or have disappeared altogether. Food tourism, while often promoted as a means of preserving culinary heritage, presents a paradox in this context. On one hand, it offers opportunities for showcasing local cuisine, generating income, and fostering cultural pride. On the other hand, the commercialization of food for tourism purposes frequently leads to the modification, simplification, or standardization of traditional dishes to suit the tastes and expectations of diverse tourists. Authentic recipes are often altered, indigenous ingredients substituted, and traditional preparation methods replaced with faster commercial techniques. Such practices risk transforming living culinary traditions into superficial representations, thereby contributing to cultural erosion rather than preservation. Cross-cultural influences play a crucial role in shaping these changes. The Kongu Nadu region has experienced increasing interaction with external cultures through tourism, labor migration, education, and media exposure. While cultural exchange is a natural and often enriching process, its unregulated impact on local food systems can result in culinary homogenization. The influx of non-native food practices and preferences often overshadows indigenous cuisines, especially when supported by aggressive marketing, branding, and global food chains. This imbalance threatens the survival of traditional foods that lack similar commercial visibility or institutional support. The erosion of traditional food practices also raises broader concerns related to cultural sustainability and intangible heritage preservation. Traditional foods embody generations of accumulated knowledge related to nutrition, health, agriculture, and ecological balance. The decline of millet-based diets, for instance, not only affects cultural identity but also has implications for food security and environmental sustainability. The replacement of local, climate-resilient crops with highly processed and resource-intensive foods contributes to nutritional imbalances and environmental degradation. Thus, the loss of traditional cuisine extends beyond cultural dimensions to encompass social, economic, and ecological consequences.

From a tourism perspective, the disappearance of authentic local cuisine undermines the uniqueness of destinations. Contemporary tourists increasingly seek experiential and meaningful travel, including opportunities to engage with local food cultures. The loss or dilution of traditional Kongu Nadu foods diminishes the region's potential as a distinctive food tourism destination. Moreover, the lack of documentation and systematic promotion of indigenous culinary practices further marginalizes these foods within mainstream tourism narratives. This gap highlights the need for empirical research that critically examines the relationship between food tourism, cross-cultural influences, and culinary heritage preservation. Existing literature on food tourism and cultural identity largely emphasizes well-known gastronomic regions, often overlooking lesser-studied rural and semi-urban contexts such as Kongu Nadu. While studies have explored globalization and food consumption patterns, limited attention has been given to region-specific experiences of culinary erosion within South India. Furthermore, there is a paucity of empirical studies that examine food tourism as both a driver of cultural preservation and a potential agent of cultural loss. Addressing this research gap is essential for developing context-sensitive strategies that balance tourism development with cultural sustainability. In this context, the present study aims to examine the impact of cross-cultural influences on the disappearance of traditional foods in the Kongu Nadu region of Tamil Nadu, with particular emphasis on the role of food tourism. By adopting a case study approach, the study seeks to identify traditional dishes that are at risk, analyze changing food preferences across generations, and assess how tourism-related commercialization affects culinary authenticity. The study also explores the perceptions of local communities and tourism stakeholders regarding the preservation of indigenous food practices. By focusing on Kongu Nadu, this research contributes region-specific empirical insights to the broader discourse on food tourism and cultural erosion. The findings are expected to offer valuable implications for policymakers, tourism planners, and hospitality practitioners seeking to promote sustainable and culturally responsible food tourism. Ultimately, the study underscores the importance of recognizing traditional foods as vital components of cultural heritage

that require deliberate protection and promotion in an increasingly globalized world.

LOGICAL BACKGROUND OF THE STUDY

Food tourism has emerged as a significant avenue for cultural expression and destination differentiation; however, increasing cross-cultural interactions have also contributed to the gradual erosion of indigenous food traditions. In regions such as Kongu Nadu in Tamil Nadu, traditional culinary practices rooted in local ecology, millet-based diets, and community customs are increasingly replaced by standardized and cross-cultural food patterns. This shift is driven by globalization, urban lifestyles, tourism commercialization, and changing consumer preferences. The declining transmission of culinary knowledge across generations further accelerates the disappearance of traditional foods. Understanding this transformation is essential to assess the implications of food tourism on cultural sustainability and regional culinary heritage preservation.

THEORETICAL BACKGROUND

The present study is grounded in interdisciplinary theoretical perspectives drawn from cultural studies, tourism theory, and food sociology to explain the disappearance of traditional foods under cross-cultural influence. Central to this research is Cultural Erosion Theory, which posits that prolonged exposure to dominant external cultures can weaken indigenous cultural practices, values, and knowledge systems. In the context of food, cultural erosion manifests through the replacement of traditional diets with standardized and commercially popular cuisines, leading to the gradual loss of culinary identity. The study also draws upon the concept of Cultural Globalization, which emphasizes the increased interconnectedness of societies and the diffusion of cultural elements across borders. While globalization facilitates cultural exchange, it often results in culinary homogenization, where global food trends overshadow local food traditions. This phenomenon is particularly evident in tourism destinations, where food offerings are modified to cater to diverse tourist expectations, compromising authenticity. Additionally, the research is informed by Food Tourism Theory, which recognizes food as both

a cultural resource and an economic product within tourism systems. According to this framework, local cuisines can enhance destination appeal and cultural preservation; however, excessive commercialization may transform traditional foods into symbolic commodities, detaching them from their original cultural contexts. The study further incorporates the concept of Intangible Cultural Heritage, as defined by UNESCO, which highlights traditional food practices as living cultural expressions requiring safeguarding. The erosion of Kongu Nadu's traditional cuisine reflects a breakdown in intergenerational knowledge transfer, exacerbated by lifestyle changes and shifting food preferences. By integrating these theoretical perspectives, the study provides a comprehensive framework to analyze how cross-cultural influences and tourism dynamics interact to shape the survival or disappearance of traditional foods in the Kongu Nadu region.

STATEMENT OF THE PROBLEM

Traditional food practices form a vital component of cultural identity and intangible heritage, reflecting the historical, ecological, and social contexts of a region. The Kongu Nadu region of Tamil Nadu possesses a rich culinary tradition characterized by millet-based diets, indigenous ingredients, and community-oriented food practices. However, in recent years, these traditional foods have been increasingly marginalized due to rapid cross-cultural influences driven by globalization, urbanization, migration, and tourism development. The growing dominance of standardized and cross-cultural cuisines has significantly altered local food consumption patterns, leading to the gradual disappearance of several indigenous dishes. Food tourism, although widely promoted as a tool for cultural preservation and economic development, presents a critical paradox in this context. While tourism creates opportunities to showcase local cuisine, it often prioritizes marketability and tourist preferences over authenticity. As a result, traditional Kongu Nadu foods are frequently modified, simplified, or excluded from mainstream tourism and hospitality offerings. This commercialization contributes to the dilution of culinary authenticity and weakens the cultural significance of indigenous food practices. Furthermore, changing lifestyles, nuclear family structures, time constraints, and the declining

interest of younger generations in traditional cooking have disrupted the intergenerational transmission of culinary knowledge. Many traditional recipes remain undocumented and are at risk of being lost permanently. Despite the cultural and tourism significance of Kongu Nadu cuisine, limited empirical research has examined the extent to which cross-cultural influences and food tourism contribute to culinary erosion in the region. The absence of systematic studies and policy-oriented interventions addressing this issue underscores the need for focused research. Understanding the dynamics behind the disappearance of traditional foods is essential for developing sustainable food tourism strategies that balance cultural preservation with tourism growth in the Kongu Nadu region.

REVIEW OF LITERATURE

Food tourism has increasingly been recognized as a critical dimension of cultural tourism, emphasizing food as a medium through which tourists experience the cultural identity of a destination. According to Richards (2021), food tourism allows destinations to differentiate themselves by showcasing local traditions, history, and authenticity through cuisine. Hall and Sharples (2020) argue that traditional foods function as cultural symbols that connect tourists with local ways of life, thereby enhancing experiential tourism. Studies have highlighted that regions with strong culinary identities benefit from increased tourist satisfaction and destination loyalty (Ellis et al., 2018; Everett & Slocum, 2021).

However, scholars caution that the commodification of food for tourism can alter its cultural meaning. Bessière (2020) notes that when traditional foods are commercialized without cultural sensitivity, they risk losing authenticity and becoming mere consumer products. This concern is particularly relevant in developing tourism regions where local cuisines are adapted to meet external tastes.

Cross-cultural interaction has long been identified as a key driver of change in traditional food systems. Globalization has intensified the flow of culinary practices across regions, leading to what Ritzer (2021) describes as "culinary homogenization." This process results in the widespread adoption of standardized food formats, often at the expense of indigenous cuisines.

Johnston and Baumann (2020) observe that global food cultures increasingly influence local dietary habits, especially among younger populations.

In the Indian context, Nair and Venkatesh (2022) found that exposure to global cuisines through urbanization, media, and migration has significantly reshaped food preferences in South Indian households. Similarly, Srinivas (2021) argues that traditional regional cuisines are increasingly marginalized as fast food and cross-cultural dishes gain social prestige. These studies suggest that cross-cultural influence, while fostering diversity, can also accelerate the decline of localized culinary traditions.

In India, studies by George and D'Souza (2023) reveal that hotels and restaurants frequently adapt regional foods by altering ingredients and preparation methods, thereby compromising authenticity. Research conducted by Kumar and Anbarasan (2024) on rural tourism in Tamil Nadu highlights that traditional foods are often excluded from tourism menus due to perceived low demand and preparation complexity. These findings indicate that tourism commercialization can contribute to the erosion of culinary heritage rather than its preservation.

UNESCO (2019) recognizes traditional food practices as a form of intangible cultural heritage that requires safeguarding through documentation, education, and community participation. Scholars such as Long (2020) argue that traditional cuisines represent accumulated indigenous knowledge related to health, agriculture, and sustainability. The decline of such food systems, therefore, signals not only cultural loss but also the erosion of sustainable food practices.

Several studies emphasize the importance of intergenerational knowledge transfer in sustaining traditional cuisines. Alonso and Kok (2021) note that younger generations often lack the skills and interest required to continue traditional cooking practices. In the South Indian context, Raghavan and Kumar (2023) found that traditional millet-based dishes are rapidly disappearing due to changing lifestyles and time constraints. These findings resonate strongly with concerns regarding Kongu Nadu cuisine, which historically relied on indigenous crops and labor-intensive preparation methods.

OBJECTIVES OF THE STUDY

1. To identify the traditional food practices of the Kongu Nadu region that are gradually disappearing.
2. To examine the extent of cross-cultural influences on food consumption patterns in Kongu Nadu.
3. To analyze the role of food tourism in shaping and transforming traditional culinary practices.
4. To assess generational differences in perceptions and preferences towards traditional Kongu Nadu foods.
5. To evaluate the impact of commercialization and tourism-driven food modification on culinary authenticity.
6. To suggest strategies for preserving and promoting traditional Kongu Nadu cuisine through sustainable food tourism.

RESEARCH QUESTIONS

1. What traditional foods of the Kongu Nadu region are currently facing decline or disappearance?
2. How do cross-cultural influences affect food consumption patterns among local residents in Kongu Nadu?
3. What role does food tourism play in transforming traditional culinary practices in the region?
4. Are there significant generational differences in perceptions and preferences toward traditional Kongu Nadu foods?
5. How does tourism-driven commercialization influence the authenticity of traditional cuisine?
6. What measures can be adopted to preserve traditional foods through sustainable food tourism practices?

CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework of the study is designed to examine the relationship between cross-cultural influences, food tourism, and the disappearance of traditional foods in the Kongu Nadu region. Cross-cultural influences arising from globalization, migration, media exposure, and changing lifestyles

act as independent variables that shape local food preferences and consumption patterns. Food tourism functions as both a mediating and influencing factor, as it can promote traditional cuisine or contribute to its commercialization and modification. The dependent variable of the study is the decline of traditional Kongu Nadu foods, reflected through reduced preparation, consumption, and transmission of culinary knowledge. Generational perception and commercialization of food serve as intervening variables that intensify or moderate the impact of cross-cultural influences. The framework also incorporates cultural sustainability as an outcome variable, highlighting the potential for sustainable food tourism to preserve culinary heritage when community participation and authenticity are emphasized.

ANALYSIS AND DISCUSSION

The analysis examines the impact of cross-cultural influence and food tourism on the disappearance of traditional foods in the Kongu Nadu region. Data were collected from local residents, youth respondents, and tourism stakeholders. The results are presented using percentage analysis and mean score interpretation to understand patterns in food preference, cultural change, and tourism influence.

Table 1: Demographic Profile of Respondents

Category	Classification	Frequency	Percentage
Age	Below 30 years	72	36.0
	31–45 years	64	32.0
	Above 45 years	64	32.0
Gender	Male	108	54.0
	Female	92	46.0
Residence	Rural	118	59.0
	Semi-urban	82	41.0

Interpretation

The demographic distribution indicates balanced representation across age groups, allowing meaningful comparison of generational perceptions. A higher proportion of rural respondents supports the relevance of the study in capturing traditional food practices rooted in local communities.

Table 2: Awareness of Traditional Kongu Nadu Foods

Level of Awareness	Respondents	Percentage
High	58	29.0
Moderate	86	43.0
Low	56	28.0
Total	200	100

Interpretation

Only 29% of respondents reported high awareness of traditional Kongu Nadu foods, while a significant proportion showed moderate to low awareness. This indicates declining familiarity with indigenous dishes, especially among younger generations, suggesting erosion of culinary knowledge.

Table 3: Frequency of Consumption of Traditional Foods

Frequency	Respondents	Percentage
Daily	34	17.0
Occasionally	92	46.0
Rarely	74	37.0
Total	200	100

Interpretation

The majority of respondents consume traditional foods only occasionally or rarely. This decline in regular consumption highlights a shift in dietary patterns influenced by lifestyle changes and the availability of cross-cultural foods.

Table 4: Factors Influencing Decline of Traditional Foods (Mean Ranking)

Factors	Mean Score	Rank
Cross-cultural food influence	4.32	I
Urban lifestyle & time constraints	4.10	II
Preference for fast/ convenience foods	3.98	III
Lack of interest among youth	3.85	IV
Limited tourism promotion	3.62	V

(Scale: 1 = Strongly Disagree, 5 = Strongly Agree)

Interpretation

Cross-cultural food influence emerged as the most significant factor contributing to the decline of traditional foods, followed by urban lifestyle changes. The findings strongly support Cultural Erosion Theory, indicating that external food cultures dominate local food choices.

Table 5: Role of Food Tourism in Traditional Food Preservation

Statement	Mean Score
Food tourism promotes local cuisine	3.21
Tourism leads to modification of recipes	4.18
Authenticity is maintained in tourism food	2.94
Traditional foods are commercialized	4.05

Interpretation

While food tourism moderately promotes local cuisine, respondents largely agree that it leads to recipe modification and commercialization. Low mean scores for authenticity indicate that tourism often dilutes traditional food practices rather than preserving them in their original form.

Table 6: Generational Difference in Food Preference

Age Group	Preference for
Traditional Foods (Mean)	
Below 30 years	2.88
31–45 years	3.46
Above 45 years	4.12

Interpretation

Older respondents exhibit a stronger preference for traditional foods compared to younger respondents. This confirms a generational gap in food culture, where younger populations are more inclined toward cross-cultural and global food options.

RECOMMENDATIONS

❖ Tourism authorities and destination marketers should actively promote authentic Kongu Nadu

dishes as part of regional food tourism circuits. Traditional foods should be positioned as cultural assets rather than modified commercial products, ensuring that original ingredients and preparation methods are preserved.

- ❖ Hotels, restaurants, and resorts operating in and around the Kongu Nadu region should be encouraged to include authentic traditional dishes in their menus. Certification or recognition for establishments serving genuine regional cuisine can enhance visibility and credibility.
- ❖ Systematic documentation of traditional recipes, cooking techniques, and food-related rituals should be undertaken through collaborations between academic institutions, local communities, and cultural organizations. This will help preserve indigenous culinary knowledge for future generations.
- ❖ Local communities, especially women and traditional food practitioners, should be actively involved in food tourism activities such as culinary workshops, food festivals, and heritage dining experiences. Community participation can ensure authenticity while generating local employment.
- ❖ Educational institutions and skill development programs should introduce modules on traditional food culture, indigenous ingredients, and sustainable diets. Engaging younger generations is critical for ensuring continuity of traditional culinary practices.
- ❖ Government agencies should recognize traditional foods as intangible cultural heritage and develop supportive policies, including financial incentives, training programs, and promotional campaigns. Public-private partnerships can further strengthen efforts to revive disappearing foods.
- ❖ Social media, digital storytelling, and online platforms should be leveraged to showcase traditional Kongu Nadu foods, their cultural significance, and preparation processes. Responsible digital promotion can counterbalance cross-cultural dominance and enhance cultural awareness.

FINDINGS

1. The study reveals that several traditional foods of the Kongu Nadu region, particularly millet-based and labor-intensive dishes, are gradually disappearing from regular household consumption.
2. Cross-cultural food influences, driven by globalization, urban lifestyles, media exposure, and tourism, have significantly altered food preferences among local residents.
3. Younger generations exhibit lower awareness, preference, and attachment to traditional Kongu Nadu foods compared to older generations, indicating a clear generational gap in culinary practices.
4. The frequency of consumption of traditional foods has declined, with most respondents consuming them only occasionally or rarely, rather than as part of daily diets.
5. Food tourism plays a dual role in the region; while it offers opportunities to promote local cuisine, it more often leads to modification and commercialization of traditional dishes to suit tourist preferences.
6. Authenticity of traditional foods is frequently compromised in tourism-oriented hospitality settings due to ingredient substitution and simplified preparation methods.
7. Limited documentation and inadequate institutional support contribute to the loss of indigenous culinary knowledge and traditional cooking skills.
8. The absence of structured food tourism policies focused on cultural preservation further accelerates the decline of traditional Kongu Nadu cuisine.
9. Respondents perceive sustainable and community-based food tourism as a viable approach for reviving and preserving disappearing traditional foods.
10. The findings collectively indicate that without targeted interventions, many traditional food practices in Kongu Nadu face the risk of permanent cultural loss.

LIMITATIONS OF THE STUDY

Despite providing valuable insights into the

disappearance of traditional foods in the Kongu Nadu region, the study has certain limitations. First, the research is confined to selected districts within Kongu Nadu; therefore, the findings may not be fully generalizable to other regions of Tamil Nadu or India. Second, the study relies primarily on self-reported data, which may be subject to respondent bias and personal perceptions. Third, time and resource constraints limited the sample size and the depth of longitudinal analysis. Fourth, the study adopts a cross-sectional design, which restricts the ability to capture long-term changes in food practices. Finally, the absence of extensive secondary data specific to Kongu Nadu cuisine constrained comparative analysis.

SCOPE FOR FUTURE RESEARCH

The present study opens several avenues for future research in the field of food tourism and culinary heritage preservation. Future studies may extend the geographical scope to include other regions of Tamil Nadu or conduct comparative analyses between Kongu Nadu and other traditional culinary regions such as Chettinad or Malabar. Longitudinal research designs could be adopted to examine changes in traditional food practices over time and assess the long-term impact of cross-cultural influences. Further research may also explore the economic impact of traditional food-based tourism on local livelihoods. In addition, the role of digital media, food influencers, and gastronomy festivals in reviving disappearing traditional foods warrants deeper investigation. Qualitative ethnographic studies focusing on indigenous knowledge holders can further enrich understanding of culinary heritage sustainability.

CONCLUSION

Food tourism has emerged as an important dimension of cultural tourism, offering destinations opportunities to showcase their unique culinary heritage while contributing to local economic development. However, the findings of the present study demonstrate that unregulated cross-cultural influences and market-driven tourism practices pose significant challenges to the survival of traditional food systems. Focusing on the Kongu Nadu region of Tamil Nadu, this study examined the disappearance of indigenous foods under the influence of cross-cultural interactions and food

tourism dynamics, highlighting the complex relationship between cultural preservation and commercialization. The study reveals that traditional Kongu Nadu foods, particularly millet-based and labor-intensive dishes rooted in local ecology and community practices, are gradually disappearing from regular consumption. Changing lifestyles, urbanization, and increased exposure to global food cultures have significantly altered dietary preferences, especially among younger generations. The findings indicate a clear generational gap in awareness and attachment to traditional foods, threatening the continuity of culinary knowledge transmission. These changes reflect broader processes of cultural erosion, where indigenous food practices are marginalized in favor of standardized and commercially dominant cuisines. While food tourism is often promoted as a mechanism for preserving culinary heritage, the study highlights its paradoxical role in the Kongu Nadu context. Tourism-driven food commercialization frequently prioritizes tourist convenience and visual appeal over authenticity, resulting in modified recipes, ingredient substitution, and simplified preparation methods. Such practices dilute the cultural meaning of traditional foods and risk transforming living culinary traditions into symbolic representations. The absence of structured policies and institutional frameworks to safeguard authenticity further intensifies the erosion of traditional food practices. The study also underscores the broader implications of disappearing traditional foods beyond cultural identity. The decline of indigenous food systems has social, nutritional, and environmental consequences, as traditional diets were closely aligned with sustainable agriculture and local food security. The replacement of these practices with cross-cultural and processed foods raises concerns regarding health and sustainability, reinforcing the need for integrated approaches to food tourism development. Despite these challenges, the findings indicate that sustainable and community-based food tourism offers a viable pathway for the revival and preservation of traditional Kongu Nadu cuisine. Initiatives that prioritize community participation, culinary documentation, youth engagement, and authenticity can help reposition traditional foods as valuable cultural and tourism assets. Policy interventions, institutional support, and responsible marketing are essential to ensure that food tourism contributes to cultural sustainability rather than

cultural loss. The study contributes region-specific empirical insights to the discourse on food tourism and cultural erosion, emphasizing the need for balanced and culturally sensitive tourism development. Preserving traditional foods in Kongu Nadu is not merely an act of cultural conservation but a strategic approach to sustaining regional identity, heritage, and tourism competitiveness in an increasingly globalized world.

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Exploring Service Excellence and Guest Experience in Luxury Hotels of Bengaluru

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ABSTRACT

The luxury hotel sector in Bengaluru has witnessed significant growth due to increasing business travel, leisure tourism, and international visitation. In this highly competitive environment, service excellence and superior guest experience have become critical determinants of customer satisfaction and loyalty. The present study explores the dimensions of service excellence and their influence on guest experience in luxury hotels of Bengaluru. The study focuses on key service attributes such as staff professionalism, service responsiveness, personalization, physical ambience, technological integration, and service reliability. Primary data were collected from tourists staying in selected luxury hotels in Bengaluru using a structured questionnaire, while secondary data were sourced from journals, reports, and industry publications. Statistical tools such as percentage analysis, mean scores, and correlation analysis were employed to analyze the data. The findings reveal that personalized services, employee behaviour, and service efficiency play a significant role in enhancing guest experience and overall satisfaction. The study also highlights the growing importance of digital services and smart technologies in shaping modern luxury hospitality experiences. The research provides practical insights for hotel managers to improve service strategies, strengthen guest relationships, and sustain competitive advantage. The study concludes that consistent service excellence is essential for delivering memorable guest experiences and positioning Bengaluru as a premier luxury hospitality destination.

KEYWORDS: *Service excellence, Guest experience, Luxury hotels, Hospitality industry, Tourist satisfaction, Service quality.*

INTRODUCTION

The hospitality industry plays a vital role in the economic development of nations by generating employment, promoting tourism, and contributing significantly to foreign exchange earnings. Among the various segments of the hospitality industry, luxury hotels occupy a prominent position due to their emphasis on superior service quality, personalized guest experiences, and high standards of comfort and convenience. In recent years, the concept of service excellence has emerged as a key differentiating factor for luxury hotels in an increasingly competitive global market. Service excellence goes beyond the mere provision of services; it involves consistently exceeding guest expectations through exceptional service delivery,

emotional engagement, and memorable experiences. The rapid growth of tourism and business travel has transformed Bengaluru, Karnataka, into one of India's most important hospitality destinations. Often referred to as the "Silicon Valley of India," Bengaluru attracts a diverse range of tourists, including business travellers, leisure tourists, international delegates, and long-stay visitors. The city's thriving information technology sector, multinational corporations, start-up ecosystem, educational institutions, and growing medical tourism industry have significantly increased demand for luxury accommodation. As a result, Bengaluru has witnessed the expansion of several national and international luxury hotel brands offering world-class facilities and services. In the luxury hospitality sector, guest

experience is considered the core of value creation. Unlike budget or mid-scale hotels, luxury hotels focus heavily on delivering unique, personalized, and emotionally satisfying experiences to their guests. Guest experience is shaped by multiple touchpoints throughout the guest journey, including pre-arrival interactions, check-in processes, room quality, food and beverage services, staff behaviour, responsiveness to guest needs, use of technology, and post-stay engagement. Each of these elements contributes to the overall perception of service excellence and influences guest satisfaction, loyalty, and positive word-of-mouth. Service excellence in luxury hotels is closely linked to service quality dimensions such as reliability, assurance, responsiveness, empathy, and tangibles. Well-trained employees, efficient service systems, aesthetically pleasing physical environments, and seamless service delivery are essential components of luxury service excellence. Employees play a particularly critical role, as their professionalism, courtesy, communication skills, and ability to anticipate guest needs significantly affect guest perceptions. In luxury hotels, service encounters are often highly personalized, and even minor service failures can negatively impact guest experience. Therefore, maintaining consistent service excellence requires continuous employee training, strong organizational culture, and effective service management practices.

Technological advancements have also reshaped the nature of service excellence and guest experience in luxury hotels. The adoption of digital technologies such as online booking platforms, mobile check-in and check-out, smart room controls, artificial intelligence-based concierge services, and customer relationship management systems has enhanced service efficiency and personalization. In a technologically advanced city like Bengaluru, guests increasingly expect luxury hotels to integrate modern technologies while maintaining a human touch. The balance between technology-driven convenience and personalized human service has become a defining feature of contemporary luxury hospitality. The expectations of tourists staying in luxury hotels have evolved considerably in recent years. Modern luxury travellers seek not only comfort and opulence but also authenticity, sustainability, wellness, safety, and meaningful experiences. Factors such as eco-friendly practices, health and hygiene standards,

customized dining options, cultural experiences, and emotional connections with the destination influence guest satisfaction. Luxury hotels in Bengaluru are therefore required to continuously innovate their service offerings to meet the changing preferences of both domestic and international tourists. Guest satisfaction and loyalty are critical outcomes of service excellence in luxury hotels. Satisfied guests are more likely to return, recommend the hotel to others, and provide positive online reviews, which significantly influence the hotel's reputation and competitiveness. In contrast, dissatisfied guests can easily share negative experiences through social media and online travel platforms, potentially damaging brand image. As a result, understanding guest perceptions of service excellence and identifying key factors that enhance or hinder guest experience is essential for luxury hotel management. Despite the growth of luxury hotels in Bengaluru, there is a need for systematic research to examine how service excellence is perceived by tourists and how it impacts overall guest experience. While many hotels invest heavily in infrastructure and technology, the effectiveness of these investments depends on how well they align with guest expectations and service delivery standards. Empirical studies focusing on service excellence and guest experience can provide valuable insights into areas of strength and opportunities for improvement within the luxury hospitality sector. The present study, therefore, aims to explore service excellence and guest experience in luxury hotels of Bengaluru. By analysing key service dimensions and tourist perceptions, the study seeks to identify the factors that contribute most significantly to positive guest experiences. The findings of this study are expected to benefit hotel managers, policymakers, and tourism stakeholders by providing practical recommendations to enhance service quality, improve guest satisfaction, and strengthen Bengaluru's position as a leading luxury hospitality destination in India. Ultimately, sustained service excellence is essential for luxury hotels to achieve long-term success and competitive advantage in a dynamic and experience-driven tourism market.

LOGICAL BACKGROUND OF THE STUDY

The rapid growth of luxury hotels in Bengaluru has intensified competition among hospitality

providers, making service excellence a crucial factor for differentiation and guest retention. As tourists increasingly seek personalized, high-quality, and memorable experiences, luxury hotels must consistently meet and exceed rising expectations. Despite significant investments in infrastructure and technology, variations in service delivery and guest experience continue to exist. Understanding how tourists perceive service excellence and the factors influencing their overall experience is therefore essential. This study is logically grounded in the need to evaluate service excellence practices in luxury hotels and their impact on guest experience, satisfaction, and loyalty in the dynamic hospitality environment of Bengaluru.

STATEMENT OF THE PROBLEM

The luxury hotel industry in Bengaluru has expanded rapidly due to increased tourism, business travel, and international visitation. Despite the presence of world-class infrastructure and premium facilities, many luxury hotels face challenges in delivering consistent service excellence and superior guest experiences. Variations in employee performance, service responsiveness, personalization, and effective use of technology often lead to gaps between guest expectations and actual service delivery. In an era where online reviews and social media strongly influence tourist choices, even minor service shortcomings can negatively impact guest satisfaction and brand reputation. Moreover, changing tourist preferences toward personalized, technology-enabled, and emotionally engaging experiences require continuous improvement in service strategies. Therefore, there is a need to systematically examine tourists' perceptions of service excellence in luxury hotels of Bengaluru and identify key factors affecting guest experience, satisfaction, and loyalty.

REVIEW OF LITERATURE

Kim and Lee (2023) examined service excellence in luxury hotels across major Asian metropolitan cities and found that personalized services and staff empathy significantly influenced guest satisfaction and repeat visit intentions. Their study highlighted that luxury guests increasingly value emotional engagement over physical luxury alone. Similarly, Singh and Srivastava (2023), in an Indian context, emphasized that service responsiveness and staff professionalism were the

strongest predictors of guest experience in five-star hotels, especially in business-oriented cities such as Bengaluru and Hyderabad.

Focusing on employee-related factors, Martínez, Rodríguez, and Pérez (2023) analysed the role of service employees in delivering luxury experiences and concluded that continuous training and empowerment directly enhance service excellence. Their findings suggest that human interaction remains central to luxury hospitality despite increasing automation. Supporting this view, Rao and Thomas (2023) observed that tourists perceive service excellence primarily through staff behaviour, communication skills, and problem-resolution efficiency in luxury hotels.

Technological integration has emerged as a major theme in recent hospitality research. Wang, Li, and Huang (2024) explored the impact of smart technologies such as mobile check-in, AI-based concierge services, and digital personalization on guest experience in luxury hotels. The study revealed that technology enhances convenience and service efficiency but must be balanced with personalized human service to maintain a sense of luxury. In a similar study, Kumar and Bhatia (2024) found that technology-enabled services significantly improved guest satisfaction in Indian luxury hotels, particularly among younger and international tourists.

Johnson and Keller (2024) studied luxury hotel guest experiences across different service touchpoints and concluded that consistency in service delivery throughout the guest journey is critical for perceived service excellence. Their research emphasized that pre-arrival communication and post-stay engagement are as important as on-site service quality. In the Indian context, Nair and Menon (2024) highlighted that personalized dining experiences, wellness services, and cultural elements play a vital role in enhancing guest experience in luxury hotels.

Brown and Wilson (2025) examined changing guest expectations in luxury hotels and noted increased emphasis on hygiene standards, safety, and contactless services. Their study concluded that health-related service excellence has become a permanent expectation rather than a temporary concern. Similarly, Iyer and Kulkarni (2025) found that trust, safety, and transparent service processes significantly influence guest satisfaction in luxury hotels in urban Indian destinations.

Chen and Xu (2025) emphasized that memorable experiences, emotional connections, and surprise elements strongly affect guest loyalty in luxury hotels. Their findings suggest that service excellence is no longer limited to standardized quality but includes experiential differentiation. In a study conducted in South India, Ramesh and Prakash (2025) reported that customized services and relationship management practices are key drivers of guest delight and positive word-of-mouth.

Anderson and Thompson (2026) proposed that luxury hotels must adopt data-driven personalization strategies to enhance guest experience while maintaining service authenticity. Likewise, Patel and Joshi (2026) emphasized the integration of technology, employee engagement, and service innovation as essential components of future luxury hospitality excellence.

OBJECTIVES OF THE STUDY

1. To examine the level of service excellence offered by luxury hotels to tourists in Bengaluru, Karnataka.
2. To analyse tourists' perceptions of guest experience in luxury hotels of Bengaluru.
3. To identify key service quality dimensions influencing guest satisfaction in luxury hotels.
4. To assess the relationship between service excellence and overall guest experience in luxury hotels.
5. To suggest measures for improving service excellence and enhancing guest experience in luxury hotels of Bengaluru.

RESEARCH QUESTIONS

1. What is the level of service excellence offered by luxury hotels to tourists in Bengaluru, Karnataka?
2. How do tourists perceive the overall guest experience in luxury hotels of Bengaluru?
3. Which service quality dimensions most strongly influence guest satisfaction in luxury hotels?
4. Is there a significant relationship between service excellence and guest experience in luxury hotels of Bengaluru?

5. What measures can be adopted by luxury hotels to enhance service excellence and improve guest experience?

ANALYSIS AND DISCUSSION

This chapter presents the analysis and discussion of data collected from tourists staying in luxury hotels in Bengaluru, Karnataka. The analysis aims to examine the level of service excellence, evaluate guest experience, identify key influencing factors, and understand the relationship between service excellence and guest experience. The data were analysed using percentage analysis, mean score analysis, and correlation analysis. The findings are discussed in light of existing literature and the objectives of the study.

Profile of the Respondents

Understanding the demographic profile of respondents is essential to interpret perceptions of service excellence and guest experience accurately.

Table 1: Demographic Profile of Respondents

Particulars	Category	No. of Respondents	Percentage
Gender	Male	72	60.0
	Female	48	40.0
Age	Below 30	30	25.0
	30–45	54	45.0
	Above 45	36	30.0
Type of Tourist	Domestic	78	65.0
	International	42	35.0
Purpose of Visit	Business	62	51.7
	Leisure	40	33.3
	Others	18	15.0
Total		120	100

Interpretation

The table indicates that a majority of respondents were male (60%) and belonged to the 30–45 age group (45%), suggesting a strong presence of business and working professionals among luxury hotel guests. Domestic tourists constituted 65% of the sample, reflecting Bengaluru's importance as a national business and tourism hub. More than half of the respondents

visited the city for business purposes, emphasizing the importance of efficient and professional service delivery in luxury hotels.

ANALYSIS OF SERVICE EXCELLENCE DIMENSIONS

Service excellence was measured using key dimensions such as staff behaviour, service responsiveness, reliability, physical ambience, and technological support.

Table 2: Mean Score Analysis of Service Excellence Dimensions
(5-point Likert scale)

Service Dimension	Mean Score	Rank
Staff Courtesy and Professionalism	4.42	I
Service Responsiveness	4.30	II
Physical Ambience and Facilities	4.18	III
Service Reliability	4.05	IV
Use of Technology	3.96	V

Interpretation

Staff courtesy and professionalism ranked first with the highest mean score (4.42), indicating that employee behaviour is the most influential factor in perceived service excellence. Service responsiveness ranked second, highlighting the importance of prompt service in luxury hospitality. Physical ambience and facilities also scored high, reflecting the significance of aesthetic appeal and comfort. Technology received the lowest mean score, suggesting scope for further improvement in digital service integration.

ANALYSIS OF GUEST EXPERIENCE

Guest experience was analyzed based on comfort, personalization, emotional satisfaction, and overall experience.

Table 3: Mean Score Analysis of Guest Experience Factors

Guest Experience Factor	Mean Score	Rank
Overall Comfort and Convenience	4.35	I

Personalized Services	4.22	II
Emotional Satisfaction	4.10	III
Value for Money	3.98	IV

Interpretation

Overall comfort and convenience ranked first, indicating that luxury hotel guests highly value comfort and seamless service. Personalized services ranked second, supporting the view that customization enhances guest experience. Emotional satisfaction also scored high, confirming that guest experience extends beyond physical facilities. Value for money ranked last, suggesting that luxury guests prioritize experience over cost considerations.

Tourists' Overall Satisfaction Level

Table 4: Level of Overall Guest Satisfaction

Satisfaction Level	Respondents	Percentage
Highly Satisfied	56	46.7
Satisfied	44	36.7
Neutral	14	11.6
Dissatisfied	6	5.0
Total	120	100

Interpretation

A majority of respondents (83.4%) were either satisfied or highly satisfied with their stay in luxury hotels. This indicates that luxury hotels in Bengaluru are largely successful in delivering high-quality services. However, the presence of neutral and dissatisfied respondents highlights the need for continuous service improvement.

Relationship between Service Excellence and Guest Experience

To examine the relationship between service excellence and guest experience, correlation analysis was employed.

Table 5: Correlation between Service Excellence and Guest Experience

Variables	Correlation Coefficient (r)
Service Excellence & Guest Experience	0.68

Interpretation

The correlation coefficient ($r = 0.68$) indicates a strong positive relationship between service excellence and guest experience. This implies that higher levels of service excellence lead to enhanced guest experience. The result supports the findings of earlier studies which emphasize that consistent service quality is a key determinant of memorable guest experiences in luxury hotels.

CHALLENGES FACED BY LUXURY HOTELS IN DELIVERING SERVICE EXCELLENCE

1. Luxury hotels in Bengaluru operate in a highly competitive and dynamic hospitality environment. One of the major challenges faced by these hotels is maintaining consistent service excellence across all departments and service touchpoints.
2. Variations in employee performance, staff turnover, and workload pressure often affect the uniformity of service delivery. Even small service lapses can significantly impact guest satisfaction in the luxury segment.
3. Another key challenge is meeting the continuously evolving expectations of guests. Modern luxury tourists expect highly personalized services, seamless digital experiences, and emotional engagement, which require constant innovation and adaptability. Balancing traditional personalized hospitality with advanced technology poses a significant challenge, as over-automation may reduce the human touch that defines luxury service.
4. The effective integration of technology is also a challenge for many luxury hotels. While digital tools enhance efficiency, inadequate staff training and technical issues can limit their effectiveness. Additionally, managing online reviews and guest feedback on digital platforms has become increasingly complex, as negative reviews can quickly influence brand image and booking decisions.
5. Cost management is another critical challenge. Delivering premium services, maintaining luxury infrastructure, and investing in skilled manpower

involve high operational costs. Maintaining service excellence while ensuring profitability remains a continuous concern for hotel management.

LIMITATIONS OF THE STUDY

The present study is subject to certain limitations that should be considered while interpreting the findings. The study is confined to luxury hotels located in Bengaluru, Karnataka; therefore, the results may not be generalized to luxury hotels in other cities or regions. The sample size is limited and based on tourists who were willing to respond to the questionnaire, which may result in respondent bias. The study relies primarily on self-reported data, and respondents' perceptions may be influenced by personal experiences, expectations, or temporary emotions. Time constraints restricted the study to a cross-sectional design, preventing an in-depth longitudinal analysis of changes in guest perceptions over time. Additionally, the study focuses on selected dimensions of service excellence and guest experience, and other influencing factors such as pricing strategies, brand loyalty, and external environmental factors were not extensively examined.

SCOPE FOR FUTURE RESEARCH

Future research can expand the scope of the study by including luxury hotels across multiple cities or states to allow comparative analysis. Longitudinal studies can be conducted to examine changes in guest expectations and service excellence over time. Further research may focus on specific dimensions such as the impact of artificial intelligence, sustainability practices, or wellness services on guest experience in luxury hotels. Studies can also compare guest perceptions across different hotel categories such as luxury, boutique, and mid-scale hotels. Additionally, qualitative research methods such as in-depth interviews and focus group discussions can be used to gain deeper insights into emotional and experiential aspects of guest experience.

RECOMMENDATIONS

- Luxury hotels in Bengaluru should prioritize continuous employee training and development programs to enhance service skills, communication abilities, and emotional intelligence. Empowering employees to handle guest requests and service recovery effectively can significantly improve guest experience.

- Hotels should strengthen personalized service strategies by using customer relationship management (CRM) systems to understand guest preferences and tailor services accordingly. Personalized welcome gestures, customized dining options, and individualized room settings can enhance guest satisfaction.
- Investment in technology should be aligned with guest expectations and service objectives. Luxury hotels should adopt user-friendly digital solutions such as mobile check-in, smart room features, and AI-assisted concierge services while ensuring that technology complements human service rather than replacing it.
- Regular monitoring of guest feedback through surveys and online review platforms is essential. Hotels should proactively address guest complaints and use feedback as a tool for continuous service improvement.

SUGGESTIONS

- Luxury hotels should focus on creating memorable and emotionally engaging guest experiences by incorporating local culture, wellness services, and unique experiential offerings. This can help differentiate their services and strengthen brand identity.
- Management should encourage a strong service-oriented organizational culture that motivates employees to deliver exceptional service. Recognition and reward systems can boost employee morale and commitment.
- Sustainability practices should be integrated into service delivery without compromising luxury standards. Eco-friendly initiatives, energy efficiency, and responsible tourism practices can enhance the hotel's image and appeal to environmentally conscious tourists.
- Hotels should also collaborate with tourism stakeholders, travel agencies, and digital platforms to enhance visibility and attract diverse tourist segments.

CONCLUSION

The study concludes that service excellence is a critical determinant of guest experience in luxury hotels of Bengaluru, Karnataka. The findings reveal that employee behavior, service responsiveness, personalization, and physical ambience play a significant role in enhancing guest satisfaction. A strong positive relationship between service excellence and guest experience indicates that consistent and high-quality service delivery leads to memorable experiences and guest loyalty. Despite the presence of world-class facilities, luxury hotels face challenges related to consistency, technology integration, and evolving guest expectations. Addressing these challenges through strategic service management, employee empowerment, and guest-centric innovations is essential for sustaining competitive advantage. The study emphasizes that a holistic approach to service excellence is necessary for luxury hotels to strengthen their position in the hospitality market and contribute to the long-term growth of tourism in Bengaluru.

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Exploring the AI-Knowledge Management Interface: Paving the Way for Sustainable Learning

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ABSTRACT

Integrating artificial intelligence (AI) with knowledge management (KM) practices offers a promising way to improve sustainable learning in higher education. However, there is limited research on how this combination works, especially in developing countries. This study aimed to explore how AI-powered KM practices affect sustainable learning outcomes in Indian higher education institutions. A model was tested using responses from 401 students. The results showed that AI-driven knowledge creation, storage, discovery, and prediction had a strong positive impact on sustainable learning when used ethically. On the other hand, AI-based knowledge capture practices and customized knowledge delivery did not significantly affect sustainable learning. The model demonstrated significant explanatory power for sustainable learning outcomes. This study adds to the “knowledge-based view” and “absorptive capacity” theories by exploring AI and KM integration in education. It also supports the “responsible AI paradigm” by considering ethical issues in AI-driven educational systems. The findings lay the groundwork for future research on the relationship between AI, KM, and sustainable learning, providing valuable insights for improving educational practices and promoting lifelong learning.

KEYWORDS: *AI-based knowledge management, Sustainable learning, Absorptive capacity, Higher education.*

INTRODUCTION

Artificial intelligence (AI) has rapidly evolved from a niche technological domain into a transformative force across sectors such as healthcare, finance, and education. In higher-education contexts, AI is increasingly used to personalize learning pathways, automate administrative processes, and generate predictive insights that enhance student success and institutional effectiveness. Early applications of AI in education centred on intelligent tutoring systems and adaptive learning environments aimed at tailoring instruction to individual learners, while recent advances in machine learning, natural language processing, and large language models have expanded its scope to include automated assessment, content recommendation, virtual learning assistants, and early-warning systems for academic risk. Parallel to these developments, knowledge management (KM)—the

systematic creation, storage, sharing, and application of knowledge—has become a strategic priority in universities; however, traditional KM practices often remain fragmented or manually driven, limiting their capacity to address dynamic academic needs. Integrating AI into KM processes offers substantial potential to enable intelligent knowledge discovery, automated content organization, real-time analytics, and context-aware decision support. Despite growing scholarly interest, empirical research on the combined influence of AI-enhanced KM practices on sustainable learning outcomes—particularly in developing-country contexts—remains limited, with most studies focusing on isolated AI applications rather than systemic KM integration. Although recent work suggests that AI-driven KM systems may support educational sustainability, the mechanisms through which AI-enabled knowledge creation, storage, discovery, and prediction affect long-term learning remain insufficiently

understood, and ethical concerns related to privacy, transparency, fairness, accountability, and governance are rarely incorporated into empirical models despite their growing importance. Addressing these gaps, this study examines the impact of AI-enhanced KM practices on sustainable learning outcomes in higher-education institutions in developing regions of the country, drawing on the Knowledge-Based View and Absorptive Capacity Theory while integrating the Responsible AI paradigm, and empirically tests a conceptual model using survey responses from 301 students analysed through Partial Least Squares Structural Equation Modeling (PLS-SEM), thereby offering theoretical advancement and practical insights for educators, institutional leaders, and policymakers seeking to foster ethical, technology-enabled, and sustainability-oriented learning environments.

RESEARCH BACKGROUND

In recent years, the integration of Artificial Intelligence (AI) into various sectors has garnered widespread attention due to its transformative potential. In education, AI's capacity to process large amounts of data, recognize patterns, and generate predictive insights has led to significant advancements in teaching, learning, and knowledge management (KM) practices. Knowledge management, which involves the systematic management of knowledge creation, storage, sharing, and application, is a critical function in higher education institutions. It aids in improving decision-making processes, enhancing collaboration, and promoting continuous learning. When combined with AI, KM systems can become even more efficient, enabling institutions to offer personalized learning experiences, streamline knowledge flows, and optimize resources for better educational outcomes.

While AI and KM hold promise for improving educational practices, their integration in higher education, particularly in developing countries, remains underexplored. Developing nations face unique challenges, such as inadequate technological infrastructure, limited access to resources, and distinct cultural and social contexts, which may influence the implementation and effectiveness of AI-enhanced KM practices. In these regions, understanding how AI-driven KM systems can contribute to sustainable

learning outcomes is crucial, but empirical studies on this subject are scarce. Most existing literature has focused on developed countries, which have more established infrastructure and resources, leaving a gap in research that considers the specific needs and conditions of developing countries like India.

RESEARCH OBJECTIVES

The rapid advancements in artificial intelligence (AI) and its applications across various sectors have sparked significant interest in higher education, particularly in enhancing learning outcomes and knowledge management (KM) practices. AI's ability to process vast amounts of data, provide predictive insights, and automate tasks has the potential to revolutionize how knowledge is created, shared, and applied within educational settings. Knowledge management, on the other hand, focuses on the effective acquisition, organization, and dissemination of knowledge to facilitate better decision-making and learning processes. When integrated, AI and KM have the potential to create a more sustainable and effective learning environment in higher education, promoting both the personal and academic growth of students.

The study aims to investigate the impact of AI-enhanced KM practices on sustainable learning outcomes in higher education institutions in developing areas of our country. By analyzing responses from 301 students and testing a proposed model using partial least squares structural equation modeling (PLS-SEM), the study seeks to explore how AI-driven knowledge creation, storage, discovery, and prediction influence learning sustainability. This research also considers the ethical dimensions of AI implementation, offering insights into how responsible AI practices can be integrated into educational systems.

In addition to contributing to the existing body of knowledge on AI and KM in education, this study expands on theoretical perspectives such as the "knowledge-based view" and "absorptive capacity" theories. It also aligns with the emerging "responsible AI paradigm," which emphasizes the importance of ethical considerations in developing and deploying AI technologies in education. Ultimately, the study aims to provide valuable insights that can guide the transformation of educational practices, fostering

an environment of lifelong learning and sustainable development.

STATEMENT OF THE PROBLEM

Higher education institutions in developing regions are increasingly adopting artificial intelligence (AI) technologies to improve teaching, learning, and administrative processes; however, knowledge management (KM) practices often remain fragmented and poorly integrated with these systems, limiting their ability to support sustainable learning outcomes. Although AI applications such as adaptive learning platforms, predictive analytics, and virtual assistants are widely promoted, their collective impact on long-term knowledge retention, self-directed learning, and lifelong skill development has not been sufficiently examined. Existing studies typically address AI adoption or KM practices separately, leaving a critical gap in understanding how AI-enhanced KM systems influence educational sustainability in resource-constrained contexts. Furthermore, ethical concerns related to data privacy, algorithmic transparency, bias, and accountability continue to affect trust in AI-driven education, yet these dimensions are rarely incorporated into empirical investigations. Consequently, there is limited theory-driven evidence to guide institutions in implementing AI-enabled KM systems responsibly, prompting this study to empirically examine how AI-enhanced KM practices influence sustainable learning outcomes while integrating responsible AI principles within a PLS-SEM framework.

RESEARCH QUESTIONS

This study develops and tests a conceptual framework examining the influence of AI-enhanced KM on sustainable learning in Indian higher education. It offers insights for scholars and practitioners in education, AI, and KM fields, exploring how AI-driven KM can facilitate sustainable learning environments. The research contributes to educational technology and sustainable development discussions by investigating the synergy between AI and KM.

RQ1: How do AI-enhanced knowledge management practices impact sustainable learning outcomes in higher education institutions in India?

RQ2: What are the key factors, including ethical considerations, that influence the successful integration of AI in knowledge management systems to improve educational practices and learning sustainability in Indian higher education?

RQ3: How do students' absorptive capacity and institutional knowledge resources shape the effectiveness of AI-enhanced KM systems in fostering long-term learning outcomes?

LITERATURE REVIEW

The need for effective management forms part of the management of knowledge creation itself. In this respect, the nature, characteristics and skills of the facilitator are crucial to the development of energy and synergy, which in turn will lead to knowledge creation, insight and innovation. A moderator's awareness of tacit knowledge and his/her ability to facilitate intangible value is vital to the success of a knowledge-focused web environment. Janette Young, in *Personal Knowledge Capital*, 2012, Knowledge creation theory is at the heart of knowledge management. It has enabled the processes of knowledge to be broken down into understandable parts. The theory of knowledge creation has been led by the work of Nonaka (1991) and Nonaka and Takeuchi (1995). Nonaka and Takeuchi's theory has achieved paradigmatic status since the mid-1990s (Gourlay 2006), and it has been described as one of the best and most influential models in knowledge strategy literature (Choo and Bontis 2002, cited in Gourlay 2006). As this theory has become so highly regarded, we need to understand the theory in further detail, to make the best use of it as we continue to advance into the twenty-first century. An organisation's ability to perceive the value of new knowledge, absorb it, and use it to accomplish desired outcomes is referred to as absorptive capacity theory (Cohen, 2013). In the context of AI-KM integration, this theory suggests that AI systems can help organisations capture diverse knowledge sources and facilitate sustainability (Rohde et al., 2024). The reviewed studies have shown the ability of AI to integrate various knowledge sources and facilitate knowledge exchange, (Manuti & Monachino, 2020; Olan et al., 2022). AI enhances knowledge discovery through techniques like natural language processing and machine learning (Lin et al., 2023; Majumder

& Dey, 2022). The notion of intelligent information processing is centred on creating computational models and methods that imitate the cognitive functions of humans, including learning, reasoning, and solving problems (Newell & Simon, 2019). In the context of AI-KM integration, this idea suggests that AI-powered tools can enhance knowledge discovery processes by identifying relevant information, extracting insights, and uncovering patterns or connections (Safder et al., 2018).

CONCEPTUAL FRAMEWORK

Fig. 1 Illustrates the conceptual framework linking AI-driven knowledge management (AI-KM) practices to sustainable learning. The framework highlights seven pathways representing key AI-KM practices: knowledge creation, knowledge capture practices, maximised knowledge storage, smart knowledge discovery, predictive knowledge, tailored knowledge delivery/sharing, and ethical AI-KM integration. Each pathway demonstrates how these AI-KM practices collectively support sustainable learning by enhancing knowledge processes and promoting responsible AI use. This framework visually synthesizes the hypotheses discussed earlier, emphasizing the central role of AI in transforming knowledge management to achieve sustainable and equitable learning outcomes.



Fig. 1. Conceptual Framework

RESEARCH METHODOLOGY

Research Sample and Design

This study was conducted among students enrolled in higher-education institutions across Kerala, India. The target population comprised learners from private, aided, and state-affiliated universities representing multiple academic levels—undergraduate, postgraduate, and

doctoral scholars—and a wide range of disciplines, including arts, humanities, science, and social sciences. A convenience sampling strategy was adopted, and a Google-based questionnaire was circulated among individuals and student groups over two months (August-September 2025). This approach was selected for its operational efficiency and ability to facilitate rapid data collection. In total, 401 usable responses were obtained, which was considered adequate for subsequent statistical analysis.

Sustainable learning was conceptualized as the endogenous construct and measured using five items. The exogenous variables included knowledge creation (four items), knowledge capture practices (KCP; four items), knowledge storage (KS; four items), knowledge discovery (KD; five items), predictive knowledge (PK; five items), tailored knowledge delivery/sharing (TKD; five items), and ethical AI-KM integration (five items), yielding a total of 37 measurement items. Instrument development was informed by an extensive review of prior literature and established measurement scales to ensure content validity.

DATA ANALYSIS

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to test the proposed research model using SmartPLS 4 software. PLS-SEM was chosen because of its suitability for exploratory research and its capacity to maximize the explained variance in complex models involving multiple latent constructs (Hair & Alamer, 2022). The software facilitates a comprehensive assessment of both measurement and structural models, including diagnostics for multicollinearity, analysis of higher-order constructs, and examination of mediation, moderation, and multigroup effects involving categorical and continuous variables.

Results: PLS-SEM Model

The first step in evaluating the validity and reliability of the items in a PLS study is to examine the outer model. The evaluation of the model depends on whether the items reflect a concept directly (reflective measures) or contribute to a concept (formative measures), along with the overall structure of the measurement model itself (Davcik, 2014). It is essential to confirm the

validity and reliability of the proposed measurement model before proceeding to hypothesis testing. Prior to analyzing the structural model, the convergent and discriminant validity of the measurement model must be assessed to ensure it meets the required standards (Hair & Alamer, 2022; Sarstedt, Marko & Ringle, 2020). For assessing reliability, the factor loadings of each item were examined. The recommended factor loading threshold is above 0.708, although values above 0.50 are also considered acceptable (Hair & Alamer, 2022). As shown in Table 1 and Figure 2, the standardized factor loadings for all items were within an acceptable range, ranging from 0.521 to 0.770.

CONSTRUCT VALIDATION

Convergent validity checks how well different measures of the same concept are related (White, 2003). In this case, the average variance extracted (AVE) values show that five constructs (KC, KCP, KD, KS, PK) are above the 0.5 threshold, indicating they are valid (Cheung et al., 2024; Chin & Yao, 2014; Hair & Alamer, 2022). However, three constructs (ethical AI integration, sustainable learning, and tailored knowledge delivery/sharing) fall below this threshold. Even though their AVE values are low, it's important to remember that social science research is often complex and relies on self-reports and grey-box models (Bruschi, 2017). The variance inflation factor (VIF) values are below 5, showing no serious collinearity issues (Sarstedt et al., 2020). Other criteria, like standardized factor loading ≥ 0.5 and composite reliability ≥ 0.7 , are also met in this model, supporting its validity (Bonett & Wright, 2014; Hanna et al., 2018; Purwanto & Sudargini, 2021).

Taking all these factors into account, convergent validity is confirmed, though further exploration is needed for constructs below the threshold.

DISCRIMINANT VALIDITY

Discriminant validity was assessed using two criteria. The first, based on Fornell and Larcker's (1981) method, suggests that the square root of the AVE for each construct should be greater than its correlation with any other construct in the model. Table 1 shows that the square root of the AVE for E AI-KM (0.650) is smaller than TKD (0.686), indicating a potential issue with discriminant validity between E AI-KM and TKD. Similarly, for PK, the square root of the AVE is smaller than TKD (0.721), suggesting a potential issue with discriminant validity between TKD and PK. The other constructs show acceptable values.

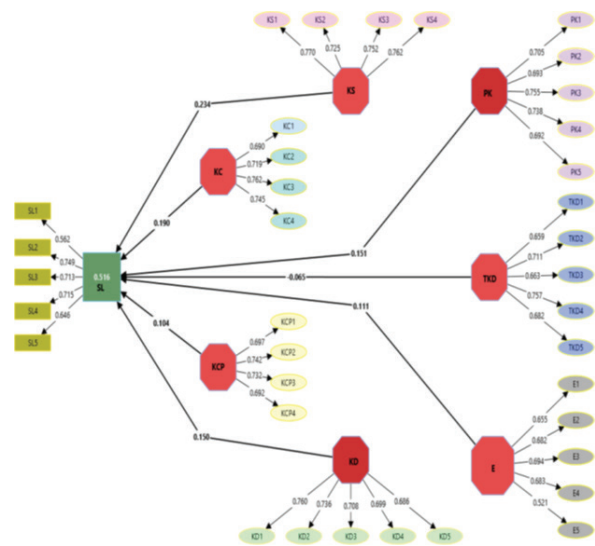


Fig. 2. PLS- Sem Algorithm

Table 1. Fornell-larcker criterion

	E	KCP	KC	KS	PK	SKD	SL	TKD
E	0.650	/						
KCP	0.539	0.716	/					
KC	0.541	0.618	0.729	/				
KS	0.539	0.637	0.558	0.753	/			
PK	0.640	0.578	0.530	0.618	0.717	/		
SKD	0.565	0.610	0.569	0.665	0.654	0.718	/	
SL	0.533	0.569	0.575	0.620	0.579	0.598	0.680	/
TKD	0.686	0.615	0.551	0.610	0.721	0.628	0.526	0.696

Next, the Heterotrait-Monotrait ratio (HTMT) values were examined. Table 2 shows that the HTMT ratio between E AI-KM and TKD, as well as between PK and TKD, is above the threshold of 0.85, indicating a lack of discriminant validity (Fornell & Larcker, 1981).

For good discriminant validity, the HTMT values should be below 0.85, ideally under 0.90, to avoid multicollinearity (Ab Hamid et al., 2017). Therefore, these two constructs need further investigation.

Table 2. Heterotrait-Monotrait ratio (HTMT) matrix

	E	KCP	KC	KS	PK	SKD	SL	TKD
E	/							
KCP	0.782	/						
KC	0.784	0.889	/					
KS	0.75	0.892	0.766	/				
PK	0.888	0.804	0.718	0.818	/			
SKD	0.781	0.844	0.774	0.875	0.86	/		
SL	0.76	0.817	0.813	0.847	0.784	0.804	/	
TKD	0.967	0.871	0.767	0.822	0.964	0.841	0.725	/

Revised Conceptual Framework

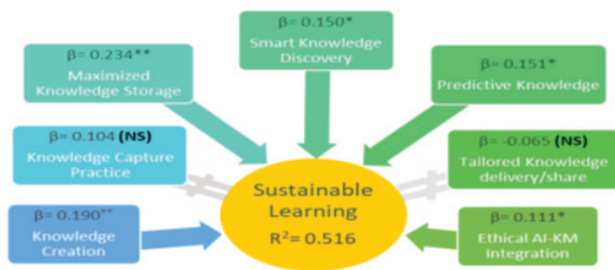


Fig.3. Revised Conceptual Framework

FINDINGS

This study examined how AI-enhanced knowledge management practices affect sustainable learning among students in higher-education institutions in Kerala using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results showed that most survey items were reliable and that the model was generally sound, even though a few areas—ethical AI integration, sustainable learning, and tailored knowledge delivery—were harder to measure precisely. Some overlap was found between ethical AI practices and personalized knowledge delivery, as well as between predictive knowledge and tailored delivery, suggesting that students often see ethical use of AI and customized learning features as closely connected. The analysis supported five of the seven proposed relationships, indicating that AI-based knowledge creation, storage, discovery, prediction, and ethical

integration significantly improved sustainable learning outcomes. However, knowledge capture practices and tailored knowledge delivery did not have a clear direct effect on long-term learning. Overall, the findings show that AI can strongly support learning when it is used to manage knowledge effectively and responsibly, but technology alone is not enough unless it is combined with good teaching strategies and institutional support.

IMPLICATIONS AND FUTURE RESEARCH SCOPE

This study provides valuable insights into the intersection of AI, knowledge management (KM), and sustainable learning in education. It tested an integrated model, offering insights into AI's role of AI in knowledge creation, storage, discovery, and prediction. The study supports five of the seven hypotheses in the model while challenging ideas about knowledge capture and tailored delivery. This highlights the complexity of learning environments and the need for more advanced frameworks. AI's impact of AI on knowledge creation and storage extends existing theories and requires new concepts that include AI capabilities. Similarly, AI's role in discovery and prediction suggests the need to expand learning analytics and KM theories to education. The importance of ethical AI-KM integration is also emphasized, suggesting the need for comprehensive models that combine KM, AI, pedagogy, and educational perspectives to support sustainable

learning. These insights can help guide AI integration decisions for knowledge optimization and student support. Additionally, focusing on ethical AI integration highlights the need for responsible development and oversight in educational technology. Future research should include more diverse perspectives, particularly from educators, and explore long-term, multidimensional studies for global sustainability in learning. The study's limitations include its focus on a single state and the lack of input from key stakeholders, such as teachers. These factors limit generalizability, and future studies should consider cultural and socioeconomic differences between countries.

CONCLUSION

This study shows that AI-enhanced knowledge management practices play an important role in supporting sustainable learning in higher-education institutions in developing regions when implemented responsibly and well-planned. The results indicate that AI tools used for knowledge creation, storage, discovery, and prediction, together with strong ethical governance, can meaningfully improve students' long-term learning experiences. Simultaneously, the findings suggest that simply capturing knowledge or tailoring content through AI systems is insufficient to guarantee lasting learning benefits unless these technologies are closely aligned with teaching methods and institutional strategies. Overall, this study highlights the need for universities and policymakers to focus not only on adopting advanced AI systems but also on integrating them thoughtfully into academic practices while ensuring transparency, fairness, and data protection. Future research should examine these relationships across different regions, include perspectives from educators and administrators, and use longitudinal approaches to better understand how AI-enabled KM systems contribute to lifelong learning.

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Educational Service Quality in Hotel Management Programmes: Effects on Student Satisfaction and Advocacy Intentions in India

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ABSTRACT

This study examined how perceived educational service quality affects student satisfaction and advocacy intention among hotel management students in India. Using a single cross sectional research design, data were collected from 303 UG students of hotel management programme. Five service quality dimensions namely Teaching and Course Content, Administrative Services, Academic Facility, Infrastructure and Support Service along with Student Satisfaction and Advocacy Intention were measured on five point Likert scales. Teaching and Course Content, Academic Facility, Infrastructure and Support Service significantly predicted satisfaction while Administrative Services was not significant. For advocacy intention, Infrastructure emerged as the strongest predictor, followed by Support Service and Teaching and Course Content. Findings indicate that strengthening academic core and student support ecosystem is central to student satisfaction whereas advocacy intentions are especially influenced by campus infrastructure and support services in hotel management programmes.

KEYWORDS: *Educational service quality, Hotel management, Student satisfaction, Advocacy intention.*

INTRODUCTION

AISHE explicitly recognises “Hotel Management & Catering Institutes” as a stand-alone institutional category (Type VII) and reports 59 registered institutes under this type. This indicates that hotel management education constitutes a distinct and nationally tracked segment within India’s higher education system (AISHE, 2022). Higher education institutions increasingly compete on the quality of the student experience. Thus, it is important to understand how students evaluate educational services and how those evaluations translate into outcomes that matter for institutions. In India, this concern is amplified by the scale and expansion of the higher education system and by policy emphasis on strengthening educational quality alongside access. Recent national-level reporting highlights a sector-wide transition from an access-oriented expansion to a stronger focus on quality, pedagogy, employability and institutional performance (NITI Aayog, 2025a; Press Information Bureau, 2025).

Student satisfaction is widely treated as a key indicator of institutional performance because it reflects students’ overall appraisal of their educational experience and can shape longer-term relationships with the institution (De-Juan-Vigaray et al., 2024; Shahsavar & Sudzina, 2017). In service settings, perceived quality is also consequential because it is linked to future-oriented behaviours such as continued preference and positive communication to others (Zeithaml et al., 1996). Mismatches between expectations and actual service design, delivery and communication can produce perceived shortfalls in service quality (Parasuraman et al., 1985). Subsequent work demonstrated that perceived service quality influences behavioural intentions that signal whether customers remain with a provider, recommend it to others and speak positively about it (Zeithaml et al., 1996).

Research in hospitality education indicates that student satisfaction is influenced by multiple programme and institutional attributes rather than a single factor,

reinforcing the need for multi-domain assessment (O'Driscoll, 2012). Quality assurance work in hotel management tertiary education also highlights that student satisfaction is tied to how effectively institutions deliver programme quality and supporting services for different student groups (Frawley et al., 2019). However, despite growing evidence linking service quality to satisfaction and loyalty-type outcomes in higher education, there remains a need for programme-focused studies that test domain-specific predictors against both satisfaction and advocacy-related intentions in the Indian context (NITI Aayog, 2025a; Press Information Bureau, 2024).

LITERATURE REVIEW

Literature Review was carried out to explore service quality and relevant dimensions, service quality with respect to educational institutions and programmes, service quality and its antecedents in hotel management educational institution setup and relationships among constructs.

Measuring educational service quality and relevant dimensions: Educational service quality is widely treated as multidimensional because student experiences span academic and non-academic encounters and higher education measurement must capture multiple domains rather than rely on generic instruments, motivating education-specific scales such as HEdPERF (Abdullah, 2006). In India, HiEdQUAL was developed to measure service quality using dimensions that reflect how students experience institutional services (Annamdevula & Bellamkonda, 2012). Service quality has also been modelled as a higher-order construct comprising academic, administrative and facilities components and linked to satisfaction and behavioural intentions (Sultan & Wong, 2014). Related work distinguished technical or transformative quality from functional quality and examined their roles in satisfaction and loyalty-related outcomes (Teeroovengadam et al., 2019). From a professional higher education perspective, a faculty-based scale highlighted training and placement, learning infrastructure and assessment as salient quality components (Kamakoty & Singh, 2023). In hospitality education, evidence indicates that student satisfaction is shaped by multiple programme attributes rather than a single factor (O'Driscoll, 2012) and quality assurance

research similarly links satisfaction to programme quality and institutional delivery systems in hotel management institutions (Frawley et al., 2019).

Service quality dimensions: The present study operationalised educational service quality through five dimensions aligned with HiEdQUAL (Annamdevula & Bellamkonda, 2012). Teaching and Course Content captures teaching quality and curriculum relevance, commonly treated as central to students' evaluations and linked to satisfaction and behavioural intentions in higher education models (Abdullah, 2006; Sultan & Wong, 2013, 2014). Administrative Services reflects efficiency, accuracy, responsiveness and respectful interactions, often distinguished from academic delivery in service quality frameworks (Sultan & Wong, 2013, 2014). Academic Facilities includes classrooms, equipment, library resources and digital infrastructure that support learning and skill development and are linked to satisfaction outcomes (Ikram & Kenayathulla, 2023; Sultan & Wong, 2014). Infrastructure covers broader campus conditions such as hygiene, safety and basic amenities, which have shown associations with satisfaction in structured evaluations (Wahyuni et al., 2024). Support Services includes mentoring, student development and placement-related support, which is emphasised in professional education contexts and contributes to satisfaction within service quality assessments (Ikram & Kenayathulla, 2023; Kamakoty & Singh, 2023; Wahyuni et al., 2024).

Educational service quality and student satisfaction: Evidence across contexts indicates positive links between service quality and student satisfaction. In South Asia, higher education service quality predicted satisfaction among business students in India and Nepal (Surya Bahadur et al., 2024). Similar findings are reported in studies using service-quality dimensions in Bangladesh (Barua & Uddin, 2021) and in comparative work on public versus private universities in Pakistan (Tahir & Saleem, 2021). Dimension-focused HEISQUAL evaluations also found that infrastructure and facilities and support staff or management contributed to overall satisfaction (Wahyuni et al., 2024). Recent work further indicates that service factors shape student satisfaction through institutional image, including mediating effects (Hossain et al., 2025). Structural models also show that service quality contributes to satisfaction alongside

related constructs such as trust and brand-related variables (Sultan & Wong, 2014; Teeroovengadum et al., 2019).

Advocacy intention as behavioural consequence in higher education: Advocacy intention reflects recommendation, positive word-of-mouth and preference to choose again. Services research identifies behavioural intentions as consequences of perceived quality, including recommendation and continued preference (Zeithaml et al., 1996), and higher education models position behavioural intentions as downstream outcomes associated with service quality through satisfaction-related processes (Sultan & Wong, 2014; Teeroovengadum et al., 2019). Empirical studies support these links: service-quality factors have been shown to influence satisfaction which in turn predicts word-of-mouth and recommendation intentions (Rasheed & Rashid, 2023). Recommendation intention has also been examined as a key behavioural outcome alongside satisfaction in private higher education contexts (Kairat et al., 2024). Related work suggests that satisfaction contributes to loyalty and that loyalty predicts recommendation-related word-of-mouth behaviours (Chen, 2016). Further evidence shows that satisfied students generate positive word-of-mouth with perceived education quality strengthening this relationship (Lin et al., 2025). Broader loyalty frameworks also highlight satisfaction as a predictor of loyalty outcomes with institutional image as an important antecedent (Shahsavari & Sudzina, 2017), while university social responsibility research indicates indirect paths to loyalty via service quality, satisfaction and trust (Latif et al., 2021). Collectively, these studies justify treating advocacy intention as a behavioural consequence of service quality perceptions in higher education.

Research Gap: Prior research shows that perceived service quality in services is shaped by delivery and design gaps (Parasuraman et al., 1985) and that higher perceived quality can lead to favourable behavioural intentions such as positive word-of-mouth and continued preference (Zeithaml et al., 1996). Further, studies examining recommendation or word-of-mouth in higher education often focus on broad institutional drivers or indirect pathways through satisfaction and related constructs rather than testing direct, dimension-

wise effects that institutions can act upon (Kairat et al., 2024; Rasheed & Rashid, 2023; Lin et al., 2025). This leaves insufficient clarity on which specific educational service quality dimensions are the strongest predictors of both satisfaction and advocacy-type intentions in hotel management education. Addressing these gaps, the present study tests a dimension-based educational service quality model in the Indian hotel management context and identifies the most influential predictors of (a) overall student satisfaction and (b) advocacy intention captured through recommendation, positive word-of-mouth and preference to choose again (Sultan & Wong, 2012, 2013; Zeithaml et al., 1996). Such research gaps lead to research objectives for the study.

RESEARCH OBJECTIVES

This study focused on achievement of these two research objectives.

1. To examine effect of perceived service quality dimensions on student satisfaction
2. To examine effect of perceived service quality dimensions on student advocacy intention

Research Methodology: Single cross-sectional research design was used to collect primary data from hotel management students in India. 303 Under Graduate (UG) programme students were surveyed from government hotel management institutions across states from India. Perceived educational service quality was measured using five dimensions and four items each and was aligned with higher education service-quality structures: Teaching and Course Content, Administrative Services, Academic Facility, Infrastructure and Support Service. Student Satisfaction and Advocacy Intention were measured as outcome constructs using a five-point Likert scale. Satisfaction model regressed Student Satisfaction on five service quality dimensions and advocacy model regressed Advocacy Intention on the same predictors. Analysis was performed using two multiple regression models, one for predicting satisfaction and one for predicting advocacy intention.

Data Analysis

Predicting Student Satisfaction: The multiple regression model predicting Student Satisfaction from the five educational service quality dimensions demonstrated strong overall fit.

Table 1 Model fit for multiple regression predicting Student Satisfaction

Model	R	R ²	Adj. R ²	S.E.	F	df1	df2	p	Durbin-Watson
1	0.917	0.842	0.839	0.434	316.00	5	297	< .001	1.853

The model explained a substantial proportion of variance in Student Satisfaction ($R^2 = .842$, adjusted $R^2 = .839$). The overall model was statistically significant, $F(5, 297) = 316.00$, $p < .001$, indicating that the set of predictors jointly contributed to explaining Student

Satisfaction. Model fit results indicated that perceived service quality dimensions collectively provided strong explanatory power for student satisfaction in the sample (Hair et al., 2019).

Table 2 Regression coefficients predicting Student Satisfaction

Predictor	B	SE B	β	t	p	Tolerance	VIF
Constant	0.051	0.099		0.518	.605		
Teaching and Course Content	0.304	0.066	0.293	4.591	< .001	0.131	7.628
Administrative Services	0.007	0.059	0.007	0.127	.899	0.155	6.441
Academic Facility	0.208	0.071	0.201	2.916	.004	0.112	8.961
Infrastructure	0.196	0.052	0.205	3.786	< .001	0.182	5.501
Support Service	0.254	0.062	0.254	4.061	< .001	0.137	7.315

Regression results showed that four of the five educational service quality dimensions significantly predicted Student Satisfaction. Teaching and Course Content was a positive and significant predictor ($B = 0.304$, $SE = 0.066$, $\beta = .293$, $t = 4.591$, $p < .001$), indicating that higher perceptions of teaching and course content were associated with higher satisfaction. Academic Facility also positively predicted satisfaction ($B = 0.208$, $SE = 0.071$, $\beta = .201$, $t = 2.916$, $p = .004$). Infrastructure showed a significant positive effect ($B = 0.196$, $SE = 0.052$, $\beta = .205$, $t = 3.786$, $p < .001$), and Support Service was also significant and positive ($B = 0.254$, $SE = 0.062$, $\beta = .254$, $t = 4.061$, $p < .001$). In

contrast, Administrative Services was not a significant predictor. Regarding relative influence, Teaching and Course Content had the largest standardized effect ($\beta = .293$), followed by Support Service ($\beta = .254$), Infrastructure ($\beta = .205$), and Academic Facility ($\beta = .201$), indicating that academic delivery and support services contributed most strongly to satisfaction in this model.

Predicting Advocacy Intention

The multiple regression model predicting Advocacy Intention from the five educational service quality dimensions demonstrated strong overall fit.

Table 3 Model fit for multiple regression predicting Advocacy Intention

Model	R	R ²	Adj. R ²	S.E.	F	df1	df2	p	Durbin-Watson
1	0.851	0.724	0.720	0.596	156.11	5	297	< .001	1.923

Model explained a substantial proportion of variance in Advocacy Intention ($R^2 = .724$, adjusted $R^2 = .720$). Overall model was statistically significant, $F(5, 297) = 156.11$, $p < .001$, indicating that the set of predictors jointly explained variation in advocacy intention. Model

fit results supported that perceived service quality dimensions collectively provided strong explanatory power for advocacy intention among hotel management students (Hair et al., 2019).

Table 4 Regression coefficients predicting Advocacy Intention

Predictor	B	SE B	β	t	p	Tolerance	VIF
Constant	0.135	0.136		0.994	.321		
Teaching and Course Content	0.251	0.091	0.232	2.760	.006	0.131	7.628

Administrative Services	-0.076	0.081	-0.072	-0.937	.350	0.155	6.441
Academic Facility	0.184	0.098	0.171	1.878	.061	0.112	8.961
Infrastructure	0.297	0.071	0.298	4.177	< .001	0.182	5.501
Support Service	0.270	0.086	0.259	3.144	.002	0.137	7.315

Regression results showed that Teaching and Course Content, Infrastructure and Support Service significantly predicted Advocacy Intention while Administrative Services and Academic Facility were not significant in the full model. Teaching and Course Content had a positive and significant effect ($B = 0.251$, $SE = 0.091$, $\beta = .232$, $t = 2.760$, $p = .006$), indicating that stronger perceptions of teaching quality and course relevance were associated with higher advocacy intention.

Discussion of Result and Conclusion: This study examined how five educational service quality dimensions predicted student satisfaction and advocacy intention among hotel management students in India. Satisfaction was driven mainly by Teaching and Course Content along with Support Service, Infrastructure and Academic Facility while Administrative Services did not influence student satisfaction. Advocacy intention showed a different emphasis with respect to service quality dimensions in hotel management programme set up. Infrastructure and Support Service were most influential factors along with Teaching and Course Content. These outcomes aligned with services research linking perceived quality to recommendation and word-of-mouth (Parasuraman et al., 1985; Zeithaml et al., 1996). Findings suggest that satisfaction depends most on academic delivery and support systems whereas advocacy is more sensitive to visible campus environment cues and student support experiences (O'Driscoll, 2012; Frawley et al., 2019).

Findings of this study should be construed with understanding of scope and limitations of the research. This study used a single cross-sectional design so the findings more likely show associations rather than pure causal effects. Data were collected through self-reported Likert measures from UG hotel management students which could have been impacted by common method bias and social desirability. Also, sample was limited to one programme context and respondent group so generalisability to other regions, institution types and PG students may be limited. Future studies can use longitudinal designs to strengthen causal inference and

track changes in satisfaction and advocacy over time. Broader and more diverse samples across public vs private institutions and UG and PG programmes can improve external validity.

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Role of Microfinance in Enhancing Rural Livelihood Opportunities: A Study with Special Reference to Nagapattinam District

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ABSTRACT

Microfinance has become a significant financial mechanism for cultivating the economic well-being of rural populations, especially amid low-income families that often lack access to formal banking systems. This study explores the part of microfinance in enhancing rural livelihood opportunities with particular reference to Nagapattinam District in Tamil Nadu. The district has a predominantly rural population whose livelihoods largely depend on agriculture, fishing, and various small-scale economic activities. In recent years, the expansion of microfinance initiatives through Self-Help Groups (SHGs), microfinance institutions, and government-backed financial inclusion programs has created new opportunities for rural development. These initiatives aim to provide accessible financial services, encourage entrepreneurial activities, and support sustainable income-generating opportunities within rural communities. The research mainly seeks to understand how microfinance services including microcredit, savings facilities, and financial assistance contribute to income generation, employment creation, and the economic empowerment of rural households. Primary data for the study were composed from beneficiaries of microfinance programs in selected rural areas of Nagapattinam District using structured questionnaires. The analysis examines the extent to which access to microfinance has enabled rural individuals, particularly women and socially disadvantaged groups, to participate in small business activities, agricultural enterprises, and other livelihood-related ventures. The results of the study reveal that microfinance has played a crucial role in increasing household income, encouraging self-employment, and enhancing financial independence among rural beneficiaries. It has also significantly supported women's involvement in economic activities and improved their role in household decision-making. Despite these positive outcomes, certain challenges remain, including limited financial literacy, pressure related to loan repayment, and restricted access to higher levels of credit. The study concludes that strengthening microfinance services, improving financial education, and implementing supportive policies can further promote rural livelihood opportunities and contribute to sustainable rural development in Nagapattinam District.

KEYWORDS: *Microfinance-rural livelihoods-self-help groups (SHGs)-Financial inclusion-rural development.*

INTRODUCTION

Rural development is widely acknowledged as a crucial element for attaining balanced economic growth and social progress in developing countries like India. A considerable portion of the nation's populace resides in rural regions and primarily depends on agriculture, fishing, and small-scale economic endeavors for their sustenance. Nevertheless, rural communities often face a multitude of challenges, such as limited access to financial services, insufficient employment prospects, low income levels, and inadequate infrastructure. These limitations frequently obstruct rural households from enhancing their economic conditions and sustaining stable and viable livelihoods. In this context, microfinance has emerged as a significant tool for fostering financial inclusion and bolstering the economic empowerment of rural communities. Microfinance typically encompasses the provision of small-scale financial services, including credit, savings, insurance, and other related financial products, to low-income individuals who generally lack access to formal banking systems. The concept gained global recognition through initiatives like the Grameen Bank in Bangladesh, which illustrated that small loans extended to impoverished individuals, especially women, could greatly improve their economic capabilities and entrepreneurial ventures. Over time, microfinance has evolved into a vital development strategy embraced by numerous countries to combat poverty, enhance livelihood opportunities, and promote social empowerment among marginalized groups. In the Indian scenario, microfinance has significantly contributed to advancing rural development and aiding economically disadvantaged segments of society. The growth of microfinance institutions, coupled with the participation of government bodies and non-governmental organizations, has facilitated the provision of financial services to previously unserved and underserved rural communities. One of the most notable initiatives in India is the Self-Help Group (SHG)–Bank Linkage Program, which has been instrumental in this regard. Another important contribution of microfinance lies in the empowerment of women. In many rural settings, women often face restrictions in accessing financial resources and participating in decision-making processes. Microfinance initiatives,

particularly those implemented through Self-Help Groups, have helped improve women's involvement in economic activities. By providing opportunities for savings and credit, these programs enable women to start small businesses, contribute to household income, and develop greater self-confidence and independence. Consequently, women who participate in microfinance initiatives often experience improved social recognition and greater involvement in both family and community decision-making processes. Despite the many benefits associated with microfinance, rural communities continue to encounter certain challenges in accessing and effectively utilizing financial services. Limited financial literacy, inadequate awareness about available financial products, relatively high interest rates in some microfinance schemes, and pressure to repay loans are among the common issues faced by beneficiaries. Additionally, factors such as natural disasters, unstable market conditions, and broader economic uncertainties can affect the success of livelihood activities supported through microfinance. Therefore, it becomes essential to periodically assess the effectiveness of microfinance programs and identify strategies to enhance their impact on rural livelihoods. Nagapattinam District in Tamil Nadu offers a relevant setting for examining the influence of microfinance on rural livelihood development. The district is predominantly rural, with a large section of the population engaged in agriculture, fisheries, and other allied activities. Being a coastal region, Nagapattinam has also faced several socio-economic challenges, including natural calamities such as cyclones and the devastating 2004 tsunami, which significantly affected the livelihoods of local communities. In response to these challenges, a number of microfinance initiatives have been introduced in the district through Self-Help Groups, microfinance institutions, cooperative banks, and various government-supported programs. These initiatives aim to extend financial assistance to rural households, stimulate entrepreneurial activities, and enhance overall socio-economic development. The growth of microfinance services in Nagapattinam District has allowed numerous rural families to obtain credit and invest in productive enterprises. Farmers, fishermen, artisans, and small-scale business owners have gained from financial assistance that enables them to maintain and grow their livelihood activities.

Additionally, microfinance programs have enhanced community cooperation through group-based financial structures such as Self-Help Groups. These groups not only offer financial support but also act as venues for knowledge sharing, skill development, and promoting collective involvement in decision-making among rural participants. However, the degree to which microfinance aids in improving rural livelihoods is influenced by several factors, including the accessibility of financial services, the capacity of beneficiaries to effectively use credit, and the presence of supportive infrastructure and market opportunities. Grasping these elements is essential for formulating policies and programs that can optimize the beneficial effects of microfinance on rural communities. In this context, the current study aims to investigate the role of microfinance in enhancing rural livelihood prospects, particularly in Nagapattinam District. The research intends to assess how access to microfinance services affects income generation, job creation, and economic empowerment among rural households. It also aims to identify the challenges faced by beneficiaries in utilizing microfinance services and suggest suitable measures to enhance the effectiveness of such initiatives. Through this examination, the study aspires to contribute to a more profound understanding of how microfinance can serve as a significant tool for rural development and socio-economic advancement in districts like Nagapattinam.

LOGICAL BACKGROUND OF THE STUDY

Microfinance has emerged as a significant strategy for enhancing the economic welfare of rural communities. In numerous rural areas, low-income families face challenges in accessing formal banking services, which limits their capacity to secure financial assistance for productive investments. As a result, many individuals in these regions turn to informal lending options that frequently charge exorbitant interest rates, thereby exacerbating their financial strain and susceptibility. To tackle this challenge, microfinance institutions and Self-Help Groups (SHGs) have arisen as alternative financial frameworks that offer small loans, savings options, and financial support to marginalized groups. These services enable rural families to initiate income-generating ventures, improve their living standards,

and attain greater financial security. In districts like Nagapattinam, where the population predominantly relies on agriculture, fisheries, and small-scale enterprises, microfinance is crucial in fostering economic opportunities. Therefore, it is vital to examine the role of microfinance in bolstering rural livelihood prospects to comprehend its impact on sustainable rural development.

STATEMENT OF THE PROBLEM

Rural areas in India continue to experience several socio-economic difficulties, including poverty, unemployment, inadequate financial resources, and limited opportunities for sustainable livelihoods. Many low-income households in rural regions have restricted access to formal banking systems and financial institutions. Factors such as lack of collateral security, low levels of financial awareness, and geographical isolation often prevent rural people from obtaining financial support from formal sources. Consequently, a large number of rural households rely on informal lenders who typically charge very high interest rates and impose unfavorable lending conditions. This dependence increases the financial strain on rural families and limits their capacity to improve their economic well-being. To address these issues, microfinance has been introduced as a supportive financial system that offers small-scale loans, savings services, and other financial facilities to economically weaker sections of society. Through mechanisms such as Self-Help Groups (SHGs) and microfinance institutions, rural individuals are encouraged to participate in entrepreneurial and income-generating activities. Despite the growing presence of microfinance programs, there is still a need to examine how effectively these initiatives contribute to improving rural livelihood opportunities. In districts such as Nagapattinam, where a majority of people depend on agriculture, fisheries, and small-scale occupations for their livelihood, evaluating the impact of microfinance programs becomes highly important. Therefore, this study aims to assess the role of microfinance in strengthening rural livelihood opportunities and to identify the difficulties faced by beneficiaries in achieving sustainable economic progress.

REVIEW OF LITERATURE

Kumar and Rani (2023) investigated the effects of microfinance on the income of rural households in Tamil Nadu, discovering that access to microcredit significantly enhanced income levels and fostered self-employment among rural beneficiaries. Their research indicated that involvement in Self-Help Groups enabled rural households to invest in small enterprises like dairy farming, tailoring, and petty trade, which led to greater financial stability. Rao and Singh (2024) explored the function of microfinance institutions in fostering rural entrepreneurship. Their findings demonstrated that microfinance services assisted rural individuals in establishing small businesses and diversifying their income sources. Nonetheless, the study also highlighted challenges such as restricted access to larger loans, market limitations, and insufficient business training for beneficiaries. A study conducted by Lakshmi and Devi (2024) assessed the effectiveness of Self-Help Groups in enhancing the socio-economic conditions of rural households in South India. The results revealed that SHGs not only provided access to credit but also encouraged savings habits, skill development, and collective decision-making among rural women. Consequently, members of SHGs experienced improvements in their income levels and overall living standards. According to Gupta and Verma (2025), microfinance is vital for advancing financial inclusion in rural areas by offering accessible financial services to economically disadvantaged segments of society. Their research underscored that microfinance programs have significantly diminished reliance on informal moneylenders and bolstered the financial security of rural households.

OBJECTIVES OF THE STUDY

- ❖ To investigate the role of microfinance in improving rural livelihood opportunities in Nagapattinam District.
- ❖ To assess the availability of microfinance services for rural households in the study area.
- ❖ To analyze the effects of microfinance on income generation and job opportunities for rural beneficiaries.

- ❖ To examine the role of Self-Help Groups (SHGs) in fostering financial inclusion and economic empowerment.
- ❖ To identify the obstacles encountered by rural beneficiaries in accessing and utilizing microfinance services.
- ❖ To propose strategies for enhancing the effectiveness of microfinance programs in supporting sustainable rural livelihoods.

RESEARCH QUESTIONS

- 1) In what ways does microfinance enhance rural livelihood opportunities in Nagapattinam District?
- 2) What is the degree of accessibility of microfinance services for rural households in the study area?
- 3) To what degree does microfinance affect income generation and employment for rural beneficiaries?
- 4) How do Self-Help Groups (SHGs) facilitate financial inclusion and economic empowerment in rural areas?
- 5) What difficulties do rural beneficiaries experience in accessing and utilizing microfinance services?
- 6) What strategies can be implemented to enhance the effectiveness of microfinance programs in fostering sustainable rural livelihoods?

RESEARCH METHODOLOGY

The present research adopts a descriptive research design to analyze the role of microfinance in promoting rural livelihood opportunities in Nagapattinam District. The study aims to understand how microfinance services help rural households improve income levels, generate employment, and achieve economic empowerment.

Area of the Study

The research is carried out in Nagapattinam District, Tamil Nadu, which is largely rural in nature. A significant portion of the population in this district depends on agriculture, fisheries, and various small-scale occupations for their livelihood. Over the years, the district has experienced the growth of several microfinance initiatives implemented through Self-Help Groups (SHGs), microfinance institutions, cooperative

banks, and government-supported financial inclusion schemes.

ANALYSIS AND DISCUSSION

This section presents the analysis of data collected from respondents regarding the role of microfinance in enhancing rural livelihood opportunities in Nagapattinam District. The analysis is based on percentage distribution and interpretation of responses.

Table 1: Gender of the Respondents

Gender	Number of Respondents	Percentage
Male	42	35%
Female	78	65%
Total	120	100%

Interpretation

The table illustrates the gender distribution among respondents involved in microfinance programs. Of the total 120 respondents, 65% are female while 35% are male. The greater involvement of women suggests that microfinance initiatives, especially Self-Help Groups, primarily focus on women to promote economic empowerment and enhance financial inclusion in rural regions.

Table 2: Age Group of the Respondents

Age Group	Number of Respondents	Percentage
Below 30 years	28	23.3%
31–40 years	46	38.3%
41–50 years	30	25%
Above 50 years	16	13.4%
Total	120	100%

Interpretation

The table shows that 38.3% of the respondents fall within the age range of 31–40 years, representing the largest segment. This implies that individuals in middle age are more engaged in microfinance activities as they pursue stable income sources and opportunities for livelihood.

Table 3: Occupation of the Respondents

Occupation	Number of Respondents	Percentage
Agriculture	34	28.3%
Fisheries	22	18.3%
Small Business	36	30%
Wage Labour	28	23.4%
Total	120	100%

Interpretation

The table indicates that 30% of the respondents are involved in small business activities, with 28.3% participating in agriculture. This suggests that microfinance has motivated rural individuals to establish small enterprises and broaden their income sources beyond conventional occupations.

Table 4: Purpose of Availing Microfinance Loans

Purpose	Number of Respondents	Percentage
Agriculture Activities	30	25%
Small Business	40	33.3%
Household Needs	28	23.3%
Education and Others	22	18.4%
Total	120	100%

Interpretation

The table indicates that 33.3% of respondents utilized microfinance loans for small business endeavors, representing the largest share. This suggests that microfinance is essential in fostering entrepreneurial initiatives and enhancing livelihood prospects in rural regions.

Table 5: Impact of Microfinance on Household Income

Response	Number of Respondents	Percentage
Highly Increased	36	30%
Moderately Increased	54	45%
Slightly Increased	20	16.7%
No Change	10	8.3%
Total	120	100%

Interpretation

The table indicates that 45% of participants observed a moderate rise in household income, whereas 30% noted a substantial increase following their engagement with microfinance services. This suggests that microfinance has played a beneficial role in enhancing the economic circumstances of rural households.

Table 6: Challenges Faced in Accessing Microfinance

Challenges	Number of Respondents	Percentage
High Interest Rates	34	28.3%
Repayment Pressure	30	25%
Lack of Financial Literacy	32	26.7%
Limited Loan Amount	24	20%
Total	120	100%

Interpretation

The table shows that 28.3% of respondents view high interest rates as the primary challenge, while 26.7% indicated a lack of financial literacy. These results imply that while microfinance programs aid rural livelihoods, there are still specific obstacles that hinder their effectiveness.

RECOMMENDATIONS / SUGGESTIONS

1. Financial literacy programs should be organized regularly to educate rural beneficiaries about proper financial management, savings habits, and effective utilization of loans. This will help borrowers make informed financial decisions and reduce repayment
2. Training programs related to entrepreneurship, skill development, and business management should be provided to microfinance beneficiaries. This will help them start and manage small-scale enterprises more effectively.
3. Microfinance institutions should adopt reasonable interest rates so that rural borrowers can repay their loans without excessive financial pressure.
4. Self-Help Groups should be further strengthened through capacity-building programs, regular

monitoring, and support from government agencies and financial institutions to ensure their sustainability.

5. Government agencies should introduce supportive policies and development schemes that promote microfinance activities, encourage rural entrepreneurship, and improve access to markets for rural products.

CONCLUDING OBSERVATIONS

Microfinance has emerged as a significant tool for fostering rural development and enhancing the socio-economic conditions of underprivileged communities. The current study regarding the impact of microfinance on improving rural livelihood opportunities in Nagapattinam District underscores the beneficial role of microfinance initiatives in raising income levels, promoting self-employment, and bolstering financial inclusion among rural households. The research indicates that microfinance programs, especially those executed through Self-Help Groups, have been instrumental in empowering rural populations, particularly women. By facilitating access to credit and promoting savings practices, microfinance has allowed numerous rural individuals to establish small enterprises, invest in productive ventures, and improve their overall living conditions. The increased involvement of women in economic activities has also led to enhanced decision-making authority and social empowerment within rural communities. Moreover, the findings suggest that microfinance has assisted rural households in diversifying their income sources and decreasing their reliance on informal moneylenders. This has resulted in greater financial stability and economic resilience among beneficiaries. Additionally, microfinance initiatives have fostered community collaboration and collective action through group-based financial systems such as Self-Help Groups. However, despite these favorable outcomes, several challenges persist that impact the effectiveness of microfinance programs. Factors such as limited financial literacy, elevated interest rates, repayment pressures, and insufficient loan amounts continue to impede the full realization of microfinance initiatives. Tackling these challenges necessitates coordinated efforts from microfinance institutions, government bodies, and

development organizations. In summary, microfinance is vital in enhancing rural livelihood opportunities and promoting sustainable rural development in areas like Nagapattinam.. In conclusion, microfinance plays a crucial role in enhancing rural livelihood opportunities and supporting sustainable rural development in regions like Nagapattinam District. With improved financial services, better policy support, and effective training programs, microfinance can further contribute to poverty reduction, economic empowerment, and long-term livelihood security for rural communities.

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Taste of Kerala: Analysing the Impact of Ethnic Cuisine on Tourist Motivation and Destination Promotion

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ABSTRACT

Kerala, widely recognized as “God’s Own Country,” has become one of the most appealing tourist destinations in India because of its rich cultural heritage, picturesque landscapes, and unique culinary traditions. Among the various cultural aspects that shape tourists’ experiences, ethnic Kerala cuisine plays a crucial role in influencing visitors’ perceptions of the destination. This study focuses on examining how traditional Kerala cuisine contributes to the promotion of tourism in the state among inbound tourists. Authentic dishes such as appam, puttu, Kerala sadya, seafood specialties, and a variety of spice-based preparations represent the region’s historical background, cultural diversity, and agricultural abundance. These traditional food practices not only reflect the local identity of Kerala but also provide international tourists with authentic and memorable gastronomic experiences. The research further investigates the influence of food on tourists’ travel motivations, their level of satisfaction, and their overall perception of Kerala as a tourist destination. It also explores the extent to which ethnic cuisine serves as a cultural attraction that enables visitors to engage more deeply with local traditions and lifestyles. The study adopts a quantitative research design and collects data through a structured questionnaire administered to inbound tourists visiting major tourist destinations in Kerala. The data gathered are analyzed using appropriate statistical techniques to determine the relationship between tourists’ culinary experiences and their perception of Kerala’s tourism appeal. The findings reveal that ethnic Kerala cuisine plays a significant role in improving tourist satisfaction, enhancing cultural awareness, and strengthening destination loyalty. A large number of inbound tourists consider culinary experiences to be an essential component of their travel plans, which also influences their willingness to revisit Kerala and recommend it to others. The study concludes that the promotion of ethnic cuisine through culinary festivals, organized food trails, and authentic dining opportunities can further enhance Kerala’s attractiveness as a tourism destination. Therefore, ethnic Kerala cuisine emerges as an important cultural resource that supports the growth and sustainability of Kerala tourism in the international tourism market.

KEYWORDS: *Ethnic Kerala cuisine, Culinary tourism, Inbound tourists, Destination promotion, Tourist experience, Kerala tourism development.*

INTRODUCTION

Tourism has emerged as one of the most important sectors contributing to economic development, cultural interaction, and global connectivity. In recent years, the nature of tourism has gradually shifted from traditional sightseeing to experience-oriented travel. Modern travelers increasingly seek authentic experiences that allow them to understand the cultural

identity and lifestyle of a destination. Among the many cultural factors that shape tourist experiences, food has become a key element. Culinary tourism, which involves exploring destinations through their local cuisines and gastronomic traditions, has gained significant popularity around the world. Traditional foods not only fulfill the basic dietary needs of travelers but also provide valuable insights into the history, culture, social practices, and agricultural traditions of

a region. Consequently, ethnic cuisine has become an effective means of promoting tourism and strengthening the cultural image of destinations. Kerala, situated in the southern part of India, is well known for its scenic landscapes, rich cultural heritage, and diverse traditions. Popularly called “God’s Own Country,” the state attracts a large number of domestic and international tourists every year. While Kerala is widely recognized for its backwaters, beaches, hill stations, and wildlife reserves, its distinctive culinary traditions also play an important role in enhancing the tourism experience. Kerala cuisine reflects the state’s geographical features, historical influences, and cultural diversity. Over centuries, trade relations with Arab, Portuguese, Dutch, and British merchants have shaped the culinary practices of the region. The generous use of coconut, aromatic spices, seafood, rice, and locally available ingredients gives Kerala cuisine a unique flavor and aroma that appeals to food enthusiasts from across the globe.

Ethnic Kerala cuisine represents a harmonious combination of tradition, culture, and local agricultural resources. Well-known dishes such as appam, puttu, idiyappam, Kerala sadya, fish curry, and various seafood specialties demonstrate the richness and diversity of the region’s culinary heritage. The traditional Kerala sadya, typically served on a banana leaf with a wide variety of vegetarian dishes, symbolizes the state’s hospitality and communal dining culture. Likewise, the Malabar cuisine of northern Kerala, which carries strong Arabian influences, offers distinctive dishes such as Malabar biryani and pathiri that are highly appreciated by international visitors. These traditional culinary practices help preserve the cultural identity of the region while simultaneously enriching the authenticity of the tourist experience.

In the context of tourism development, food plays a significant role in influencing tourists’ perceptions and satisfaction. Many travelers consider local cuisine to be an essential component of their travel experience, as it enables them to connect more closely with the cultural identity of a destination. Culinary experiences allow visitors to explore regional traditions, interact with local communities, and gain an understanding of the historical importance of ingredients and cooking methods. In some cases, tourists choose destinations specifically to experience their distinctive food culture.

This growing fascination with gastronomy has led to the development of culinary tourism as a specialized segment that contributes significantly to destination marketing and branding.

Recognizing the importance of food as a tourism asset, Kerala has increasingly incorporated culinary experiences into its tourism promotion strategies. Several initiatives such as food festivals, traditional cooking demonstrations, visits to spice plantations, and heritage dining experiences have been introduced to attract tourists interested in exploring the state’s rich gastronomic traditions. Many hotels, restaurants, and resorts in Kerala emphasize authentic ethnic dishes to provide visitors with a genuine taste of the local culture. Furthermore, Kerala’s global reputation as the “Land of Spices” enhances its appeal among international travelers who are interested in spice-based cuisines and culinary traditions.

Inbound tourists, who arrive from various countries and cultural backgrounds, often seek unique and memorable experiences during their travels. Food plays a central role in creating such experiences by providing a sensory connection to the destination. The flavors, ingredients, presentation styles, and dining customs associated with ethnic Kerala cuisine offer visitors an immersive cultural experience that enhances their overall satisfaction. Positive culinary experiences can shape tourists’ perceptions of a destination, encourage them to revisit, and inspire them to recommend the destination to others through word-of-mouth. Therefore, understanding how ethnic cuisine influences tourist behavior is crucial for developing effective tourism promotion strategies.

By analysing the connection between culinary experiences and tourism promotion, this research highlights the importance of ethnic Kerala cuisine as a valuable cultural and tourism resource. The findings of this study are expected to provide meaningful insights for tourism stakeholders, policymakers, and hospitality professionals in developing effective strategies that integrate traditional cuisine into Kerala’s tourism marketing initiatives. Ultimately, the study emphasizes that ethnic cuisine is not merely an aspect of hospitality but a significant cultural asset that contributes to enhancing the attractiveness, identity, and sustainability of tourism destinations.

LOGICAL BACKGROUND OF THE STUDY

In recent years, the tourism sector has increasingly focused on experience-based and culture-oriented travel, where tourists seek meaningful interactions with the traditions, lifestyles, and heritage of a destination. Among the many factors that shape such experiences, local cuisine has become an important cultural element. Food not only fulfills the basic nutritional needs of travelers but also represents the history, geographical characteristics, agricultural practices, and cultural identity of a place. Consequently, culinary tourism has emerged as a significant niche within the tourism industry, encouraging destinations to highlight their traditional cuisines as part of their tourism offerings. Kerala, renowned for its rich cultural heritage and scenic natural environment, has established a strong presence in the international tourism market. Apart from its well-known attractions such as backwaters, beaches, and hill stations, the state is also famous for its distinctive culinary traditions. Ethnic Kerala cuisine is notable for its extensive use of spices, coconut, rice, and seafood, which reflect the region's agricultural resources and its long history of trade with other cultures. Traditional dishes like Kerala sadya, appam, puttu, and various Malabar seafood specialties showcase the diversity and richness of the state's culinary heritage. Inbound tourists visiting Kerala often display a keen interest in tasting authentic local foods, as these culinary experiences help them gain a deeper understanding of the region's culture and traditions. This study seeks to analyze how traditional Kerala food supports tourism promotion and enhances the overall travel experience of visitors to the state.

STATEMENT OF THE PROBLEM

Tourism has become one of the most important sectors contributing to economic development, cultural exchange, and regional promotion. In recent years, tourists have increasingly shown interest in experiential travel, where authentic cultural elements such as local traditions, heritage, and cuisine play a vital role in shaping their travel experiences. Among these elements, traditional and ethnic cuisines have gained recognition as a key component of destination attractiveness. Many countries and regions actively promote their culinary

heritage as part of their tourism development strategies to attract international visitors and enhance their overall travel experience. Kerala, widely recognized for its scenic beauty and cultural richness, has also developed a strong reputation for its distinctive ethnic cuisine. The state's traditional dishes, characterized by the use of spices, coconut, rice, and seafood, reflect its cultural diversity and historical influences. Despite the richness and uniqueness of Kerala cuisine, the role of ethnic food in promoting tourism among inbound tourists has not been sufficiently explored in academic research. Most tourism studies related to Kerala focus primarily on natural attractions, heritage sites, and wellness tourism, while the potential contribution of traditional cuisine as a tourism resource receives relatively limited attention. Inbound tourists frequently look for genuine culinary experiences that represent the cultural identity of the places they visit. However, it is important to understand the extent to which ethnic Kerala cuisine shapes tourists' perceptions, satisfaction levels, and overall travel experiences. In this context, the present study seeks to analyze the role of traditional Kerala cuisine in promoting tourism in the state among inbound tourists and to determine its importance in enhancing Kerala's appeal as a destination in the international tourism market.

REVIEW OF LITERATURE

Okumus, Kock, and Scantlebury (2021) examined how local culinary experiences influence tourists' perceptions of authenticity. Their study found that when tourists participate in authentic food traditions, they are more likely to form deeper emotional connections with the destination. This link improves their overall satisfaction and encourages them to share positive recommendations and word-of-mouth promotion about the destination.

In the Indian context, Babu and Manikandan (2022) examined the role of traditional cuisine in promoting cultural tourism in South India. Their findings suggested that regional dishes and food festivals play a significant role in attracting tourists and preserving local culinary heritage.

Similarly, Nair and Kumar (2023) studied the influence of Kerala's ethnic cuisine on tourist experiences

and found that traditional dishes such as Kerala sadya, seafood preparations, and spice-based curries significantly enhance visitors' cultural understanding and travel satisfaction.

Furthermore, Joseph and Thomas (2024) emphasized that Kerala's culinary heritage, shaped by historical trade connections and diverse cultural influences, contributes to the state's tourism identity. Their research suggested that promoting authentic food experiences through culinary festivals, food trails, and heritage restaurants can strengthen Kerala's tourism competitiveness.

OBJECTIVES OF THE STUDY

1. To analyse the level of awareness and interest of inbound tourists towards traditional Kerala food.
2. To identify the influence of ethnic Kerala cuisine on the overall travel experience and satisfaction of inbound tourists.
3. To evaluate how culinary experiences contribute to tourists' intention to revisit and recommend Kerala as a travel destination.
4. To suggest strategies for promoting ethnic Kerala cuisine as a key component of Kerala tourism development.

RESEARCH QUESTIONS

1. What is the significance of ethnic Kerala cuisine in promoting Kerala as a tourism destination?
2. What is the level of awareness and interest among inbound tourists toward traditional Kerala cuisine?
3. In what ways do traditional dishes and culinary practices contribute to the cultural image of Kerala tourism?
4. Does the experience of Kerala's ethnic cuisine influence tourists' intention to revisit and recommend Kerala to others?
5. What strategies can be adopted to promote ethnic Kerala cuisine as a major attraction for inbound tourists?

ANALYSIS AND DISCUSSION

The analysis and discussion section presents the interpretation of the data collected from inbound

tourists regarding their perceptions, experiences, and preferences related to ethnic Kerala cuisine. The data were collected through a structured questionnaire distributed among 120 inbound tourists visiting major tourist destinations in Kerala such as Kochi, Munnar, and Alappuzha. The collected responses were analysed using simple percentage analysis and presented through tables for better interpretation.

Table 1: Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	68	56.7
	Female	52	43.3
Age	20–30 years	38	31.7
	31–40 years	44	36.7
	41–50 years	26	21.7
	Above 50	12	10
Region	Europe	42	35
	Asia	38	31.7
	North America	24	20
	Others	16	13.3

Interpretation

Table 1 shows the demographic profile of the respondents included in the study. Out of the total 120 respondents, 56.7% were male and 43.3% were female. With regard to age distribution, the largest group of tourists belonged to the 31–40 age category (36.7%), followed by the 20–30 age group (31.7%). This suggests that young and middle-aged travelers represent the major segment of inbound tourists who are interested in culinary experiences. In terms of geographical origin, tourists from Europe formed the largest share (35%), followed by visitors from Asia (31.7%) and North America (20%). This pattern indicates that Kerala attracts tourists from a wide range of regions, many of whom are keen to explore the state's cultural heritage and traditional cuisine during their visit.

Table 2: Awareness of Ethnic Kerala Cuisine among Inbound Tourists

Awareness Level	Frequency	Percentage (%)
Highly aware	48	40

Moderately aware	46	38.3
Slightly aware	18	15
Not aware	8	6.7
Total	120	100

Interpretation

Table 2 illustrates the level of awareness of ethnic Kerala cuisine among inbound tourists. The results show that 40% of respondents were highly aware of traditional Kerala dishes such as appam, puttu, Kerala sadya, and seafood delicacies. Another 38.3% were moderately aware, indicating that a large proportion of tourists had some knowledge of Kerala cuisine before visiting the destination. Only 6.7% of respondents reported having no prior awareness of Kerala's traditional food. This finding suggests that Kerala's culinary reputation has gained international recognition, often through travel media, online platforms, and previous tourist experiences.

Table 3: Tourists' Interest in Experiencing Ethnic Kerala Cuisine

Level of Interest	Frequency	Percentage (%)
Very interested	52	43.3
Interested	40	33.3
Neutral	16	13.3
Not interested	12	10
Total	120	100

Interpretation

Table 3 illustrates the level of interest among inbound tourists in experiencing ethnic Kerala cuisine. The results show that 43.3% of the respondents were highly interested in tasting traditional Kerala dishes, while 33.3% indicated a moderate interest in trying the local cuisine. This indicates that more than three-fourths of the tourists have a favorable attitude toward Kerala's culinary culture. Only 10% of the respondents reported a lack of interest, which may be attributed to specific dietary choices or unfamiliarity with regional food. Overall, the findings highlight that traditional cuisine significantly contributes to increasing the appeal of Kerala as a tourist destination.

Table 4: Influence of Ethnic Cuisine on Overall Tourist Experience

Response	Frequency	Percentage (%)
Strongly agree	50	41.7
Agree	42	35
Neutral	16	13.3
Disagree	12	10
Total	120	100

Interpretation

Table 4 presents the influence of traditional Kerala cuisine on tourists' overall travel experiences. The analysis reveals that 41.7% of the participants strongly believed that tasting authentic Kerala dishes improved their travel experience, while another 35% agreed with this opinion. In total, about 76.7% of the respondents expressed favorable perceptions, indicating that local food significantly contributes to tourists' enjoyment and satisfaction during their visit. Only a limited proportion of participants reported neutral views or disagreement. These results clearly suggest that experiencing ethnic Kerala cuisine acts as an important cultural attraction that enhances the overall tourism experience of inbound visitors.

Table 5: Tourists' Satisfaction with Ethnic Kerala Cuisine

Satisfaction Level	Frequency	Percentage (%)
Highly satisfied	54	45
Satisfied	40	33.3
Neutral	16	13.3
Dissatisfied	10	8.4
Total	120	100

Interpretation

Table 5 shows that 45% of respondents were highly satisfied with ethnic Kerala cuisine, while 33.3% were satisfied, indicating a high level of positive response toward local food experiences. Only 8.4% expressed dissatisfaction, which may be due to differences in taste preferences or unfamiliar ingredients. Overall, the findings recommend that Kerala cuisine contributes positively to tourists' perception of the destination and enhances their overall travel satisfaction.

Table 6: Influence of Cuisine on Revisit Intention

Response	Frequency	Percentage (%)
Yes	70	58.3
Maybe	34	28.3
No	16	13.4
Total	120	100

Interpretation

Table 6 indicates that 58.3% of inbound tourists stated that their experience with Kerala cuisine influenced their intention to revisit the destination, while 28.3% responded that it might influence their future travel decisions. Only 13.4% reported that cuisine would not influence their revisit intention. These results demonstrate that culinary experiences play a significant role in creating memorable travel experiences and encouraging repeat visits.

MAJOR FINDINGS OF THE STUDY

The analysis of the data collected from inbound tourists reveals several key findings regarding the importance of ethnic Kerala cuisine in promoting tourism in the state. The study shows that a considerable number of inbound tourists are already aware of Kerala's traditional culinary heritage even before visiting the destination. This awareness is often developed through travel media, online sources, and recommendations from previous travelers. Such exposure indicates that Kerala's cuisine has gained international recognition and contributes positively to the state's image as a global tourism destination. The findings also indicate that a large proportion of inbound tourists express a strong interest in experiencing ethnic Kerala cuisine during their stay. Traditional dishes such as Kerala sadya, appam, puttu, seafood curries, and Malabar specialties attract visitors because of their distinctive taste, unique presentation, and cultural importance. Tourists view these foods as authentic representations of Kerala's cultural identity and local traditions. In particular, the experience of enjoying traditional meals served on banana leaves and prepared with fresh, locally sourced ingredients enhances the sense of cultural authenticity during their visit. Another important finding of the study is that ethnic Kerala cuisine has a significant impact on tourists' overall travel experience and satisfaction. Many respondents reported that culinary experiences

helped them gain a deeper understanding of Kerala's culture and made their visit more memorable. The use of traditional spices, coconut-based ingredients, and regional cooking techniques produces unique flavors that distinguish Kerala from other tourist destinations. In addition, the study highlights that positive culinary experiences motivate tourists to recommend Kerala to others and increase their intention to revisit the destination in the future. Food experiences act as an effective medium for cultural interaction and leave lasting impressions on visitors. Overall, the findings demonstrate that ethnic Kerala cuisine plays a vital role in improving tourist satisfaction, enhancing the destination's image, and supporting the promotion of Kerala tourism in the global tourism market.

RECOMMENDATIONS

Based on the findings of the study, several references can be suggested to strengthen the role of ethnic Kerala cuisine in promoting tourism among inbound visitors. Firstly, tourism authorities and other stakeholders should emphasize Kerala's traditional cuisine as an important element of the state's tourism marketing strategy. Showcasing authentic dishes such as Kerala sadya, appam, puttu, and Malabar seafood specialties in promotional campaigns can attract international tourists who are interested in exploring cultural and gastronomic experiences.

Second, organizing culinary festivals and food fairs at major tourist destinations can provide visitors with opportunities to explore a wide variety of traditional dishes in a single setting. Such events can showcase Kerala's diverse food culture and encourage tourists to engage more deeply with local traditions. These festivals can also help local chefs, small restaurants, and traditional cooks gain greater visibility.

Third, the development of culinary tourism circuits and food trails across different regions of Kerala can enhance tourists' experiences. For example, Malabar cuisine in northern Kerala, traditional vegetarian sadya in central Kerala, and seafood specialties in coastal areas can be promoted as unique culinary attractions.

Fourth, tourism stakeholders should encourage authentic dining experiences in hotels, resorts, and restaurants by incorporating traditional cooking methods, local ingredients, and cultural dining practices such as serving

meals on banana leaves. This can help preserve the authenticity of Kerala cuisine while offering memorable experiences to tourists.

Fifth, training programs and workshops should be organized for hospitality professionals and chefs to promote the preparation and presentation of traditional Kerala dishes. This will ensure quality and authenticity in culinary experiences offered to international visitors.

Finally, effective use of digital marketing, social media, and travel platforms can help promote Kerala's ethnic cuisine globally. Sharing food stories, cooking videos, and culinary travel experiences can attract potential tourists and strengthen Kerala's image as a unique gastronomic destination. By implementing these strategies, Kerala can effectively utilize its rich culinary heritage as a powerful tool for tourism promotion and sustainable tourism development.

CONCLUDING OBSERVATIONS

Tourism has increasingly shifted from conventional sightseeing toward experience-based travel, where visitors seek authentic cultural engagement and meaningful local interactions. In this context, food has emerged as an important cultural element that reflects the traditions, lifestyle, and heritage of a destination. Ethnic cuisine, therefore, has become a significant factor in enhancing the attractiveness of tourism destinations and enriching the overall travel experience of visitors. This study examines how ethnic Kerala cuisine contributes to the promotion of Kerala tourism among inbound tourists, emphasizing the role of culinary experiences in shaping tourists' perceptions and satisfaction. Kerala, widely known as "God's Own Country," is celebrated for its natural beauty, cultural diversity, and traditional practices. Along with its backwaters, beaches, and hill stations, the state possesses a rich culinary heritage influenced by centuries of trade, cultural exchange, and local agricultural practices. Kerala's cuisine is distinguished by the use of spices, coconut, rice, and seafood, producing unique dishes such as sadya, appam, puttu, idiyappam, and Malabar biryani. The findings of the study reveal that many international tourists are interested in exploring Kerala's traditional food culture. Culinary experiences enable visitors to understand the region's cultural history, agricultural background, and social customs. Authentic dining practices, including meals served on banana leaves and traditional cooking

techniques, further enhance tourists' satisfaction and create memorable experiences. Additionally, positive food experiences encourage tourists to revisit Kerala and recommend the destination to others. The study highlights that promoting ethnic cuisine through food festivals, culinary trails, and heritage restaurants can strengthen tourism development while preserving cultural traditions and supporting local communities. Overall, Kerala's distinctive cuisine serves as an important cultural asset that enhances its global tourism appeal.

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Scarcity to Scalability: Survey on Abusive Content Detection in Low-Resource Languages

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ABSTRACT

The rapid proliferation of social media has transformed digital platforms into global forums for interaction, yet it has simultaneously facilitated the rise of harmful behaviors, most notably the spread of abusive language. While automated detection systems have matured significantly for high-resource languages like English, they face a “bottleneck” when applied to the linguistically diverse and resource-constrained landscape of Indic languages. This paper provides a comprehensive survey of the current state of abusive language detection, focusing specifically on the unique challenges posed by the Indian context. We delineate the core technical and socio-cultural hurdles, including the extreme linguistic diversity of the Indian subcontinent, the prevalence of code-mixing (the blending of native and Roman scripts), and the acute scarcity of high-quality, human-annotated datasets for low-resource languages. The survey evaluates the persistent performance gap between high-resource and low-resource detection systems and explores contemporary strategies to bridge this divide. Specifically, we analyze the role of multilingual transformer-based models (such as mBERT and XLM-R) and the efficacy of cross-lingual transfer learning and data bootstrapping techniques in mitigating data sparsity. By synthesizing recent advancements in Indic-specific datasets—such as MACD and HASOC—this paper highlights the transition from monolingual approaches toward scalable, multilingual frameworks. Finally, we discuss future research frontiers, emphasizing the need for socio-culturally aware models that can navigate the complex dynamics of online abuse in one of the world’s most populous and linguistically vibrant digital ecosystems

KEYWORDS: *Abusive language detection, Indic languages, Low-resource NLP, Multilingual models, Transfer learning, Cross-lingual transfer, Annotated datasets.*

INTRODUCTION

In the last decade, social media platforms such as Twitter, Facebook, YouTube, and Instagram have experienced a sharp increase in adoption, with billions of users joining daily to share updates and communicate instantly. Statistics indicate there are now over 1.6 billion social network users worldwide, with more than 64 percent of internet users accessing these services online. While these platforms were originally conceived to act as peaceful online “town squares”

that facilitate the massive expansion of social networks and the exchange of thoughts, they have increasingly been exploited by “bad actors”. These actors use the openness of cyberspace to spread propaganda, violence, and various forms of abuse. This shift has slowly converted these digital forums into “mosh pits” where marginalized groups are extensively targeted.

Abusive content is a broad and challenging category that encompasses several distinct forms of digital hostility, including hate speech, cyberbullying, offensive

language, and general abusive language. Abusive language is defined as extremely rude, insulting, or hurtful language—often using profanity—that shows a debasement of someone or something or expresses intense emotion. Hate speech specifically involves attacks or insults directed at individuals or groups based on personal qualities such as race, religion, gender, or social status. Cyberbullying involves targeted harassment that can have devastating effects on individuals. The lack of a single, objectively “correct” definition for these terms makes the task of automatic detection inherently difficult, as content perceived as hateful by one individual may not be seen as such by another.

The prevalence of online abuse has severe and far-reaching real-world consequences. Repeated exposure to such harmful content can lead to psychological trauma, radicalization, and even self-harm or suicide among victims. Beyond the individual level, online abuse can ignite social tensions, trigger violent real-world situations, and result in the devaluation and exclusion of minority members. For the social media platforms themselves, hosting such hostile content can damage their reputation and threaten their stature as safe spaces for interaction. Consequently, the natural language processing (NLP) and computational linguistics communities have prioritized the development of robust automatic detection systems to ensure online peace and safety.

To mitigate the spread of abusive content, platforms establish specific guidelines and employ human moderators to review flagged posts manually. However, manual moderation is hindered by several critical factors, including the sheer scale and velocity of data—with an uncontrolled number of posts appearing every second—making it impossible for humans to track and govern all content effectively. Furthermore, human moderators often suffer from significant psychological stress and trauma due to constant exposure to abusive material. They also struggle with the rapid evolution of vernacular and may lack the necessary linguistic expertise to moderate content in diverse languages.

While advances in machine learning and NLP have led to marked improvements in detection system performance, significant challenges remain regarding

their generalizability and efficiency. Key innovations in the field include the use of deep learning and ensemble architectures, contextual word embeddings like BERT and XLM-R, and the inclusion of user-level variables within models. Despite these technical gains, most existing research and detection capabilities are concentrated on major languages like English and Spanish. There is a severe lack of resources and research for low-resource languages, particularly those spoken in India.

India represents a unique and complex frontier for abusive content detection, as it is home to one-sixth of the global population and has some of the largest user bases for major social media platforms. The country’s vast linguistic diversity, featuring 22 recognized languages, poses significant challenges for automated systems. These challenges are further compounded by the prevalent trend of “code-mixing” or “code-switching,” where users write native languages using English characters or switch between multiple languages in a single conversation. Additionally, many abusive incidents in the region are tied to specific socio-political movements, anti-religious propaganda, or smearing campaigns against public figures, requiring models that can understand localized nuances. Current research efforts aim to address these gaps by developing large-scale, human-annotated multilingual datasets like MACD and specialized models like AbuseXLMR to foster safer digital environments globally.

CHALLENGES IN ABUSIVE LANGUAGE DETECTION

Vidgen et al. (2019) talked about the biggest problems with finding abusive content, such as linguistic ambiguity, dataset bias, and the fact that there aren’t any publicly available datasets. They stressed the need to clearly define tasks and separate abusive language categories to make research more consistent and models more reliable [1]. Singh et al. (2024) looked into the technical problems that come up when trying to automatically find toxic language. They focused on how toxicity depends on the context and how too much reliance on explicit offensive words can be a problem. They emphasized the necessity for more sophisticated algorithms that can comprehend nuanced and implicit harmful content [2]. Pamungkas et al.

(2021) did a thorough study of how to find abusive language in multiple domains and languages. They said that dataset bias, inconsistent terminology, class imbalance, and weak cross-domain and cross-lingual generalization were some of the biggest problems with making detection systems that can grow and work well [3]. Vidgen et al. (2020) stressed how important it is to have high-quality training data, saying that models that are based on biased or poorly annotated datasets are not reliable. They talked about problems like low agreement between annotators, language differences that are specific to each platform, and the need to make large, low-bias datasets [4]. MacAvaney et al. (2019) examined difficulties in hate speech detection, encompassing linguistic subtleties, diverse definitions of hate speech, restricted dataset availability, and the interpretability deficit in machine learning models. They also talked about possible ways to make detection more accurate and open [5].

Gong et al. (2021) examined the detection of abusive language in heterogeneous contexts, highlighting the variability of abuse patterns across different domains. They pointed out that there aren't many different annotated datasets and that traditional detection methods have problems. They suggested using supervised attention mechanisms to make things better [6]. Pamungkas et al. (2019) examined the detection of abusive language across domains and languages. They recognized domain dependency, the complexities of disambiguating profanity, the lack of low-resource language data, and the challenges in transferring knowledge across languages and domains [7]. Jarquín-Vásquez et al. (2024) suggested a domain-adapted BERT method to improve the detection of abusive language. They used specialized pre-training tasks to fix problems with vocabulary, adapting to informal and offensive language, and adapting to new domains [8]. Zhu et al. (2024) presented a deep prompt multi-task network for the identification of abusive language. They pointed out the problems with traditional fine-tuning methods, the lack of use of pre-trained language model knowledge, and the difficulties of prompt optimization. They suggested a multi-task prompt-based framework to make things more accurate [9]. Alhejaili et al. (2022) investigated the detection of hate speech and abusive language on Twitter, highlighting the importance of

context sensitivity, the evolution of slang, the diversity of expression, and the challenges in differentiating hate speech from free speech. They talked about how important it is to have detection systems that can adapt and understand the context [10].

Sharon et al. (2024) examined abuse detection in continuous speech for Indian languages, emphasizing multilingual speech processing in authentic audio contexts. They pointed out problems like mistakes in automatic speech recognition (ASR), trouble finding keywords, and dealing with the fact that Indian languages are very different from each other [11].

Bora et al. (2024) examined the detection of abusive language in low-resource contexts, specifically for languages such as Assamese. They talked about how hard it is to find abuse against protected groups when resources are scarce and suggested an attention-based LSTM model to improve detection in low-resource settings [12]. Joshi et al. (2023) investigated the application of pre-trained sentence transformers for the detection of offensive language in Indian languages. Their research highlighted the scarcity of high-quality datasets, the distinctive linguistic features of Indian languages, and the inadequate representation of low-resource languages, including Assamese, Bengali, and Gujarati [13]. Kar, (2025) has researched on Hate Speech detection in Indian Languages: A Hybrid Soft Computing Approach. Multilingualism, code-mixing, unavailability of annotated corpora and English-dominated research were identified as the main challenges to effective detection systems for Indian languages in the study [14]. Pahwa (2022) performed an analysis of the impact of data augmentation for Tamil abusive comment detection problems using Indic-transformer models. The challenge exposed the difficulty of creating datasets with low-resource Tamil and multilingual models trained on specialized architectures without relevant language transformations [15].

Jhaveri et al. (2022) focuses on detecting toxicity in Indic multilingual social media content. Within the context of low-resource NLP development, they talked about problems like informal grammar, noisy social media text, multiple representations of text, the desktop for code-mixing and code-switching complexity, few

linguistic resources are available in a language with weak metadata non-standard formats of input text [16]. Das et al. (2022) proposed data bootstrapping approaches to improve abusive language detection for low-resource Indic languages. They emphasized high annotation costs, linguistic diversity, code-mixing, varied writing styles, dataset scarcity, regional variations in abusive speech, adversarial robustness issues, and the need for scalable models [17]. Pathak et al. (2022) introduced μ Boost, an effective method for Indic multilingual text classification. Although primarily focused on improving classification performance rather than challenge analysis, their work contributed to enhancing multilingual text classification solutions for Indic languages [18].

Linguistic Diversity in India

Kar (2025) highlighted that multilingualism and frequent code-mixing in Indian languages significantly hinder hate speech detection. The study emphasized the lack of tailored linguistic resources and methodologies specifically designed for diverse Indian language settings [19]. Das et al. (2022) examined low-resource abusive language detection for Indic languages and pointed out that variations in writing styles, semantics, dialects, cultural contexts, and language families require customized low-data learning and language-specific detection approaches [20].

Sharon et al. (2024) focused on abuse detection in continuous speech for Indian languages, noting that dialectal, syntactic, and semantic variations in spoken language reduce the effectiveness of standard detection models [21]. Bora et al. (2024) addressed abusive language detection in low-resource languages such as Assamese, emphasizing that the scarcity of digital and annotated resources complicates model development and limits performance [22]. Singh et al. (2024) proposed a federated and multilingual framework for hate speech detection in low-resource Indian languages. They stressed that diverse dialects and cultural nuances require distributed and fair data selection strategies to effectively manage linguistic diversity and data scarcity [23].

Pahwa (2022) analyzed Tamil abuse detection and highlighted Tamil's low-resource status, poor adaptation of multilingual models, and the absence of strong

language-specific transformers as major barriers to accurate detection [24]. Jhaveri et al. (2022) discussed toxicity detection in Indic multilingual social media content, emphasizing that code-mixing, multiple text representations, informal formats, weak grammatical resources, and overall multilingual diversity increase the difficulty of building robust NLP models [25]. Joshi et al. (2023) explored offensive language detection using pre-trained sentence transformers and noted that unique linguistic characteristics of languages such as Assamese, Bengali, and Gujarati demand specialized transformer-based solutions rather than generic multilingual models [26]. Jagdale et al. (2024) emphasized that Hindi-English code-mixing introduces significant linguistic variation, cultural nuances, and data sparsity, making traditional NLP models ineffective for handling mixed embeddings in hate speech detection [27].

Tiwari et al. (2025) highlighted that code-mixed social media text is often short, noisy, and lacks clear context, which obscures user intent and makes abusive language detection more challenging [28]. Jhaveri et al. (2022) discussed toxicity detection in Indic multilingual content, noting that multiple text representations, inconsistent grammar, and varied sentence structures reduce classification accuracy in code-mixed scenarios [25]. Ranjan et al. (2022) pointed out that transliteration and the use of multiple scripts within a single sentence complicate analysis, making it difficult to accurately identify abusive content in code-mixed text [29]. Revanth Reddy et al. (2024) addressed Telugu-English code-mixed abusive comment detection, highlighting that mixed scripts and blended linguistic structures require advanced multilingual transformer models such as XLM-RoBERTa and mBERT for improved performance [30].

Al-Hussaeni et al. (2023) examined the impact of preprocessing on hate speech detection in Hindi-English tweets, emphasizing that spelling variations, informal writing styles, and language blending significantly affect detection accuracy [31]. Nithya et al. (2024) focused on offensive language detection in code-mixed social media text, noting that the blending of native and English languages creates diverse abusive patterns that require context-aware and adaptive frameworks [32]. Kaliyar et al. (2023) proposed ACDNet for Hinglish data and highlighted that unique lexical and syntactic

features in code-mixed language make it difficult to distinguish between hate, abusive, and neutral content [33]. Balouchzahi et al. (2022) explored abusive comment detection in Tamil and indicated that code-mixed Tamil text increases classification complexity, although their work focused more on model performance than theoretical aspects of code-mixing [34].

Digital Resource Scarcity in Low-Resource Indian Languages

Bora et al. (2024) highlighted that limited training data for languages like Assamese significantly reduces model accuracy and weakens the detection of abusive content, especially when targeting protected groups [35]. Pakray et al. (2025) discussed broader challenges in processing low-resource languages, emphasizing that the lack of annotated corpora, inconsistent translations, and absence of standardized terminology hinder effective NLP model development [36]. Ghosh et al. (2023) focused on hate speech detection in Bodo and Assamese, noting that scarce datasets in these languages make model training difficult and lead to lower classification accuracy [37]. Joshi et al. (2023) pointed out that limited datasets for languages such as Assamese restrict the effectiveness of transformer-based models in offensive language detection [26]. Singh et al. (2024) proposed a multilingual federated learning approach and emphasized that data scarcity, along with cultural and linguistic diversity, poses major challenges for building generalizable models across Indian languages [23]. Das et al. (2022) highlighted that reliance on transfer learning from high-resource languages may overlook local linguistic nuances, thereby reducing the effectiveness of abusive language detection systems in Indic languages [20]. Sazed (2021) examined abusive content detection in transliterated Bengali-English text and found that inadequate datasets and the complexity of transliteration reduce the performance of monolingual models [38]. Ranasinghe et al. (2021) evaluated multilingual offensive language identification methods for Indian languages and observed that limited data availability negatively impacts model training and overall detection accuracy [39]. Vikram et al. (2025) addressed low-resource challenges in Tulu, emphasizing that scarce labeled corpora, unique linguistic characteristics, and code-switching require dedicated corpus creation and language-specific fine-tuning approaches [40].

Lack of Annotated Datasets in Low-Resource Languages

Bora et al. (2024) highlighted that insufficient digital resources and annotated datasets for languages like Assamese significantly hinder the development of robust abusive language detection systems [35]. Pakray et al. (2025) emphasized that the lack of labeled datasets and digital resources is a major bottleneck in NLP, affecting the development of reliable abusive language detection models in low-resource languages [36]. Marreddy et al. (2022) analyzed Telugu as a resource-poor language and noted that limited datasets, along with complex morphology, syntax, and semantics, reduce the effectiveness of NLP models [41]. Ghosh et al. (2023) pointed out that the scarcity of annotated corpora for Bodo and Assamese limits the training and evaluation of machine learning and deep learning models [37]. Sazed (2021) observed that the lack of publicly available annotated datasets, along with challenges in handling transliterated text, negatively impacts classifier performance in Bengali-English abusive content detection [38]. Vikram et al. (2025) discussed low-resource challenges in Tulu, highlighting limited labeled data, weak pretraining representations, and poor generalization of transfer learning models [40]. Zampieri et al. (2022) examined offensive content detection in Marathi and found that data scarcity and the absence of structured annotation frameworks restrict fine-grained classification tasks [42]. Shahid et al. (2025) highlighted systemic issues such as restricted data access, lack of community involvement, and inability to capture linguistic nuances, which further limit the creation of high-quality annotated datasets for low-resource languages [43]. Jhaveri et al. (2022) noted that toxicity detection in Indic multilingual social media content is challenged by annotated data scarcity, informal grammar, multiple text representations, and inconsistent formats [25].

Performance Gap in Abusive Language Detection Across Languages

Tuarob et al. (2023) showed that supervised models perform poorly in low-resource settings due to limited labeled data, but incorporating unlabeled data through co-training significantly improves performance, achieving high F1-scores in both binary and fine-

grained classification tasks [44]. Pelicon et al. (2021) observed a substantial performance drop when models are applied to low-resource languages, highlighting that cross-lingual training and intermediate pre-training can help bridge the gap between high-resource and low-resource scenarios [45]. Awal et al. (2023) demonstrated that limited training samples in low-resource languages reduce classifier effectiveness and proposed meta-learning approaches to improve multilingual transfer performance. Their HateMAML approach further improves cross-domain adaptability and outperforms existing models even under data-scarce conditions [46]. Islam et al. (2024) found that large language models outperform traditional transformer models in low-resource settings, achieving higher accuracy and demonstrating better handling of limited data [47]. Das et al. (2021) explored abusive language detection in Urdu and noted that performance improvements rely on transfer learning from resource-rich languages like Arabic, indicating dependency on high-resource data [48]. Bora et al. (2024) reported moderate performance (around 75% accuracy) for Assamese abusive content detection, reflecting the limitations imposed by low-resource conditions compared to high-resource language benchmarks [49].

METHODS FOR HANDLING DATA SCARCITY

Handling Data Scarcity with Multilingual and Transfer Learning Models

Röttger et al. (2022) proposed data-efficient strategies by initially fine-tuning models on high-resource languages like English and then applying multilingual transfer learning to low-resource languages, significantly reducing the need for large annotated datasets [50]. Anirudh et al. (2023) demonstrated that transfer learning, multilingual embeddings, and cross-lingual models can effectively leverage shared linguistic features across languages, improving performance in low-resource settings [51]. Awal et al. (2023) introduced the HateMAML framework, which uses meta-learning and self-supervision to enhance cross-lingual adaptation. This approach improves model generalization and enables better performance even with limited training data [52]. Ranasinghe et al. (2021) evaluated multilingual offensive language detection

methods and highlighted the effectiveness of cross-lingual pretrained transformers, zero-shot and few-shot learning, and data augmentation strategies for low-resource languages [53]. Wang et al. (2024) emphasized the importance of language-agnostic models and large multilingual language models such as XLM-R and GPT-based systems, which enable effective cross-lingual transfer and improve detection performance in resource-scarce scenarios [54]. Mozafari et al. (2022) proposed a cross-lingual few-shot learning approach using Proto-MAML, demonstrating that models can achieve effective performance with minimal labeled samples by leveraging meta-learning techniques [55].

Role of Multilingual and Large Models in Abuse Detection

Röttger et al. (2022) demonstrated that multilingual models such as XLM-T leverage fine-tuning on high-resource languages like English to significantly improve generalization and detection performance in low-resource languages, even with minimal annotated data [56]. Das et al. (2022) showed that data bootstrapping combined with multilingual transfer learning enables effective zero-shot and few-shot classification, improving abusive language detection across Indic languages with limited data [57]. Mozafari et al. (2024) highlighted that pretrained multilingual models such as mBERT and XLM-R facilitate transfer learning, enabling better offensive language detection in low-resource languages like Persian despite limited annotations [58]. Röttger et al. (2022) further emphasized that multilingual pretraining reduces annotation costs and enhances cross-lingual adaptability, making models more efficient in handling low-resource scenarios [56]. Pamungkas et al. (2019) proposed a hybrid approach combining deep learning with multilingual lexicons such as HurtLex, demonstrating that shared linguistic knowledge can support cross-domain and cross-lingual abusive language detection [59]. Mozafari et al. (2022) introduced a meta-learning-based approach for cross-lingual few-shot detection, showing that shared representations across languages enable effective learning even with minimal labeled samples [60]. Islam et al. (2024) found that large language models such as GPT-based systems outperform traditional transformers in low-resource settings by effectively utilizing zero-shot and few-shot learning capabilities

[61].Subramanian et al. (2023) demonstrated that multilingual transformer models like MuRIL and mBERT improve abusive language detection in Tamil, including challenging code-mixed scenarios, by leveraging shared multilingual representations [62].

Cross-Lingual Transfer for Abuse Detection

Dela Peña Sarracén et al. (2023) introduced vicinal risk minimization (VRM)-based methods such as MIXAG, showing that data augmentation and continual pre-training significantly improve few-shot cross-lingual adaptation and reduce errors in low-resource abusive language detection [63].Eronen et al. (2022) demonstrated that carefully selecting appropriate high-resource transfer languages can significantly improve zero-shot performance, even without any labeled data in the target language [64].Ghorbanpour et al. (2025) proposed a cross-lingual nearest neighbor retrieval approach, where relevant multilingual labeled examples are leveraged to enhance detection accuracy beyond models trained only on target-language data [65].Pelicon et al. (2021) showed that cross-lingual and intermediate training strategies effectively mitigate performance degradation in low-resource languages, improving overall model robustness [66].Bigoulaeva et al. (2022) highlighted that shared cross-lingual embeddings and bootstrapping techniques enable effective knowledge transfer without requiring extensive annotated data in low-resource languages, reducing dependency on labeled datasets [67].Ahn et al. (2020) introduced a transfer-based approach using Translation Embedding Distance (TED) to select transferable samples from high-resource languages, demonstrating improved offensive language detection performance in multilingual settings [68].Bigoulaeva et al. (2021) further demonstrated that models trained on high-resource languages like English can be successfully transferred to other languages such as German without additional annotations, confirming the effectiveness of cross-lingual transfer learning [69].

DATA RESOURCES IN INDIC LANGUAGES

Abusive Dataset in Indic Languages

Ghosh et al. (2025) analyzed multiple datasets such as HASOC (Hindi 2019, Marathi 2021) and HS-Bangla (2021), and introduced new datasets like HS-Assamese

and HS-Bodo to address low-resource language scarcity. The study also highlighted challenges such as data cleaning and annotator agreement in hate speech labeling [70].Das et al. (2022) emphasized the importance of annotated datasets by distinguishing between Devanagari Hindi and code-mixed Hindi, showing how variations in writing style affect model performance. They also stressed the need for more datasets in languages like Hindi, Bengali, and Urdu [71].Sharon et al. (2024) focused on abuse detection in continuous speech and introduced the use of the ADIMA dataset, highlighting challenges in detecting abusive content in real-world multilingual audio data [72].Baruah et al. (2024) introduced the Khasi Abusive Language Dataset (KALD), specifically designed for a low-resource language, and emphasized dataset creation as a critical step toward improving detection systems [73].Sankar et al. (2025) addressed the scarcity of large-scale multilingual speech datasets by introducing the BHASA ANUVAAD dataset, which supports speech translation across 14 Indian languages and contributes to broader multilingual NLP research [74].Gupta et al. (2022) proposed the ADIMA dataset, a multilingual audio dataset covering 10 Indic languages with over 11,000 samples, addressing the gap in audio-based abusive content detection [75].Vaidya et al. (2024) presented a dataset for gendered abuse detection consisting of around 6,500 social media posts in Hindi, Tamil, and Indian English, highlighting the importance of domain-specific datasets [76].Arora et al. (2024) introduced the ULI dataset for detecting online gender-based violence in Hindi and Tamil tweets, using participatory annotation involving community experts to better capture contextual and nuanced abuse [77].

In the last decade, social media platforms such as Twitter, Facebook, YouTube, and Instagram have experienced a sharp increase in adoption, with billions of users joining daily to share updates and communicate instantly. Statistics indicate there are now over 1.6 billion social network users worldwide, with more than 64 percent of internet users accessing these services online. While these platforms were originally conceived to act as peaceful online “town squares” that facilitate the massive expansion of social networks and the exchange of thoughts, they have increasingly been exploited by “bad actors”. These actors use the openness of

cyberspace to spread propaganda, violence, and various forms of abuse. This shift has slowly converted these digital forums into “mosh pits” where marginalized groups are extensively targeted.

Abusive content is a broad and challenging category that encompasses several distinct forms of digital hostility, including hate speech, cyberbullying, offensive language, and general abusive language. Abusive language is defined as extremely rude, insulting, or hurtful language—often using profanity—that shows a debasement of someone or something or expresses intense emotion. Hate speech specifically involves attacks or insults directed at individuals or groups based on personal qualities such as race, religion, gender, or social status. Cyberbullying involves targeted harassment that can have devastating effects on individuals. The lack of a single, objectively “correct” definition for these terms makes the task of automatic detection inherently difficult, as content perceived as hateful by one individual may not be seen as such by another.

The prevalence of online abuse has severe and far-reaching real-world consequences. Repeated exposure to such harmful content can lead to psychological trauma, radicalization, and even self-harm or suicide among victims. Beyond the individual level, online abuse can ignite social tensions, trigger violent real-world situations, and result in the devaluation and exclusion of minority members. For the social media platforms themselves, hosting such hostile content can damage their reputation and threaten their stature as safe spaces for interaction. Consequently, the natural language processing (NLP) and computational linguistics communities have prioritized the development of robust automatic detection systems to ensure online peace and safety.

To mitigate the spread of abusive content, platforms establish specific guidelines and employ human moderators to review flagged posts manually. However, manual moderation is hindered by several critical factors, including the sheer scale and velocity of data—with an uncontrolled number of posts appearing every second—making it impossible for humans to track and govern all content effectively. Furthermore, human moderators often suffer from significant psychological

stress and trauma due to constant exposure to abusive material. They also struggle with the rapid evolution of vernacular and may lack the necessary linguistic expertise to moderate content in diverse languages.

While advances in machine learning and NLP have led to marked improvements in detection system performance, significant challenges remain regarding their generalizability and efficiency. Key innovations in the field include the use of deep learning and ensemble architectures, contextual word embeddings like BERT and XLM-R, and the inclusion of user-level variables within models. Despite these technical gains, most existing research and detection capabilities are concentrated on major languages like English and Spanish. There is a severe lack of resources and research for low-resource languages, particularly those spoken in India.

India represents a unique and complex frontier for abusive content detection, as it is home to one-sixth of the global population and has some of the largest user bases for major social media platforms. The country’s vast linguistic diversity, featuring 22 recognized languages, poses significant challenges for automated systems. These challenges are further compounded by the prevalent trend of “code-mixing” or “code-switching,” where users write native languages using English characters or switch between multiple languages in a single conversation. Additionally, many abusive incidents in the region are tied to specific socio-political movements, anti-religious propaganda, or smearing campaigns against public figures, requiring models that can understand localized nuances. Current research efforts aim to address these gaps by developing large-scale, human-annotated multilingual datasets like MACD and specialized models like AbuseXLMR to foster safer digital environments globally.

CONCLUSION

The main obstacles and recent developments in abusive language detection were examined in this survey, with a focus on low-resource Indian languages. It demonstrates how the performance of current systems is constrained by linguistic diversity, a lack of digital content, and a lack of well-annotated datasets, resulting in distinct differences between high-resource and low-resource languages.

The review covered new approaches that enhance performance through cross-lingual knowledge sharing, like multilingual models, transfer learning, and cross-lingual strategies. In situations where there is a lack of data, large multilingual models in particular exhibit great promise for supporting underrepresented Indic languages.

Significant obstacles still exist in spite of these positive developments. Richer datasets, consistent assessment procedures, and more equitable models are desperately needed. Future advancements will rely on persistent efforts to develop resources and creative, inclusive modeling techniques.

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Optical Character Recognition-based Anaemia Classification and Prediction System Using Artificial Intelligence: A Comparative Performance Analysis

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ABSTRACT

Anaemia is a common blood disorder that occurs due to an abnormal level of haemoglobin (Hb). The common symptoms of an anaemic patient are dizziness, lack of concentration and shortness of breath. The report of the World Health Organisation (WHO) and the National Family Health Survey (NFHS-5) report of the Government of India show the alarming rise in anaemia. Unlike the existing system that uses structured digital inputs, the proposed system is capable of processing heterogeneous Complete Blood Count (CBC) reports and performing multi-class anaemia classification using an integrated Optical Character Recognition (OCR) and Machine Learning (ML) approach. Also provides a comparative analysis of various AI models for the automatic identification and multi-class classification of anaemia using CBC reports. Laboratory reports were collected in the form of images, printed documents (PDF), and Excel files. For the anemia data set, a total of eight classifiers—Logistics Regression (LR), Naive Bayes (NB), K-Nearest Neighbors (K-NN), Support Vector Machine (SVM), Random Forest (RF), and XGBoost classifiers—as well as their optimized versions were used. Model evaluation was done using accuracy, macro-averaged precision, recall, and F1-score. The results of experimental analysis clearly indicate that the tuned model of RF and XGBoost models provides an improved outcome over traditional models. The Random Forest (Tuned) model provides an accuracy 99.2%, precision 96.13%, recall 99.58% and F1 score 97.48%. XGBoost (Tuned) model provide 97.63% accuracy, a precision 88.55%, a recall 92.02%, an F1-score 89.87% Outcome shows that the RF is the best-performing model over all other models. The outcomes clearly indicate that the proposed optimised machine learning algorithms show immense potential and effectiveness for the automatic identification and multi-class classification of anaemia using CBC.

KEYWORDS: DHR, OCR, Anaemia detection, Classification, Complete blood count, AI ML in healthcare.

INTRODUCTION

The Indian government's NFHS-5, which was conducted between 2019 and 2021, revealed that the country's anaemia rates had dramatically increased from NFHS-4 (2015-16). Divide anaemia into four groups: moderate, severe, mild, and normal.

Anaemia is considered to be one of the most common haematological conditions found across the world. According to the WHO and health surveys, a large number of people are affected by anaemia, which can

lead to reduced physical and mental abilities and higher morbidity rates if it is not diagnosed and treated at an early stage. The Complete Blood Count test is a widely used and cost-effective method for diagnosing anaemia and its severity. However, in many healthcare settings, the CBC test result is still maintained in unstandardized formats such as scanned images or PDF files, which are not easily used for large-scale data analysis. The lack of standardized digital health records makes it difficult to apply advanced data analytics and machine learning methods for automated diagnosis and decision support,

thus making the need for systems that can convert unstructured laboratory reports into structured digital health records.

Recent works have investigated the application of OCR methods for the digitization of medical reports, as well as machine learning algorithms for the detection of anaemia based on structured CBC reports. Although machine learning-based methods and OCR methods are useful for the extraction of text information from scanned medical reports, they have been separately evaluated and are susceptible to changes in the format of medical reports and image quality. Similarly, machine learning-based anaemia detection models are known to assume the availability of clean and structured datasets and are mostly restricted to binary classification problems that classify patients into either anaemic or non-anaemic categories. Although these models are less applicable in real-world settings, where data heterogeneity and multiple levels of anaemia severity are prevalent, most existing models have been validated using only publicly available datasets and are restricted to the classification of patients based on only real-world CBC reports.

Table 1. Age and Gender-Wise Reference Haemoglobin Level Anemia Prediction (in gm/dL)

Age-wise Population Distribution	Anemia			
	Normal Level	Mild	Moderate	Severe
Children 6-59 months of age	Hb \geq 11.0 or higher	10.0-10.9	7.0-9.9	Hb < 7
Children 5-11 years of age	Hb \geq 11.5 or higher	11.0-11.4	8-10.9	Hb < 8
Children 12-14 years of age	Hb \geq 12 or higher	11.0-11.9	8-10.9	Hb < 8
Non-pregnant women (Age>15 years)	Hb \geq 12 or higher	11.0-11.9	8-10.9	Hb < 8
Pregnant Woman (Age>15 years)	Hb \geq 11 or higher	10.0-10.9	7.0-9.9	Hb < 7
Men (Age>15 years)	Hb \geq 13 or higher	11.0-12.9	8.0-10.9	Hb < 8

^a NFHS-5 (2019-21 India) [20]

Overall, the developed system improves the performance of the health care system. Helpful to a new doctor in decision making and predicting the health risk because they know all the history of the patient through this DHR, and also compare their prescription/treatment with the predicted outcome to give their best service by reducing human diagnostic error.

The proposed work describes an end-to-end automated system that combines the OCR-based extraction of CBC

parameters from unstructured lab reports with the multi-class classification of anaemia using machine learning, thus facilitating the applicability of the proposed system in a healthcare setting where structured digital records are not readily available.

The rest of this paper is organized as follows. Section II discusses the related work in the area of medical report digitization using OCR and machine learning for the detection of anemia. Section III describes the proposed approach for the detection of anemia using machine learning. Section IV describes the experimental setup for the comparison of the performance of the machine learning models used in this study. Section V discusses the results obtained, and Section VI concludes this paper with its findings.

LITERATURE REVIEW

In literature, various research papers from journals, including IEEE Transactions, PubMed, Springer, Scopus-indexed journals, Elsevier, and other healthcare agencies such as the WHO, NFHS-4, 5 and the Indian Medical Association (IMA), report on the health sector, especially focusing on anaemia detection and Classification.

Alansari proposed an OCR and rule-based automated system for data extraction from scanned CBC pathology reports. The system used image processing and Tesseract OCR to extract the CBC parameters, age and gender information from reports. The performance of the system depends upon the clarity of the input images, unclear images negatively impact the performance of the system, and high-resolution images increase the accuracy. The study covers CBC-specific rule-based medical interpretation, in contrast to current OCR-based digitisation techniques, allowing for quick preliminary diagnosis of haematological abnormalities. Additionally, the system facilitates the scalable creation of structured CBC datasets, which may be useful for ML-based medical diagnosis and clinical decision support system[1].

Li et al. develop OCR based deep learning system to enhance tabular data extraction from scanned pathology reports in order to overcome the problem of traditional OCR-Rule based approaches. The Objective of the study was to accurately identify table structure, cell

boundaries and text content in different medical report layouts and convert in to digital form. Indirectly, it supports ML-based diagnosis and EHR integration for clinical predictions [2].

The DETR R18 and YOLOv8s algorithms were used for table detection. Paddle OCR and Encoder Dual Decoder (EDD) model were used for table recognition [3][4]. Ma et al. develop a system that integrates NLP techniques with OCR to identify test names, values, units and reference ranges from the scan reports. The model provides high accuracy on complex layouts. Obtain 93% accuracy and 0.86 F1 score on the 153 test reports collected from PKU1. The average time to process each report was 0.78 s [5].

Amjad et al. (2025) proposed ML based models for identification of anaemia and leukemia from CBC parameters. Generated hybrid synthetic data used to supplement original data set to address the issue like data imbalance and small size data. RF classifier model was achieved highest accuracy of 98% [6].

The importance of administrative health data, to analyse the demographic pattern of the disease and its severity, can be identified by these data. To improve the development of the health prediction model, greater focus must be placed on important health information. These research also included a comparison of the outcomes from various methods for three commonly simulated diseases utilizing electronic health data [7].

It gives a detailed overview of different ML and DL models used for data analysis in electronic health records. Special attention is given to the prediction analysis and scheduling the next visit to the doctor by using the Doctor AI model. It also helps in the prediction-based diagnosis of the patient. Discuss various data extraction techniques from electronic health records [8].

Patient privacy and security are addressed in this paper. Blockchain-based electronic health record file sharing was developed, which was more secure and robust to external attack. The health organisations use different electronic record formats, so it is not easy to access the record, to address this issue, develop a keyword-based search algorithm, which also protects the privacy of the patient and easily accesses the patient information from the electronic health record [9].

Design and develop a smart health card that simulated on Aldac Active-HDL student's edition. Smart cards are able to store patient data and securely provide access. A cryptographic AES-based security system was included in the smart card for secure information sharing and transfer [10].

Text documents are classified by using the Naive Bayes algorithm, which was really helpful for increasing the efficiency of the algorithm. Develop a health prediction model based on the RF and Random Tree models. In which RF methods predict health more accurately [11].

Talk about the Fast Healthcare Interoperability Resource (FHIR). To specify how the data kept in the EHR should be organized, methodically explained, and shared, standards and technological specifications were created [12].

It displays Deepr, also known as Deep Record, is a novel end-to-end deep learning system that automatically forecasts future risk by learning to extract information from medical records. A record is converted by Deepr into a series of distinct elements spaced by coded time [13].

The Ministry of Health and Family Welfare, government of India, designed the EHR/EMR standards [14]. By using the fusion node concept on big data, it's possible to improve the efficiency of health risk prediction. DL techniques consist of many machine learning techniques, and by using this data analysis, performance increases. Here wider scope to compare the results on different algorithms to find the most accurate one [15].

Need to address the semantic gap present in the electronic health record due to the diversity present in the different regions by considering the medium of instruction with the patient. Disease etiology and physiology affect the accuracy of the health prediction system [16].

The development of Data-driven systems efficiently works only when the complete data of patients is present in the DHR, but most of the time, data is missing in the record. To fill this missing data, Generative Adversarial Networks (GAN) were developed [17].

Study the various barriers present in the adoption of the digital health record and design a counter policy to increase the adoption of the DHR by providing the

financial benefits to the person who is using the DHR and the organization who were implementing these services for technology implementation in their hospitals [18].

Diseases vary regionally due to the climate and living conditions in the region. It weakens the algorithm's prediction accuracy. Overcoming this challenge requires diverse patient data in great volume. It mainly focuses on data classification, dividing the data into two types: structured data and unstructured data. By applying the CNN-MDRP algorithm, we can increase efficiency [19] [20].

Although various research works have been conducted individually on the digitization of medical reports using OCR or the detection of anaemia using machine learning, a research gap still exists in the development of combined frameworks that integrates OCR and multi-class anaemia classification.

By going through the different literature following objectives are formulated to carry out further research work.

- Extraction of raw health data from digital DHR.
- Finding the different health parameters to predict health risk.
- Testing and validating artificially generated digital health data.
- Health prediction using the most optimised ML algorithm.

METHODOLOGY

The methodology involves a comprehensive framework for the classification of anaemia based on the complete blood count data obtained from laboratory reports. The framework involves data retrieval from unstructured report formats, the use of OCR techniques for parameter retrieval, data validation and preprocessing, feature representation, and model development using machine learning techniques. Unlike traditional methodologies that rely on the assumption of the availability of digital datasets, the proposed methodology is intended to work directly with unstructured CBC reports and is capable of multi-class anaemia classification using a stratified cross-validation learning pipeline.

The research framework is mainly divided into four parts.

The first part deals with the dataset description, Data Acquisition, and Digital Transformation, which mainly includes CBC Report Input and Data Preprocessing. The second part mainly consists of Feature Engineering, like Feature Extraction and Feature Selection. The third part consists of the training and testing of the AI models for Anaemia Classification and Prediction.

Data Set Description

Dataset Sources and Overview: The dataset obtained in this research work involves two different sources: (i) actual laboratory CBC reports gathered from a pathology lab, and (ii) a publicly accessible benchmark dataset sourced from Kaggle. A total of 253 actual laboratory CBC reports were gathered in image and PDF format. All patient identifiers were clear before analysis. Additionally, a publicly accessible Kaggle dataset containing 1,281 samples was employed to aid in the training of the model, as well as in the evaluation of its performance. The combination of actual laboratory data with a formal public dataset allows for the evaluation of both the applicability of the model and its performance.

The combined class-wise distribution of the laboratory and Kaggle datasets is shown in Table 2, which reflects the variability of haematological parameters and the class imbalance inherent in real-world clinical datasets.

Table 2. Combine Class-Wise Distribution of Laboratory and Publicly Available CBC Datasets on Kaggle

Diagnosis Class of Anaemia	Data Set Availability	
	Laboratory (n=253)	Kaggle (n=1281)
Healthy	53	336
Normocytic hypochromic	4	279
Normocytic normochromic	68	269
Iron deficiency	3	189
Other microcytic	88	59
Macrocytic	11	18
Thrombocytopenia	6	73
Leukemia	20	47
Leukaemia with thrombocytopenia	0	11
Total	253	1281

Demographic Analysis: The anonymisation or unavailability of detailed demographic characteristics like age and gender in the laboratory dataset was due to privacy considerations during data collection. Nonetheless, the CBC reports collected are typical clinical cases involving a diverse patient population, thereby ensuring variability in blood parameters and disease severity. The Kaggle dataset also does not contain patient-identifiable demographic information. Consequently, the analysis will be on haematological parameters, which is in line with previous studies involving CBC for diagnosis.

Justification of Sample Size: The choice of sample size is a balance between the availability of real-world data and the robustness of the approach. The laboratory data set of 253 samples was adequate to prove the validity and applicability of the OCR extraction pipeline in a real-world clinical setting. To overcome the issues of sample size and class imbalance, a larger publicly available data set was used. The approach adopted in this study is a common practice in medical machine learning research to ensure the clinical validity of laboratory data and the robustness of the approach.

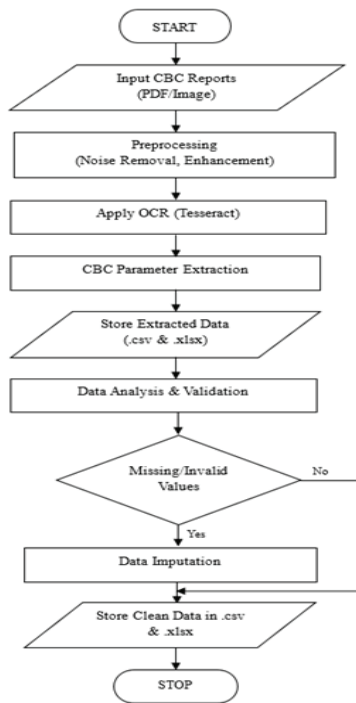


Fig. 1. Flowchart for Data Extraction from CBC Reports and converting it in to digital format.

Fig. 1 shows the flowchart for OCR based Data extraction from CBC reports. Collected CBC reports are in the form of an image and a PDF. In the very first step, apply the image preprocessing technique, which enhances the quality of the image and removes the noise present in it. Then, apply the OCR-based Tesseract open source engine developed by HP and maintained by Google. The Tesseract tool supports multiple languages. After the extraction of text, apply natural language processing/machine learning to extract the CBC parameters and their values from the text and store it into the .csv format. After the extraction, did the data analysis and validation, finding the missing value as well as outliers. Data imputation filled all missing values by mean, mode or median according to the column values variation. The cleaned and processed data were again stored in the new .csv and .xlsx formats. Process files facilitate smooth integration with downstream machine learning applications and EHR systems.

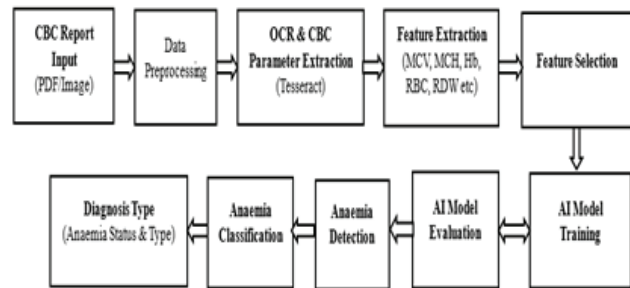


Fig. 2. Block diagram of the proposed system for health prediction using Digital Health Record (Anaemia Prediction)

The proposed research framework is mainly divided into three parts. The first part deals with the Data Acquisition and Digital Transformation, which mainly includes CBC Report Input and Data Preprocessing. The second part mainly consists of Feature Engineering, like Feature Extraction and Feature Selection. The third part consists of the training and testing of the AI models for Anaemia Classification and Prediction.

Data Acquisition Unit and Digital Transformation

The 253 people CBC report were collected from the pathology lab. Patient identity is hidden due to privacy concerns. Mainly, the CBC reports were in the form of an image and a PDF file. The offline record was preprocessed and converted into a digital health record

(DHR). For preprocessing, the image enhancement was done by adjusting the contrast and denoising the image.

REG NO. : NPL / 34
 NAME : AGE : 24 Years SEX : Female
 REF. BY : DATE : 18/08/2025

HAEMATOLOGY			
TESTS	RESULTS	UNITS	REFERENCE RANGE
COMPLETE BLOOD COUNT			
Haemoglobin	: 12.2	gm/dl	12 - 16
R.B.C. Count	: 4.10	mil/cmm	3.8 - 5.8
Total WBC Count	: 6800	/cmm	4000 - 11000
Packed Cell Volume	: 35.5	%	35 - 47
Mean Corpuscular Volume	: 86.59	cu micron	80 - 96
Mean Corpuscular Hemoglobin	: 29.76	picograms	27 - 32
Mean corpuscular Hb Con.	: 34.37	g/dl	32 - 36
Neutrophils	: 73	%	40 - 70
Lymphocytes	: 19	%	20 - 45
Eosinophil	: 04	%	0 - 6
Monocytes	: 04	%	0 - 8
Basophils	: 00	%	0 - 1
Platelets	: 2,53,000		150000 - 450000
Malarial Parasite	: Not seen		

Fig. 3. CBC/Haematology report sample collected from the pathology Lab

For data extraction used the Google Colab open source platform. Import the libraries like tesseract and Pillow(PIL) for image handling. The process of data extraction from the CBC report is shown in Fig.3, and the result of data extraction is shown in Table 3.

Table 3. Patient Data Extracted in the .CSV or XLSX Format

ID	Extracted Parameter from CBC Reports									
	Gender	Age	Hb	R.B.C	HCT	MCV	MCH	MCHC	RDW	WBC
12035	F	95	7.0	2.46	20.1	81.71	28.4	34.83	16.0	11090
12036	F	68	8.5	1.84	23.2	126.09	46.20	36.64	12.5	4120
12037	M	80	12.1	3.53	35.3	100.00	34.4	34.28	14.5	9210
12038	M	15	13.0	3.97	38.4	96.73	32.6	33.85	12.5	10820
12039	F	45	11.5	4.25	32.4	76.24	27.0	35.49	15.9	3820
12040	F	28	15.2	4.63	39.0	84.1	32.7	38.9	12.9	19280
12041	M	38	15.3	4.11	44.3	107.79	37.1	34.54	13.5	6950
12042	F	28	15.3	4.65	44.9	96.56	32.9	34.08	12.7	20660
12043	M	26	13.9	4.51	38.8	86.03	30.8	35.82	13.0	10421
12044	M	59	13.2	3.62	38.6	106.63	36.4	34.20	13.2	13550
12045	M	80	11.5	3.36	32.1	95.54	34.1	35.83	14.0	8760

First, it takes the CBC reports and identifies the reports in the form of an image or a PDF. If it's an image, then it directly applies the OCR and extracts the information. If it's in PDF format, then it checks the readability. If it's readable, then apply the OCR directly; otherwise it convert the PDF into an image and then apply the OCR and extract the information.

Feature Engineering

For precise and accurate data extraction, train the ML model with the sample CBC report present in the Image and PDF and extract the information. The extracted parameters were stored in the .csv and .xlsx formats.

Blood parameters were extracted from the various CBC reports, and 11 parameters are shown in Table 3. Information stored in .csv and .xlsx was again preprocessed for anomaly detection in the data. Data validation was done through outlier detection. Find out the missing values and replace them with mean, mode and median depending upon the parameter variation. All data was also validated manually for precautionary measures. The final clean data is shown in the following format.

The feature selection was performed using the data set available on Kaggle, as mentioned in the reference section. The same feature selection applies to the data extracted from CBC reports. It was done by observing the correlation matrix with the help of a heatmap. Fig. 4 shows the Feature Correlation or feature importance graph for RF and XGBoost algorithms. By evaluating each feature's utility in building the boosted decision trees, the RF and XGBoost algorithm calculates feature importance. A feature is more influential in forecasting when it has a higher importance score. The difference in the feature selection score in both models is due to the inherent differences in the models.

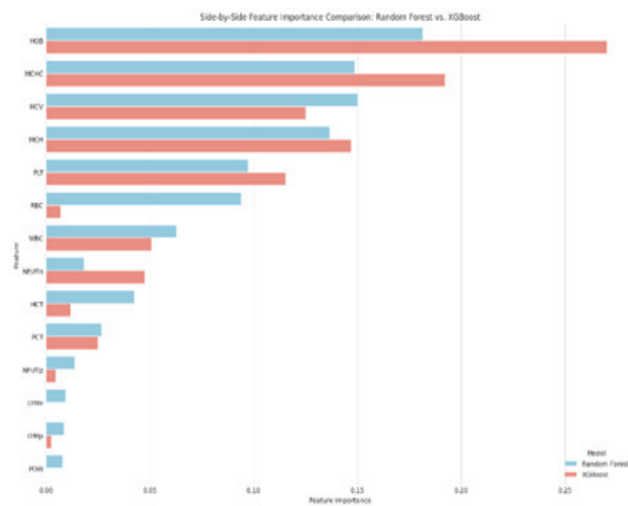


Fig. 4. Feature Correlation comparison of RF and XGBoost algorithm

Training and Testing of AI Models

The data set was taken from the open-source, publicly available data set on Kaggle. The data set consists of a total of 1281 samples. It consists of a total of 15 columns. Out of 15, 14 are CBC parameters, and the last one is the diagnosis, i.e., outcome. The data preprocessing was done on the data set, and observed the data quality issues. Again, the same steps, like data preprocessing and data validation, were done on the online dataset to make it ready for AI model training.

The AI model was trained for six core ML algorithms, and two tuned ML models of RF and XGBoost were used for Comparative Performance Analysis discuss in result section.

RESULT ANALYSIS

The performance of the OCR module was tested to determine the accuracy of the extraction of CBC parameters from unstructured laboratory reports, since the reliability of the OCR process affects the performance of the classification task. The accuracy of the extraction of key parameters was tested at the field level for haemoglobin, RBC, WBC, and platelet counts using ground-truth values verified from laboratory reports.

The data extraction accuracy is given by

$$Accuracy = \frac{No. of correctly evaluated field}{Total No. of fileld} * 100$$

The OCR component performed well in terms of reliability of extraction of CBC parameters. The accuracy of extraction at the level of fields was above 91.13% for haemoglobin, RBC, WBC, and platelet count parameters. This indicates robustness of the component with respect to differences in the layout and font style of reports. Some minor errors in extraction were noticed in cases where the resolution of images in reports was low or the tabular representation was complex.

Table 4. Field-Level OCR Performance for CBC Parameter Extraction

CBC Parameter	Total Fields Evaluated (n=R)	Correctly Extracted Fields	Extraction Accuracy (%)
Haemoglobin (Hb)	253	215	84.98

RBC Count	253	178	70.36
WBC Count	253	250	98.81
Platelet Count	253	248	98.02
MCV	253	240	94.86
MCH	253	243	96.05
MCHC	253	240	94.86
Mean Accuracy			91.13

A total of eight ML algorithms were trained for anaemia Classification and Prediction. Accuracy, macro-averaged precision, recall, and F1-score were used as evaluation metrics. Thorough comparative analysis to assess the performance of several machine learning classifiers. The findings show that ensemble-based techniques outperform over conventional classifiers.

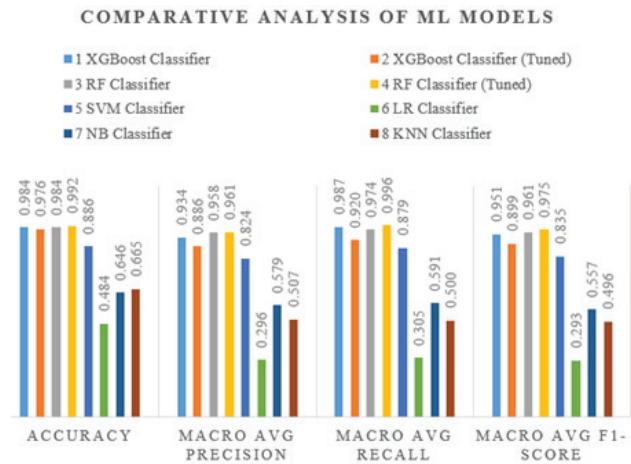


Fig. 5. Comparative Performance Analysis of Different AI Models.

Top-Performing Models: The best-performing models were the Random Forest Classifier and the XGBoost Classifier, both of which achieved the same accuracy of 98.43% , macro average precision of RF model 0.958 higher over XGBoost 0.933, The macro average recall rate of XGBoost was 0.986 slightly higher over the 0.973 RF model recall rate. The macro average F1 score of Rf was 0.96 and that of XGBoost 0.95 slightly higher. Overall RF model outperforms all other ML models.

When apply tuning to the RF and XGBoost model then it increase the accuracy of RF model to 99.2% and slightly decrease the accuracy of XGBoost model to 97.63%, Its happens due to the inherent data handling capacity of both algorithm. The tuning process is suitable for

improving the performance of the model. It optimize the hyper parameter to obtain best performance on given data set.

The SVM demonstrate the accuracy of 88.58% but compare to above model performance is not satisfactory. It indicate the limitation for handling class distribution and nonlinear boundaries although good accuracy and recall.

By observation of above bar graph accuracies below 67% and relatively low micro average score the models like KNN and Naive Bayes perform moderately. The LR classifier shows poor performance with accuracy 48% It shows that the model unable to capture the complexity of dataset.

Observation: Visual analysis of bar plots further reinforced these findings, clearly explaining the superior and consistent performance of RF and XGBoost across all metrics. In conclusion tuned approaches particularly the RF Classifier, were the most effective and reliable models for this dataset, providing high accuracy and stable class-wise performance.

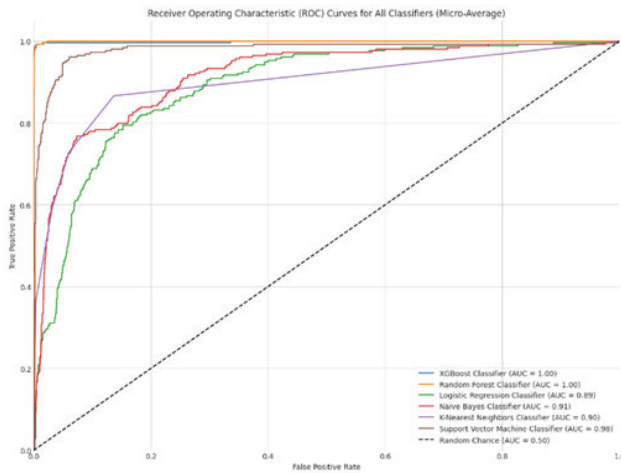


Fig. 6. Evaluation of Different ML Models based on ROC

The comparison among classifiers based on accuracy, macro precision, recall, and F1 score are the strong indirect evidence related to ROC-AUC, Receiver operating characteristics represents how well a model can differentiate classes by considering various threshold as well as imbalance data set.

The area under curve (AUC) indicate how well model discriminate the true positive instances and true

negative instances. The curve near to top left corner 1 indicate the clear cut discrimination in classes while curve near to 0.5 indicate no discrimination ability of the model. From Table 5 it is clear that Random Forest Tuned AI Models provides the highest accuracy and robust macro-averaged metrics.

Table 5. Comparative Performance Analysis of AI Models

AI Model (Classifier)	Evaluation Parameter of AI Models				
	Accuracy	Macro Average Score			
		Precision	Recall	F1-Score	ROC
XGBoost	0.984	0.934	0.987	0.951	1.00
RF	0.984	0.958	0.974	0.961	1.00
LR	0.484	0.296	0.305	0.293	0.89
NB	0.646	0.579	0.591	0.557	0.91
K-NN	0.665	0.507	0.500	0.496	0.90
SVM	0.886	0.824	0.879	0.835	0.98
RF (Tune)	0.992	0.961	0.996	0.975	1.00
XGBoost (Tune)	0.976	0.886	0.920	0.899	1.00

The large area under curve in ROC-AUC denote the AI Models robustness to handle the class boundaries. Whereas the XGBoost models maintained good class despite performing marginally worse than its baseline, suggesting relatively high ROC

From the analysis of fig.6 and Table 5 it's clear that the tune model provides the highest efficiency and ROC values for class discrimination threshold independent performance. ROC-AUC is an important model evaluation criterion for medical diagnosis applications.

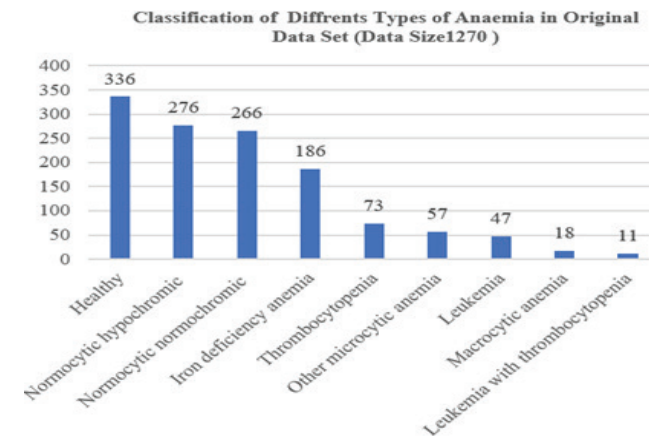


Fig. 7. Statistics of Anaemias Data Set

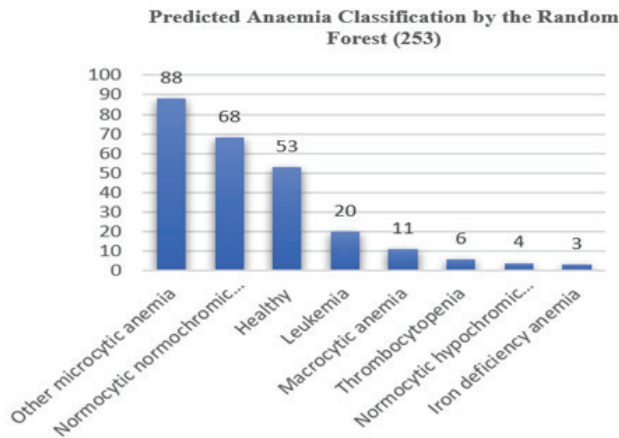


Fig. 8. Predicted Classification of Anaemia

The predicted output indicates that out of 253 CBC reports, 88 identified other microcytic anaemias. 53 persons with CBC patient reports are healthy.

Cross-validation: Cross-validation is a powerful statistical technique in machine learning that assesses how well a model generalises to a different dataset. Its primary goals are to: 1. Calculate Model Performance, 2. Steer clear of overfitting and modify hyperparameters.

We employ the StratifiedKFold technique, which is helpful for multiclassification problems, for this model. It guarantees that every fold preserves the same distribution of classes as the original data set. For a fair assessment, it is crucial. Here, we employ (K=5) folds cross validation for 1281 samples. Following cross-validation, Table 6 displays the model’s strong generalization ability and reliable performance.

Table 6. Comparative Performance Analysis of AI Models with Cross Validated Models

SN	Comparative Evaluation Metrics of the Cross-Validated Model with the Original One				
	Model (Classifier)	Accu- racy	MA Precision	MA Recall	MA F1- Score
1	XGBoost	0.984	0.934	0.987	0.951
2	XGBoost (Tune)	0.976	0.886	0.920	0.899
3	XGBoost (CV)	0.987	0.971	0.964	0.966
4	RF	0.984	0.958	0.974	0.961
5	RF (Tune)	0.992	0.961	0.996	0.975
6	RF (CV)	0.983	0.952	0.905	0.920

7	SVM	0.886	0.824	0.879	0.835
8	SVM (CV)	0.913	0.869	0.847	0.853
9	K-NN	0.665	0.507	0.500	0.496
10	K-NN (CV)	0.687	0.545	0.499	0.500
11	NB	0.646	0.579	0.591	0.557
12	NB (CV)	0.630	0.594	0.628	0.567
13	LR	0.484	0.296	0.305	0.293
14	LR (CV)	0.376	0.161	0.194	0.158

Table 6 shows the performance parameters of models with or without tuning and with cross-validation. It is observed that among the high-performing models, the performance of the XGBoost model is increased while the RF model is decreased. XGBoost’s performance improves after the 5-fold cross-validation. Evaluating the RF and XGBoost classifiers shows robust performance over other classifiers.

CONCLUSION, LIMITATIONS AND FUTURE SCOPE

Conclusion: This work addressed the issue of earlier approaches that rely on structured digital datasets by introducing an automated OCR-assisted machine learning framework for multi-class anaemia classification using real CBC reports. In this work, machine learning classifiers for multi-class classification and anaemia prediction using complete blood count data were systematically compared. The findings show that tune-based models regularly perform better over other classifiers. With the highest accuracy 99.2% and macro-averaged precision, recall, and F1-score of 0.961, 0.996, and 0.975, respectively, the tune RF classifier in particular had the best overall performance across all anaemia classes.

The efficiency of tune models was able to identify complex relations among CBC parameters, confirmed by the comparative results of the standard RF and XGBoost classifiers. The RF model’s performance improved significantly after hyperparameter tuning, but the tuned XGBoost model’s performance somewhat decreased in comparison to its untuned model, it shows how sensitive boosting techniques are to parameter selection. While Logistic Regression, Naive Bayes, and K-NN showed much lower accuracy and macro-averaged F1-scores, indicating their limited applicability for complicated, multi-class CBC data, the SVM

performed moderately. Overall, the results show that tuned ensemble learning techniques are best suitable for automated anaemia classification and prediction, with great potential for indulging into large-scale screening systems and clinical decision support system.

Future Scope: Larger, multi-centre datasets with more comprehensive clinical annotations and standardized diagnostic criteria should be used in future research to address these problems. Reproducibility would be enhanced and batch effects could be corrected by incorporating metadata on collection procedures and laboratory practices. Additionally, sophisticated methods for managing uncommon classes and balanced sampling strategies may improve the robustness of the model. In the end, these advancements will improve machine learning techniques for anaemia detection and classification's generalisability and clinical relevance.

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A Study on Use of Disposable Mask in M20 Grade Concrete by Partially Replacing Fine Aggregate

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ABSTRACT

The COVID-19 pandemic has created not only a public health emergency but also an escalating environmental concern, particularly due to the improper disposal of personal protective equipment (PPE). Addressing this dual challenge calls for interdisciplinary innovation. This study proposes a sustainable solution by repurposing used disposable face masks as a partial replacement for fine aggregate in concrete production. A series of experimental tests were conducted on M20-grade concrete cubes in which 5%, 10%, and 15% of fine aggregate were replaced with shredded face mask fibers. The results indicated that concrete containing face mask material not only met the required strength criteria but also demonstrated improvements in mechanical performance. Specifically, the addition of 10% shredded face mask yielded the highest unconfined compressive strength (24 N/mm²). Moreover, increasing the percentage of face mask content up to 15% resulted in further gains in stiffness but there decrement of compressive strength. Therefore making it a promising material for sustainable construction practices.

INTRODUCTION

The outbreak of the COVID-19 pandemic led to a dramatic increase in the use of personal protective equipment (PPE), particularly disposable face masks and gloves. Many nations enforced regulations mandating the public to wear face coverings to curb the virus's spread. While these measures proved effective in reducing transmission rates, they also triggered a significant environmental issue due to the massive generation and improper disposal of PPE waste.

Daily face mask usage has soared globally, with estimates indicating over 700 million used per day in Africa and more than 2.2 billion in Asia. Although recent, comprehensive global statistics are unavailable, it was reported in June 2020 that approximately 129 billion face masks were being discarded monthly. This estimate likely underrepresents the current figures, as it

predates the widespread enforcement of mask mandates. According to a model by Nzediegwu and Chang (2020), global daily face mask usage could be as high as 6.88 billion, producing around 206,470 tons of waste each day, much of which ends up in landfills or is incinerated.

Unfortunately, used masks are frequently found littered across cities, parks, and waterways. Even when disposed of properly, their lightweight composition allows them to be easily transported by wind or rain into rivers and oceans. Once there, these plastic-based masks begin to degrade into microplastics, posing a serious risk to ecosystems and wildlife. Ingestion of such particles can be fatal to marine animals, and even masks disposed of in landfill sites can contribute to this pollution due to poor containment.

Compounding the issue, disposable masks are composed of non-biodegradable synthetic polymers,

which persist in the environment for centuries. As a result, addressing the environmental impact of PPE waste requires urgent, cross-disciplinary collaboration. Civil engineering, in particular, heavily relies on natural resources, and the extraction of raw materials contributes significantly to greenhouse gas emissions. Additionally, the construction industry is responsible for generating nearly half of all global solid waste, mainly through demolition activities. In response, there has been a growing shift toward the recycling and reuse of construction and demolition debris to promote sustainable practices. Within this context, repurposing sterilized PPE waste—such as face masks—for use in civil and geotechnical engineering presents a practical and eco-friendly solution. Incorporating these materials into infrastructure projects not only diverts waste from landfills but also reduces reliance on virgin resources.

Moreover, traditional water treatment systems are currently ineffective at filtering out microplastics, allowing them to remain in the environment. These particles can also bond with toxic substances in ocean water, increasing the risk of harm when consumed by marine life. Although the long-term effects of microplastic ingestion on human and animal health remain uncertain, efforts are underway in many countries to minimize their release and presence in the environment.

Methodology: The primary aim of this study is to develop a microplastic-infused concrete by incorporating polypropylene fibers sourced from disposable face masks. The goal is to enhance the compressive strength of the concrete while also achieving cost-effectiveness by partially replacing fine aggregate with shredded face mask material in proportions of 5%, 10%, and 15%.

The core material investigated in this research is concrete modified with recycled polypropylene fibers extracted from single-use PPE face masks. The methodology is divided into two main phases: the recycling and preparation of the face mask material, followed by the formulation and testing of the concrete mix.

Mask Processing and Preparation:

- a) Discarded single-use face masks were collected from various locations.

The collected masks were sanitized using alcohol-

based disinfectant sprays to eliminate any biological contaminants.

- b) The sanitized masks were then cut into smaller pieces.
- c) These were further shredded into square pieces approximately 1.5–2.0 mm in size using a paper-cutting machine.
- d) The mask fragments were melted at a temperature range of 175°C to 195°C, then cooled at room temperature. The cooled material was then crushed into a fine powder using a hammering method.
- e) The powdered face mask material was mixed with standard coarse and fine aggregates, along with cement, maintaining a constant water-cement ratio.
- f) Concrete cubes of M20 grade were cast for compressive strength testing, incorporating 5%, 10%, and 15% face mask material as a partial replacement for fine aggregate.

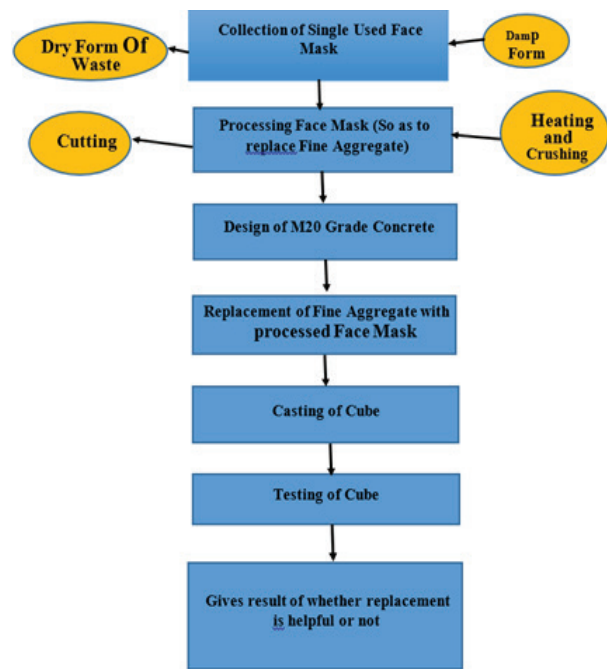


Fig. 1: Flowchart of Methodology

Results: In this research we have partially replaced fine aggregate with single used face mask (by heating and crushing). The effect of partially replaced concrete is then checked for compressive strength when it is replaced by 5%, 10%, and 15% of single use face mask.

Table 1: Compressive Strength of cube in 7 days

S. No	Concrete With Partially Replaced FA	Compressive Strength (N/mm ²)
1	0%	13.5
2	5%	16.84
3	10%	17.8
4	15%	18.5

Seven day compressive strength should be 65% of characteristic compressive strength. So for M20 Grade concrete it should be more than 13 N/mm². From above results it is clearly seen that there is increment in strength by 29.5%, 36% and 42% in 7 day compressive strength when we have replaced with 5%, 10% and 15% respectively.

Table 2: Compressive Strength of cube in 14 day

S. No	Concrete With Partially Replaced FA	Compressive Strength (N/mm ²)
1	0%	16
2	5%	20.5
3	10%	22.5
4	15%	24

Seven day compressive strength should be 90% of design characteristic compressive strength. So for M20 Grade concrete it should be more than 18 N/mm². From above results it is clearly seen that there is increment in strength by 13.8%, 25% and 33% in 14 day compressive strength when we have replaced with 5%, 10% and 15% respectively.

Table 3: Compressive Strength of cube in 28 days

S. No	Concrete With Partially Replaced FA	Compressive Strength (N/mm ²)
1	0%	21
2	5%	23.86
3	10%	24.5
4	15%	23.03

Seven day compressive strength should be 99% of design characteristic compressive strength. So for

M20 Grade concrete it should be more than 19.8 N/mm². From above results it is clearly seen that there is increment in strength by 20.5%, 23.7% and 16.3% in 28 day compressive strength when we have replaced with 5%, 10% and 15% respectively.

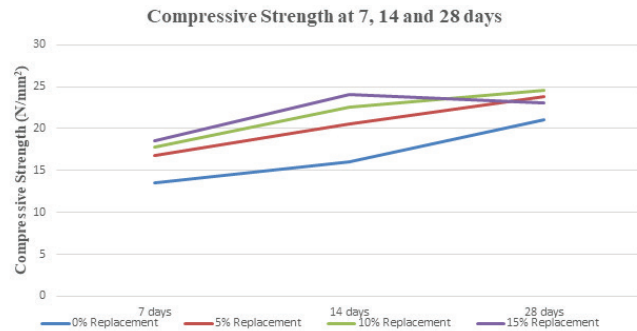


Fig. 2: Compressive strength of partially replaced fine aggregate with shredded Face Mask in Concrete at 7 days, 14 days and 28 days

Conclusion: The global outbreak of COVID-19 has resulted in an unprecedented rise in the production and disposal of single-use face masks, creating a significant environmental challenge. Addressing this growing concern requires innovative and sustainable waste management solutions. This study evaluated the feasibility of incorporating shredded disposable face masks into concrete as a partial substitute for fine aggregate, with a focus on assessing the mechanical performance of the resulting material.

Based on the experimental findings, the following conclusions were drawn:

- Substituting fine aggregate with 5%, 10%, and 15% shredded face masks led to an increase in compressive strength by approximately 20.5%, 23.7%, and 16.3%, respectively.
- The compressive strength of the concrete improved progressively with higher percentages of face mask inclusion and at 15% replacement of fine aggregate with finely shredded face mask the compressive strength shows decrement by 7.4% when compared with 10% replacement of fine aggregate.
- Therefore, replacing more than 10% of fine aggregate with face mask material may negatively impact the workability of the concrete mix and is therefore not recommended.

The widespread generation and improper disposal of face masks during the pandemic pose severe environmental risks. Utilizing this waste in concrete production offers a sustainable and eco-conscious alternative that aligns with the principles of the circular economy. This approach not only mitigates environmental pollution and reduces landfill dependency but also conserves natural resources. The study confirms that incorporating up to 10% of mask-derived fibers by volume can significantly enhance both the mechanical strength and durability of concrete, presenting a viable pathway toward environmentally sustainable construction practices.

Food and Beverage Service Delivery in the Hospitality Sector: A Comparative Study of Three-Star and Five-Star Hotels in Bengaluru

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ABSTRACT

The hospitality sector is pivotal in shaping the overall experience of hotel patrons, with food and beverage (F&B) services being one of the most vital elements of hospitality operations. The quality, efficiency, and presentation of F&B services significantly impact customer satisfaction and the reputation of hotels. Amidst rising competition in the hospitality industry, hotels are working to elevate their service standards to fulfill the varied expectations of their guests. This study seeks to investigate and compare the provision of food and beverage services in three-star and five-star hotels located in Bengaluru, a prominent tourism and business center in Karnataka, India. The research employs a descriptive research design and gathers primary data through structured questionnaires distributed to hotel guests and staff members. Secondary data were sourced from journals, books, industry reports, and hospitality publications. The study emphasizes key aspects of service delivery, including service quality, staff professionalism, and menu variety, and ambience, responsiveness, and customer satisfaction. A comparative analysis is performed to uncover differences and similarities in service practices between three-star and five-star hotels. The results reveal that five-star hotels typically exhibit superior service standards, enhanced facilities, and a stronger focus on personalized guest experiences. Conversely, three-star hotels also provide satisfactory service levels with efficient operations and cost-effective offerings that attract budget-conscious travellers. The study underscores the significance of training, service innovation, and effective management practices in improving food and beverage service delivery across various hotel categories. The research offers valuable insights for hospitality managers and policymakers aiming to enhance service quality and bolster the competitiveness of the hotel industry in Bengaluru.

KEYWORDS: *Food and beverage services, Hospitality industry, Service quality, Customer satisfaction, Star category hotels, Bengaluru city.*

INTRODUCTION

The hospitality sector is among the fastest-expanding areas within the global economy, significantly contributing to tourism promotion, job creation, and economic growth. Within the diverse elements of the hospitality industry, food and beverage (F&B) services constitute a vital operational segment that directly impacts guest satisfaction and the overall reputation of hotels. F&B services include a broad spectrum of

activities, such as food preparation, service provision, menu design, beverage oversight, and customer engagement. In contemporary hospitality operations, the quality and efficiency of F&B services have emerged as critical factors influencing customer loyalty and competitive positioning. As guests increasingly desire unforgettable dining experiences alongside comfortable lodging, hotels must uphold high service delivery standards within their food and beverage divisions. In

this regard, analyzing service practices across different hotel categories is essential to comprehend how varying service standards influence guest experiences and operational efficiency.

In India, the hospitality industry has experienced significant growth over the last few decades, driven by a rise in domestic tourism, international travel, and business activities. The rapid pace of urbanization, economic development, and enhancements in transportation infrastructure have facilitated the proliferation of hotel establishments in major urban centers. Bengaluru, the capital of Karnataka, is widely acknowledged as one of India's foremost metropolitan areas and a key center for information technology, commerce, education, and tourism. The city draws a substantial number of domestic and international visitors annually, including business professionals, leisure travelers, conference attendees, and students. Consequently, Bengaluru has established a robust hospitality framework that includes hotels across various categories, from budget-friendly options to luxurious five-star accommodations. Within this framework, three-star and five-star hotels represent two distinct market segments, each catering to different clientele with diverse expectations, service levels, and pricing strategies.

Food and beverage services constitute an essential aspect of hotel operations, significantly impacting both the revenue and reputation of hospitality establishments. The F&B department is tasked with delivering high-quality food, beverages, and related services across restaurants, bars, banquet facilities, room service, and other dining venues within hotels. Beyond revenue generation, this department also plays a crucial role in enhancing the guest experience by providing a variety of culinary choices, professional service, and inviting dining atmospheres. Hotels frequently leverage their food and beverage offerings as a strategic means to attract patrons, distinguish themselves from competitors, and establish unique brand identities. Luxury hotels, in particular, place a strong emphasis on gourmet dining, specialized culinary concepts, and personalized service to provide exceptional experiences for their guests.

Three-star and five-star hotels exhibit significant differences in service standards, facilities, staff training, pricing strategies, and customer expectations. Five-star

hotels are typically marked by opulent infrastructure, exceptionally trained personnel, refined dining settings, and a diverse selection of both international and regional cuisines. These establishments frequently include multiple restaurants, specialty dining venues, bars, lounges, and banquet facilities, all crafted to deliver premium dining experiences. They also prioritize personalized services, meticulous attention to detail, and innovative culinary presentations. Conversely, three-star hotels generally provide moderate facilities and services tailored to meet the requirements of mid-range travelers who prioritize comfort, affordability, and efficient service. While three-star hotels may offer fewer dining options and simpler menus compared to luxury hotels, they strive to uphold satisfactory service quality and deliver value for money to their patrons.

The notion of service delivery in food and beverage operations encompasses several critical components, such as service quality, responsiveness, staff conduct, food presentation, menu diversity, hygiene standards, and the overall dining atmosphere. These elements collectively influence customer perceptions and satisfaction levels. In the hospitality sector, service quality is frequently assessed based on the effectiveness with which the service provided meets or surpasses customer expectations. When guests experience prompt, courteous, and professional service alongside high-quality food and beverages, they are more inclined to form positive impressions and become repeat patrons. Conversely, inadequate service delivery can result in dissatisfaction, unfavorable reviews, and missed business opportunities. Consequently, hotel managers place significant importance on employee training, enhancing operational efficiency, and upholding consistent service standards.

Bengaluru's varied population and cosmopolitan culture have fostered a lively culinary scene that embodies both traditional and international influences. Hotels in the city provide an extensive array of cuisines, encompassing Indian, continental, Asian, and fusion dishes, thereby catering to the diverse tastes and preferences of various customer segments. The influx of multinational corporations, technology firms, and international tourists has further amplified the demand for high-quality food and beverage services within the hotels of the city. In this competitive landscape, hotels

are required to consistently innovate and enhance their service delivery to remain appealing to customers. A comparison of the service practices between three-star and five-star hotels in Bengaluru offers valuable insights into how different hotel categories manage their food and beverage operations and the impact of these practices on customer satisfaction. The current study is centered on examining and contrasting the food and beverage service delivery in three-star and five-star hotels in Bengaluru. By scrutinizing various elements such as service quality, menu selections, staff professionalism, dining atmosphere, and customer satisfaction, the study seeks to uncover the similarities and differences in service practices between these two hotel categories. Recognizing these distinctions is crucial for both academic inquiry and practical applications within the hospitality sector. The study's findings can assist hotel managers in refining their service strategies, enhancing guest experiences, and sustaining competitive advantages in the marketplace. Bengaluru's diverse population and cosmopolitan culture have cultivated a vibrant culinary landscape that reflects both traditional and global influences.

STATEMENT OF THE PROBLEM

Hotels in the city offer a wide range of cuisines, including Indian, continental, Asian, and fusion dishes, thus catering to the varied tastes and preferences of different customer segments. The arrival of multinational corporations, technology companies, and international tourists has further increased the demand for high-quality food and beverage services in the city's hotels. In this competitive environment, hotels must continually innovate and improve their service delivery to remain attractive to customers. A comparison of service practices between three-star and five-star hotels in Bengaluru provides valuable insights into how different hotel categories manage their food and beverage operations and the effects of these practices on customer satisfaction. The current study focuses on examining and comparing the food and beverage service delivery in three-star and five-star hotels in Bengaluru. By analyzing various factors such as service quality, menu options, staff professionalism, dining ambiance, and customer satisfaction, the study aims to reveal the similarities and differences in service practices between these two hotel categories. Understanding these

distinctions is essential for both academic research and practical applications within the hospitality industry. The findings of the study can help hotel managers refine their service strategies, improve guest experiences, and maintain competitive advantages in the market.

LOGICAL BACKGROUND OF THE STUDY

The food and beverage (F&B) department stands as one of the most crucial operational units within the hospitality sector, as it plays a direct role in enhancing guest satisfaction and generating revenue. In contemporary hotels, dining services have progressed beyond mere food provision to encompass high-quality service, a variety of menu options, an inviting atmosphere, and tailored guest experiences. As tourism and business travel continue to expand in major urban centers like Bengaluru, hotels are increasingly prioritizing the enhancement of their food and beverage service standards to maintain competitiveness in the hospitality industry. Three-star and five-star hotels represent distinct segments of the hospitality market, each serving specific customer demographics with differing expectations, service levels, and pricing models. While five-star hotels prioritize luxury, innovation, and high-end dining experiences, three-star hotels concentrate on delivering comfortable and efficient services at reasonable prices. These distinctions in service delivery result in variations in customer perceptions, satisfaction levels, and operational methodologies within the F&B departments of these establishments. In light of the increasing significance of service quality in the hospitality industry, it is imperative to investigate how food and beverage services are provided across various hotel categories. Consequently, this study seeks to offer a comparative analysis of the service practices, facilities, and customer experiences within the food and beverage departments of three-star and five-star hotels in Bengaluru city.

REVIEW OF LITERATURE

Kumar and Singh (2023) undertook a study examining operational practices within hotel restaurants located in selected star-category hotels throughout South India. The results revealed that five-star hotels typically uphold superior service standards, attributed to their

advanced infrastructure, specialized culinary staff, and ongoing training programs for employees. Conversely, the research also pointed out that three-star hotels effectively draw in customers by providing competitive pricing and efficient service delivery.

Patel and Desai (2024) investigated the influence of various service quality dimensions, including reliability, responsiveness, assurance, and empathy, on customer loyalty within hotel restaurants. Their results indicated that personalized service and timely attention to customer requirements significantly enhance repeat patronage and favorable word-of-mouth referrals. The study advised hotel management to prioritize continuous staff training and service innovation to sustain a competitive edge.

Nair and Mathew (2025) performed research focusing on the dining experience and customer satisfaction in urban hospitality venues across India. Their findings underscored that elements such as hygiene standards, menu innovation, and staff courtesy play a crucial role in shaping guests' perceptions of hotel dining services. Furthermore, the study highlighted that ensuring consistent service quality is vital for fostering long-term customer relationships.

Ahmed and Khan (2026) explored the comparative service standards across various hotel categories in emerging tourism destinations. The findings illustrated significant disparities in infrastructure, service training, and guest engagement strategies between mid-scale and luxury hotels. The study concluded that while five-star hotels prioritize luxury experiences and personalized services, three-star hotels focus on operational efficiency and affordability to cater to the needs of middle-income travelers.

OBJECTIVES OF THE RESEARCH

1. To investigate the practices of food and beverage service delivery in three-star and five-star hotels located in Bengaluru city.
2. To evaluate the standards of service quality within the food and beverage departments of three-star and five-star hotels.
3. To assess customer satisfaction levels concerning food quality, service efficiency, and dining atmosphere in the selected hotels.

4. To determine the factors that affect effective food and beverage service delivery in the hospitality industry.
5. To offer recommendations for enhancing food and beverage service quality in star-rated hotels in Bengaluru.

RESEARCH QUESTIONS

1. What are the primary attributes of food and beverage service delivery in three-star and five-star hotels located in Bengaluru city?
2. In what ways does the quality of food and beverage services vary between three-star and five-star hotels?
3. Which factors affect customer satisfaction regarding food and beverage services in star-category hotels?
4. How do guests evaluate the efficiency of service, staff conduct, and dining atmosphere in three-star and five-star hotels?
5. What enhancements can be implemented to improve food and beverage service delivery in hotels within Bengaluru city?

ANALYSIS AND DISCUSSION

The collected data were analyzed using simple percentage analysis to understand the differences in food and beverage service delivery between three-star and five-star hotels in Bengaluru city. The analysis focuses on factors such as food quality, service efficiency, staff behavior, menu variety, and overall customer satisfaction.

Table 1: Respondents Based on Type of Hotel

Type of Hotel	Number of Respondents	Percentage
Three-Star Hotels	60	50%
Five-Star Hotels	60	50%
Total	120	100%

Interpretation

Table 1 illustrates the distribution of participants according to hotel category. Among the total of 120 respondents, 60 individuals (50%) were patrons of three-star hotels, while the remaining 60 individuals

(50%) were patrons of five-star hotels. This equal representation facilitates a balanced comparison of food and beverage service delivery across the two hotel categories.

Table 2: Customer Opinion on Food Quality

Opinion	Three-Star Hotels	Five-Star Hotels
Excellent	15 (25%)	32 (53%)
Good	28 (47%)	20 (33%)
Average	12 (20%)	6 (10%)
Poor	5 (8%)	2 (4%)
Total	60 (100%)	60 (100%)

Interpretation

Table 2 demonstrates that the quality of food is regarded as superior in five-star hotels in comparison to three-star hotels. In five-star establishments, 53% of participants rated the food quality as excellent, whereas merely 25% of participants in three-star hotels shared this view. Nonetheless, a significant portion of respondents (47%) in three-star hotels assessed the food quality as good. This indicates that although five-star hotels offer enhanced culinary experiences, three-star hotels continue to uphold satisfactory food standards.

Table 3: Customer Opinion on Service Efficiency

Opinion	Three-Star Hotels	Five-Star Hotels
Very Fast	18 (30%)	35 (58%)
Fast	25 (42%)	17 (28%)
Moderate	12 (20%)	6 (10%)
Slow	5 (8%)	2 (4%)
Total	60 (100%)	60 (100%)

Interpretation

Table 3 illustrates that the efficiency of service is markedly superior in five-star hotels. Approximately 58% of participants rated the speed of service as very fast in five-star establishments, while merely 30% conveyed a similar sentiment regarding three-star hotels. Nonetheless, 42% of respondents assessed the service as fast in three-star hotels, suggesting that these hotels manage to uphold a reasonably efficient level of service delivery despite possessing fewer resources.

Table 4: Staff Professionalism and Behavior

Rating	Three-Star Hotels	Five-Star Hotels
Excellent	20 (33%)	38 (63%)
Good	26 (43%)	15 (25%)
Average	10 (17%)	5 (8%)
Poor	4 (7%)	2 (4%)
Total	60 (100%)	60 (100%)

Interpretation

The table reveals that staff professionalism is more prominent in five-star hotels. Around 63% of respondents rated staff behavior as excellent in five-star hotels, compared to 33% in three-star hotels. The higher ratings in five-star hotels may be attributed to better staff training programs, service standards, and hospitality management practices.

Table 5: Overall Customer Satisfaction

Satisfaction Level	Three-Star Hotels	Five-Star Hotels
Highly Satisfied	18 (30%)	40 (67%)
Satisfied	27 (45%)	14 (23%)
Neutral	10 (17%)	4 (7%)
Dissatisfied	5 (8%)	2 (3%)
Total	60 (100%)	60 (100%)

Interpretation

Table 5 illustrates the general satisfaction levels of customers concerning food and beverage services. In five-star hotels, 67% of participants reported a high level of satisfaction, whereas only 30% of those surveyed in three-star hotels felt the same. Nevertheless, 45% of respondents in three-star hotels indicated that they were satisfied with the services offered. This suggests that while five-star hotels provide more opulent dining experiences, three-star hotels still succeed in satisfying a significant number of guests through effective service and reasonable pricing.

MAJOR FINDINGS

The research conducted on food and beverage service delivery within three-star and five-star hotels in Bengaluru city uncovers several significant insights. The comparative evaluation suggests that five-star hotels typically offer a superior level of service quality in their

food and beverage sectors when contrasted with three-star hotels. Patrons at five-star hotels reported higher satisfaction regarding elements such as food quality, presentation, menu diversity, dining atmosphere, and staff professionalism. The availability of well-trained service personnel, state-of-the-art kitchen facilities, and a variety of international cuisine options enhances the exceptional dining experience provided by five-star hotels. Furthermore, the study revealed that service efficiency, which includes prompt order taking and timely food delivery, is comparatively greater in five-star hotels due to enhanced operational management and technological assistance.

Conversely, three-star hotels were noted for their strong performance in terms of affordability and value for money. Numerous customers expressed appreciation for the efficient service and satisfactory food quality provided by these establishments. Although the selection of menu items and luxurious dining atmosphere may be more limited in comparison to five-star hotels, three-star venues still succeed in upholding acceptable service standards that align with the expectations of mid-range travelers. The findings also emphasize that staff conduct, hygiene practices, and responsiveness to customer requirements play a crucial role in influencing guest satisfaction across both hotel categories. In summary, the study indicates that while five-star hotels prioritize luxury and premium service experiences, three-star hotels focus on efficiency and cost-effective service delivery.

SUGGESTIONS /RECOMMENDATIONS

According to the results of the study, various recommendations can be made to enhance the delivery of food and beverage services in hotels. Firstly, three-star hotels ought to prioritize the enhancement of staff training programs to elevate professionalism, communication abilities, and customer service techniques. Ongoing training can enable employees to deliver more efficient and courteous service, thus boosting customer satisfaction. Secondly, hotel management should focus on upholding high standards of hygiene and food safety during the preparation and serving of food and beverages. Maintaining clean dining areas and adhering to proper sanitation practices can greatly affect customer perceptions and trust.

Thirdly, hotels should contemplate the introduction of a wider variety of menu options, incorporating regional, national, and international cuisines, to accommodate the diverse tastes of guests visiting Bengaluru. Innovation in menu design and presentation can significantly improve the overall dining experience. Fourthly, the implementation of modern technology such as digital ordering systems, customer feedback platforms, and automated service management tools can enhance operational efficiency and minimize service delays. This is especially advantageous for three-star hotels aiming to improve their service quality. Lastly, hotel management should proactively gather and analyze customer feedback to pinpoint areas for enhancement and uphold consistent service standards. Attending to guest opinions can assist hotels in continuously refining their food and beverage service strategies.

CONCLUDING OBSERVATIONS

Food and beverage services are essential in shaping the overall guest experience within the hospitality sector. In a competitive tourism and business hub like Bengaluru, hotels must consistently work to improve the quality and efficiency of their dining services. This study offers a comparative analysis of food and beverage service delivery in three-star and five-star hotels, emphasizing the distinctions in service standards, operational practices, and levels of customer satisfaction. The results reveal that five-star hotels excel in providing opulent dining settings, a wide variety of menu choices, and highly skilled service personnel, all of which lead to elevated customer satisfaction. Conversely, three-star hotels present economical dining alternatives and effective service that attract budget-conscious travelers and business patrons. Both hotel categories are vital in supporting the hospitality industry by addressing different market segments. The research underscores that enhancing service quality, investing in employee training, upholding hygiene standards, and embracing modern technology are crucial strategies for improving food and beverage service delivery. By concentrating on these elements, hotels can bolster customer loyalty, enhance their competitive edge, and contribute to the overall advancement of the hospitality industry in Bengaluru. Ultimately, the proficient management of food and beverage services will remain a pivotal factor

in achieving sustainable success within the hospitality sector.

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An Analysis of Factors Influencing Consumer Preference for Amway Products in Tiruchirappalli District

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ABSTRACT

Consumer preferences within the direct selling sector are influenced by a multifaceted interaction of product characteristics, personal engagements, and socio-economic elements. Amway, a well-known global multi-level marketing (MLM) entity, provides a wide array of health, wellness, beauty, and home care items, rendering it a crucial context for analyzing consumer behavior. In areas such as Tiruchirappalli District, where traditional retail and relationship-driven marketing coexist, comprehending the factors that shape consumer preferences becomes especially important. This analysis relies on primary data gathered through a structured questionnaire from consumers of diverse demographic backgrounds, complemented by secondary data from academic and industry references. The key variables examined include product quality, price perception, brand reputation, availability, promotional tactics, and the impact of distributors and peer recommendations. Additionally, demographic factors such as age, gender, education, occupation, and income are integrated to evaluate their influence on purchasing choices. Consumers are increasingly leaning towards health-focused and eco-friendly products, which boosts the attractiveness of Amway's offerings. However, challenges such as high pricing, limited accessibility, and skepticism regarding MLM models hinder broader acceptance. Enhancing awareness campaigns, refining pricing strategies, and utilizing digital platforms for distribution and communication can significantly improve consumer preference and facilitate market growth in Tiruchirappalli District.

KEYWORDS: *Consumer preference, Amway products, Direct selling, Multi-level marketing (MLM), Buying behaviour, Tiruchirappalli district.*

INTRODUCTION

Consumer preference is a crucial concept in marketing that indicates the choices and priorities of individuals when selecting products and services from competing options. It is influenced by a variety of factors, such as product quality, pricing, brand reputation, accessibility, personal values, and social

influences. In the current highly competitive and ever-changing market landscape, comprehending consumer preference has become vital for organizations to formulate effective marketing strategies, cultivate strong customer relationships, and ensure long-term growth. The swift transformation of consumer expectations, along with heightened awareness and

access to information, has rendered the examination of consumer behavior more intricate and important than ever before. One of the distinctive and evolving sectors within the marketing domain is direct selling, particularly the multi-level marketing (MLM) model. Unlike conventional retail systems, direct selling removes intermediaries and depends on independent distributors to promote products directly to consumers through personal interactions, demonstrations, and word-of-mouth communication. This model prioritizes relationship marketing, trust-building, and personalized customer engagement. Amway is recognized as one of the leading global entities in this sector, providing a diverse array of products that include health supplements, personal care items, cosmetics, and home care products. Its business model merges product distribution with income opportunities for distributors, thus establishing a dual role for consumers as both users and potential sellers.

In the Indian context, direct selling has experienced significant growth over the last decade, fueled by a rise in entrepreneurial ambitions, heightened health awareness, and the proliferation of digital communication platforms. Amway has secured a robust foothold in India by branding itself as a supplier of high-quality, research-driven products that meet contemporary lifestyle demands. Nevertheless, the success of such enterprises is largely contingent upon consumer perceptions of their products and the trustworthiness of their distribution networks. In the realm of multi-level marketing (MLM), consumer preferences are shaped not only by product attributes but also by interpersonal trust, social connections, and the efficacy of distributor communication. Tiruchirappalli District, a notable urban and semi-urban area in Tamil Nadu, offers a compelling backdrop for analysing consumer preferences regarding Amway products. The district showcases a fusion of traditional values and modern consumption trends, characterized by a burgeoning middle-class demographic and an increasing awareness of health, wellness, and lifestyle products. Consumers in this locality encounter both organized retail formats and alternative distribution methods such as direct selling. Consequently, their purchasing choices are swayed by a blend of rational assessment and social engagement. Investigating consumer preferences in this

setting aids in comprehending how localized elements interact with global marketing approaches. Multiple factors significantly influence consumer preferences for Amway products.

The quality of the product is frequently regarded as the most critical factor, as consumers generally link Amway with high-quality and dependable offerings. Additionally, brand image and trust play a vital role, especially in a market where there may be skepticism regarding MLM practices. Price perception is another key element, as Amway products are typically priced higher than standard alternatives. The willingness of consumers to pay these prices is contingent upon their perceived value and the satisfaction they derive from the product. Moreover, the function of distributors is essential to the effectiveness of Amway's business model. Distributors serve as intermediaries who not only market products but also educate, motivate, and influence consumers. Their communication abilities, product knowledge, and capacity to establish trust have a significant effect on consumer preferences and repeat purchasing behavior. Recommendations from word-of-mouth and peer influence can either enhance or diminish consumer attitudes toward the brand. Often, consumers depend on their personal networks rather than formal advertising when making purchasing choices related to direct selling products.

Demographic factors such as age, gender, income level, education, and occupation also affect consumer preferences. For example, younger consumers may be more attracted to personal care and wellness products, while those in higher income brackets may be more willing to invest in premium products. Likewise, educated consumers might prioritize product ingredients, safety, and environmental sustainability. These differences underscore the necessity of market segmentation and the customization of marketing strategies to address the varied needs of consumers. Another emerging factor that affects consumer preference is the increasing awareness of health, sustainability, and eco-friendly products. Contemporary consumers are becoming more concerned about the long-term effects of their consumption choices on both their health and the environment. Amway's emphasis on natural ingredients, nutritional supplements, and environmentally responsible products resonates

with these evolving preferences, thus increasing its attractiveness to conscious consumers. However, despite these favourable aspects, certain challenges persist that impact consumer preference for Amway products. Elevated pricing, limited physical availability, and misconceptions regarding MLM practices may deter potential customers. Tackling these challenges necessitates strategic measures such as enhancing transparency, improving product accessibility via digital platforms, and bolstering consumer education initiatives. In this regard, examining the factors that influence consumer preference for Amway products in the Tiruchirappalli District is particularly pertinent. This analysis not only sheds light on consumer behavior within a specific regional context but also contributes to a broader comprehension of the direct selling industry. It aids marketers, distributors, and policymakers in identifying essential drivers and obstacles, allowing them to formulate more effective strategies to improve customer satisfaction and expand market reach. Ultimately, a more profound understanding of consumer preference can facilitate the sustainable growth of direct selling enterprises in emerging markets.

STATEMENT OF THE PROBLEM

The direct selling sector, especially the multi-level marketing (MLM) framework, has experienced notable growth in recent years owing to its distinctive method of product distribution and customer interaction. Firms such as Amway have created a robust presence by providing a diverse array of health, wellness, personal care, and home care items through independent distributors. Despite its international recognition and product variety, the acceptance and preference for Amway products differ significantly across various regions and consumer demographics. In Tiruchirappalli District, consumers are increasingly encountering both traditional retail avenues and alternative marketing strategies like direct selling. Although Amway products are recognized for their quality and brand reliability, they frequently encounter obstacles related to elevated pricing, restricted accessibility, and skepticism surrounding MLM practices. Numerous consumers remain doubtful about the value proposition of these products when compared to easily accessible alternatives in the marketplace. Furthermore, the dependence on distributors for product promotion introduces variability

in communication, which affects consumer perceptions and purchasing choices. Another significant concern is the absence of a clear understanding of the factors that either promote or impede consumer preference for Amway products within the local context. Aspects such as product quality, price perception, brand reputation, trust in distributors, and word-of-mouth impact may influence consumer behaviour differently based on demographic factors such as age, income, education, and occupation. Nevertheless, there is a scarcity of empirical evidence that systematically investigates these relationships within Tiruchirappalli District.

Moreover, evolving consumer trends, such as heightened health awareness and a growing inclination towards eco-friendly products, complicate purchasing behaviour. Although Amway is in alignment with these trends, it remains uncertain how significantly these elements affect actual consumer preferences and buying choices in the area. Consequently, the primary issue examined in this research is to identify and evaluate the critical factors that shape consumer preference for Amway products in the Tiruchirappalli District, as well as to comprehend the degree to which these factors influence purchasing behaviour. Tackling this issue is vital for refining marketing strategies, bolstering consumer trust, and broadening the scope of direct selling enterprises in the region.

LOGICAL BACKGROUND OF THE STUDY

The increasing intricacy of contemporary markets necessitates a comprehensive understanding of the fundamental elements that shape consumer preferences, especially within non-traditional distribution frameworks like direct selling. In contrast to standard retail models, direct selling relies on personal interactions, relationship cultivation, and transactions grounded in trust. This unique methodology redirects attention from solely product characteristics to a blend of social influence, perceived trustworthiness, and experiential value. Consequently, consumer preferences in this arena are influenced not only by logical assessments but also by emotional and social considerations. Amway, recognized as a trailblazer in the multi-level marketing (MLM) sector, exemplifies a business model where consumers are directly linked

to distributors who serve as both marketers and influencers. This dual function fosters a distinctive consumption atmosphere where purchasing choices are frequently influenced by personal connections, product demonstrations, and word-of-mouth referrals. The logical basis of this study is to investigate how these elements interact with conventional factors such as product quality, pricing, and brand reputation to shape consumer preferences. In a locale like Tiruchirappalli District, where economic growth, urbanization, and levels of awareness are progressively rising, consumer behaviour showcases a fusion of traditional values and modern consumption trends. Consumers are increasingly health-conscious, quality-focused, and brand-aware, while still being sensitive to pricing and availability. This duality necessitates a logical inquiry into whether consumers prioritize product advantages over costs, and how trust in distributors influences their readiness to purchase Amway products. Moreover, the growing focus on wellness, sustainability, and environmentally friendly products establishes a significant theoretical foundation for this research. Amway's product positioning is in harmony with these emerging trends, indicating that consumer preferences may be shaped by shifts in lifestyle and value-driven consumption. Nevertheless, the existence of skepticism regarding MLM practices introduces a contradictory aspect, necessitating an evaluation of how trust and perception influence consumer choices. Consequently, the theoretical framework of this research is rooted in the amalgamation of consumer behaviour theories, principles of relationship marketing, and socio-economic factors. It aims to create a definitive connection between key influencing elements and consumer preferences within the particular context of direct selling, thus offering a systematic foundation for empirical research in the Tiruchirappalli District.

REVIEW OF LITERATURE

Reddy et al. (2023) examined the impact of word-of-mouth communication and social networks on consumer behaviour within MLM enterprises. Their results demonstrated that endorsements from friends, family, and familiar distributors exert a more significant influence than conventional advertising techniques. This underscores the critical role of social influence in shaping consumer preferences.

Nair and Pillai (2023) investigated consumer perceptions regarding health and wellness products in South India. The research underscored that a growing awareness of health and a preference for natural products have positively affected the demand for brands such as Amway. Consumers expressed a readiness to pay higher prices for products deemed safe and beneficial.

Patel and Singh (2024) analyzed the significance of digital platforms and the integration of e-commerce in direct selling. Their findings indicated that the use of digital tools by distributors improves product accessibility, awareness, and customer engagement. The research highlighted that digital transformation is essential for maintaining competitiveness in the MLM industry.

Fernandes and D'Souza (2024) explored the relationship between price perception and consumer satisfaction in premium product categories. The authors concluded that although elevated prices may initially deter consumers, perceived value and product efficacy can foster long-term loyalty.

Arun and Karthik (2025) carried out a regional analysis in Tamil Nadu, concentrating on consumer attitudes towards MLM practices. Their findings indicated that skepticism and a lack of transparency remain common among potential consumers, impacting brand perception and purchase intentions. Nevertheless, positive experiences shared by current users assist in gradually overcoming these obstacles.

ANALYSIS AND DISCUSSION

The analysis is based on primary data collected from respondents in Tiruchirappalli District. Statistical tools such as percentage analysis and weighted ranking have been used to interpret consumer preferences toward Amway products.

Table 1: Demographic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	56	56%
	Female	44	44%
Age	18-25	28	28%
	26-35	34	34%

Age	36-45	22	22%
	Above 45	16	16%
Income	Below ₹20,000	20	20%
	₹20,001-40,000	38	38%
	₹40,001-60,000	26	26%
	Above ₹60,000	16	16%

Interpretation

The majority of participants are male (56%), with a notable percentage (34%) in the 26-35 age range, indicating that young adults constitute the primary consumer demographic. Most participants are categorized as middle-income earners (₹20,001-40,000), implying that affordability is a crucial factor in their purchasing choices.

Table 2: Awareness of Amway Products

Response	Frequency	Percentage (%)
Yes	82	82%
No	18	18%

Interpretation

A significant awareness level of 82% suggests that Amway enjoys robust brand recognition in the Tiruchirappalli District. Nevertheless, a minor segment of respondents remains unaware, underscoring the necessity for improved promotional strategies.

Table 3: Factors Influencing Consumer Preference (Weighted Ranking)

Factors	Total Score	Rank
Product Quality	450	1
Brand Image	420	2
Trust in Distributor	395	3
Word-of-Mouth Influence	370	4
Price	340	5
Availability	310	6

Interpretation

The quality of a product is the most significant factor, demonstrating that consumers place a high value on effectiveness and reliability. Additionally, the brand’s image and the trustworthiness of distributors are vital, highlighting the importance of credibility in direct selling. Conversely, price and availability are of lesser importance, indicating that although they are relevant, they take a backseat to perceived value.

Table 4: Consumer Satisfaction Level

Satisfaction Level	Frequency	Percentage (%)
Highly Satisfied	36	36%
Satisfied	42	42%
Neutral	12	12%
Dissatisfied	10	10%

Interpretation

A significant portion of respondents (78%) express satisfaction or high satisfaction with Amway products, reflecting a robust level of customer approval. Nevertheless, a minor percentage of dissatisfaction indicates potential areas for enhancement in pricing or accessibility.

Table 5: Challenges Faced by Consumers

Challenges	Frequency	Percentage (%)
High Price	40	40%
Limited Availability	25	25%
Lack of Awareness	20	20%
Trust Issues (MLM Model)	15	15%

Interpretation

High pricing is identified as the major challenge (40%), which may restrict wider adoption. Limited availability and lack of awareness also affect consumer access. Trust issues related to the MLM model, though lower, still influence perception.

LIMITATIONS OF THE STUDY

While the study offers significant insights, it is not without its limitations. Firstly, the research is

limited to the Tiruchirappalli District, which hinders the applicability of the findings to other areas with varying socio-economic contexts. Secondly, the study relies on primary data gathered through a structured questionnaire, and the responses may be subject to personal biases, perceptions, or a lack of awareness among the respondents. Thirdly, although the sample size is sufficient for analysis, it may not accurately reflect the entire population of Amway consumers. Moreover, the study emphasizes specific factors such as product quality, pricing, brand image, and distributor influence, while neglecting other possible variables like cultural influences, psychological aspects, and exposure to digital marketing. Time limitations and restricted access to comprehensive company data further constrained a more in-depth analysis. Finally, the ever-changing nature of consumer behavior implies that preferences may evolve over time, a factor that is not thoroughly addressed in this cross-sectional study.

SUGGESTIONS AND RECOMMENDATIONS

Based on the results of the study, several recommendations can be proposed to improve consumer preference for Amway products: Amway should contemplate implementing more competitive pricing strategies or providing flexible pricing options, discounts, and combo packages to appeal to price-sensitive consumers. Enhancing product accessibility via online platforms, mobile applications, and authorized retail locations can assist in overcoming distribution challenges linked to direct selling. The company ought to concentrate on bolstering awareness campaigns through digital marketing, social media interaction, and localized promotional efforts to engage a broader audience. Organizing product demonstrations, free trials, and educational initiatives can further improve consumer comprehension and trust. Given that distributors play a crucial role in shaping consumer behaviour, it is essential to equip them with enhanced training in communication, product knowledge, and ethical selling techniques. This will aid in fostering stronger relationships with customers and alleviating skepticism associated with MLM models. Amway can also take advantage of the increasing demand for health, wellness, and eco-friendly products by highlighting the

natural ingredients, safety standards, and sustainability features of its offerings. Clear communication regarding product advantages and business practices will further enhance credibility and consumer trust.

CONCLUSION

The preferences of consumers for Amway products in the Tiruchirappalli District are shaped by a mix of product-related, social, and economic factors. This study indicates that the most critical factors influencing consumer choice are product quality, brand reputation, and trust in distributors. The direct selling approach, which is bolstered by personal interactions and word-of-mouth communication, is essential in influencing consumer perceptions and purchasing decisions. However, obstacles such as elevated pricing, restricted accessibility, and doubts regarding MLM practices persistently hinder the growth of the consumer base. Tackling these challenges through strategic measures can greatly improve market penetration and enhance customer satisfaction. In summary, the research underscores the necessity of aligning product value with consumer expectations while enhancing relationship marketing and distribution effectiveness. By prioritizing quality, transparency, and customer engagement, Amway can further strengthen its market position. The insights gained from this study not only enhance the understanding of consumer behavior within the direct selling sector but also offer practical recommendations for refining marketing strategies in semi-urban areas like the Tiruchirappalli District.

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Deepfake & Identity Fraud Detector

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ABSTRACT

The rapid development of the deepfake making technologies and identity changing apps has caused serious concerns regarding the online security, biometric authentication, and credibility. The current deep-learning methods enable easy creation of fake media, which makes the traditional rule-based and manual testing techniques insufficient to detect altered face features. The DF and identity fraud detection system based on deep CNN is created to effectively differentiate between the fake and natural facial images. The data set will include real and manipulated face images obtained in publicly available DF repositories created in 2018-2023 and with different facial expressions, light conditions, and modes of manipulation. The process of data preprocessing includes image scaling, image normalization, image augmentation, dataset balance to enhance generalization and reduce overfitting. There are four improved architectures- MobileNetV2, InceptionV3, DenseNet201 and Xception which are trained in a gpu-accelerated setup to promote features extraction and classification. Measurement of performance is done in terms of accuracy, precision, recall, F1-score, confusion matrix and classification report. Experimental evaluation indicates that the Xception architecture achieves the best performance with the accuracy, precision, recall, and F1-score of 98.0, 98.0, 98.0 and 98.0 respectively. The presented solution improves the reliability of detection and enables rapid real-time execution of detecting identity fraud instigated by DF.

KEYWORDS: *Deepfake detection, Identity fraud detection, Convolutional neural networks, Xception architecture, Face forgery detection, Real-time image classification, Flask deployment, Digital forensics.*

INTRODUCTION

The rapid advancement of artificial intelligence and generative models of the process has radically changed the production, editing, and sharing of digital content on modern web platforms. Yet, there has been a new opportunity in the entertainment, digital communication, and multimedia production presented by technologies that generate reasonably realistic synthetic images and movies. However, there have also been new security issues with these technologies in the production of distorted visual content. The DF technology has gotten to great attention due to the ability to produce convincingly altered facial media that is highly similar to natural human expressions and movement. The threats to digital authenticity and

information reliability have increased in number in most industries due to the improvement of quality and availability of synthetic media in the banking sector, government, and social communication among others [1]. So, the preservation of the integrity and authenticity of visual data has become one of the primary demands in modern digital ecosystems [2].

Despite the development of various methods of checking the authenticity of various media, it remains a critical challenge to detect more complex changes in the face. Traditional security and forensic practices often rely on a manual analysis, a rule-based analysis, or a restricted extraction feature, which are ineffective in locating subtle differences in visual features of highly realistic synthetic content. Modern technologies of

generation have been able to produce entities that are hard to recognize using conventional means, hence compromising the existing verification systems. Besides, the increased availability of DF creation tools has made syntax media creation accessible to a more significant number of people, increasing the risk of being used in malicious activities. These developments highlight an acute shortcoming of current digital security solutions and the need to include reliable and scalable detection algorithms in identifying distorted visual messages in the real-life contexts [3][4].

The point is that it should develop an automated detection mechanism that can distinguish between authentic facial content and manipulated media in the complex digital environment. The proposed approach focuses on analysis of visual patterns and structural inconsistencies that might be present in the course of synthesis and adjustment. The technology aims to increase the trustworthiness of the identity-verifying tools used in online platforms based on data learning and massive visual processing. The model is meant to support automated analysis and consistency of performance when using different types of modified content, therefore, increasing the competence of existing digital verification systems [5][6][7].

The development of efficient systems to detect DF has significant implications on the maintenance of digital trust and protection of personal identity. Effective detection algorithms can be used to strengthen crucial applications like biometric authentication, web-based identity verification, distance assessment, and online on boarding processes. The increased reliability of the visual authentication systems will help mitigate the risks of disinformation, impersonation and unauthorized access as well. With the spread of digital interactions across the globe, the ability to distinguish accurately between authentic media and manipulated content is getting even more crucial to maintaining secure digital space and protecting the confidence of people in visual data [8][9][10].

LITERATURE REVIEW

The recent advances in artificial intelligence have significantly increased the effectiveness of identity fraud detection and DF analysis systems. Murthy

[11] introduced an AI-based system of identity theft detection that gives more priority to anomaly detection when making data input because explainable artificial intelligence is significant in increasing transparency in decision-making. The presented approach increased the accuracy of detection of abnormal patterns of identity-related data, and the use of interpretable models in security architectures is necessary. The paper is mostly concerned with the anomalies of data and not the manipulation of visual media. The legal implications of DF technology considered by Mansoor [12] were the solution of privacy violations, identity theft, and regulatory challenges. This paper provides valuable information regarding the social and legal concerns that are related to the use of DF, but it does not mention the technological methods of detection that can be used to identify DF in an automated manner.

Several studies have focused on the development of defensive models to address the problem of synthetic media-driven fraud. Nagamani [13] introduced a multi-layered artificial intelligence defense scheme that aims at combating phishing and DF-related financial fraud in digital environments, in real-time. The framework highlighted the possibility of stratified detection strategy to enhance the fraud prevention systems. Woolham [14] examined how DF technology has affected authentication standards in financial systems by noting the danger of more and more realistic synthetic media that threatens the traditional authentication procedures. Although these studies highlight the seriousness of the fraud caused by DF, they mostly focus on theoretical models and effects on the industry instead of detailed visual forensic processes.

Future studies have been based on artificial intelligence in detecting altered media and synthetic identity fraud. Chitraju [15] has studied the possibility of using artificial intelligence to detect fake identities and enhance the effectiveness of digital fraud detection. Even though there is little empirical research related to visual DFs, the study highlights the potential benefits of using ML strategies to improve identity verification systems. In order to distinguish real material and altered media, Farooq et al. [16] have come up with the broad DF detector model utilizing such variables as identification, behavioral, and geometrical. The study revealed that

many feature representations may be stacked to provide detection effectiveness; however, the intricacy of incorporating dissimilar signatures may be expensive to calculate real-time signage.

Further studies have encompassed the extensive measures of mitigation of risks presented by synthetic identities. In a comprehensive study of deepfake detection methods, Uppal et al. [17] investigated various ways of fighting synthetic identity attacks. Their results showed that scalable detectors, which can resist numerous manipulation methods, are needed. In a study conducted by Hosur et al. [18], it was observed that artificial intelligence could be applied to develop fraud prevention in government subsidies, which is a type of fraud, through the integration of DF detection and audio forensics with blockchain security systems. This strategy will enhance the reliability of the system as a whole; however, the various technologies to be used will increase the cost incurred in implementing and complicate the system.

More current research has focused on the broader security implications of DF technology within systematized fraud. Lin [19] reviewed the application of synthetic media to organized fraud and highlighted the management concerns involved in the management of new manipulation technologies. Similarly, Shetye et al. [20] explored the application of DF in financial fraud considering its generation, detection, and mitigation. Although the studies provide valuable data on the transformation of the threat environment, most of them focus on theoretical examination or require complex multi-modal systems, which may be hard to adopt.

The present paper highlights the increasing risks of identity fraud through the use of DFs and the need to develop effective detection methods. Despite the high levels of detecting accuracy, computing efficiency, and real-time running efficiency, though, they are still hard to accomplish. To address such gaps, this research paper creates an effective DL-based detection model capable of identifying altered content of faces and is likely to be useful in the real-world of digital environments.

METHODOLOGY

Through automated facial analysis, the proposed system offers a thorough deep learning framework for

identifying deepfake photos and stopping identity fraud. The dataset includes both real and altered facial images that were gathered from publicly accessible deepfake repositories between 2018 and 2023, guaranteeing a variety of facial expressions, lighting, resolutions, and manipulation methods. To ensure objective performance evaluation, the dataset is split into subsets for training (70%), validation (15%), and testing (15%).

All images are normalized to a [0,1] range and resized to 224x224 pixels during preprocessing. To enhance generalization and lessen overfitting, data augmentation methods like horizontal flipping, rotation ($\pm 15^\circ$), zooming (0.2), and brightness adjustment are used. Weighted loss functions are used to address class imbalance.

Transfer learning with ImageNet pre-trained weights is used to implement four CNN architectures: MobileNetV2, InceptionV3, DenseNet201, and Xception. Sigmoid activation is used in a binary classification function head to refine the final layers. The Adam optimizer (learning rate = 0.0001), batch size of 32, and 25 epochs are used for training. To avoid overfitting, early stopping and model checkpointing are used.

TensorFlow/Keras is used to implement the system in Python, and it is trained on a GPU-enabled environment. Accuracy, precision, recall, F1-score, confusion matrix, and classification report are examples of evaluation metrics. To examine model convergence, loss/accuracy curves for training and validation are also plotted. A Flask-based web application for real-time image and live camera detection is used to implement the top-performing model.

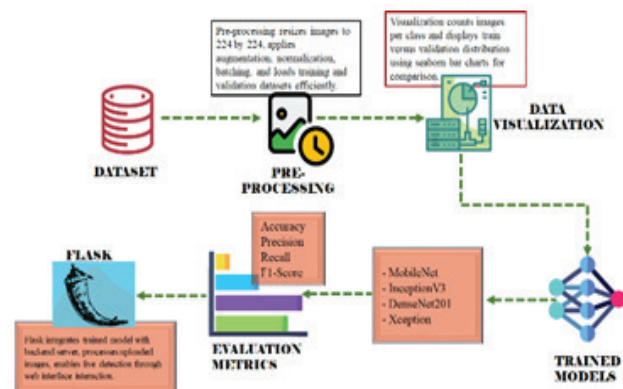


Fig. 1 Proposed Architecture

The entire system architecture of the DF and identity fraud detection is presented in figure 1. The procedure begins with a set of the real and distorted facial photos. The pre-processing stage consists of shrinking, processing, and normalizing photos to 224×224 with an objective of offering standard input presentation. Data visualization is carried out to look into the distribution of classes by use of bar graphs. The processed data is used in order to train different DL models, including MobileNet, InceptionV3, DenseNet201, and Xception. The model is evaluated based on the accuracy, precision, recall, and F1-score with the best model being deployed as a Flask-based web interface to allow real-time detection.

Dataset Collection

DFs identity fraud detection dataset requires the use of facial photographs, which are either actual or fake, which are also publicly available in DF repositories. The Real class is that of real-life photos of faces in different lighting, expressions, and backgrounds, whereas the Fake class is that of simulated images created with face-swapping and DF syntheses. The data is organized in a more organized directory fashion, making it easier to label it automatically and perform binary classification with supervision. Images provide a realistic visual diversity with variations in resolution, positioning of faces and lighting. This heterogeneity enhances the resilience of the models and enables greater generalization of prediction of altered facial content in a wide range of real-life situations.

Pre-Processing

Picture dataset is pre-processed to normalize and prepare the data set to be used in reliable ML in the context of DF and identity fraud detection. Images of faces obtained through different sources often vary in their resolution, direction of light, and the face position effecting a decrease in the learning effectiveness. To eliminate this, all images are reduced to a uniform size of 224 224 pixels to ensure that there is consistent input representation across the dataset. The concept of data augmentation is to add horizontally flipped versions of photographs and therefore increase diversity and the capacity of generalization. The images are then converted to numerical forms of tensors that can be processed by DL models with normalization to provide

a homogenous distribution of pixel values. This process stabilizes the training behaviour, improves convergence when optimizing as well as enables efficient mini-batch learning through organized training and validation data loaders.

Visualization

To analyse the data set populace and ensure fair representation of all the classes employed in the identification of DF, the visualization is also conducted. The data is categorized into two: Real and Fake. Each category is processed separately on the train and validation subsets in terms of the amount of images in the category. The potential cause of the imbalance in classes is revealed through this research and could make the model biased on the side of the dominating class and decrease the reliability of detection. The samples grouped in each category are represented through a bar chart which compares the partitions of the data clearly. The representation is such that the data is split in a fair and appropriate way as well as it makes the process of data preparation easier to comprehend. This step will help in the development of a stronger and objective detection system and make informed decisions before training.

Algorithms

MobileNetV2: MobileNetV2 is a high-performing CNN that is optimized to classify pictures under a resource-constrained environment. The architecture applies the use of inverted residual architecture and depth wise separable convolution to reduce the complexity of the computing power without compromising the strong feature extraction capabilities of uncovering subtle visual patterns.

InceptionV3: InceptionV3 uses parallel CNN to obtain spatial information on pictures on multiple scales. Factorized convolutions and normalizations leads to increased stability and efficiency of training which enables the model to learn more complex hierarchical representations and better classification performance to many diverse visual patterns.

DenseNet201: DenseNet201 uses dense connectivity whereby every layer is fed with information in all preceding layers leading to effective reuse of features and better gradient flow. This framework enhances the

representation learning and enhances the strength with capturing instance complex visual features in deep network layers.

Xception: Xception as a deep CNN employs depth wise separable convolution and residual links to make features learning more efficient. The network isolates the spatial and channel-wise processing to identify fine details of image mismatch, which enable accurate and reliable visual segregations.

EXPERIMENTAL RESULTS

Accuracy: Accuracy of a test is described as the ability of a test to capture the correct cases of patients and healthy cases. In order to determine the accuracy of a test, it is important to take the ratio of the true positives and true negatives in all the cases that were evaluated. This may be mathematically stated as:

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \tag{1}$$

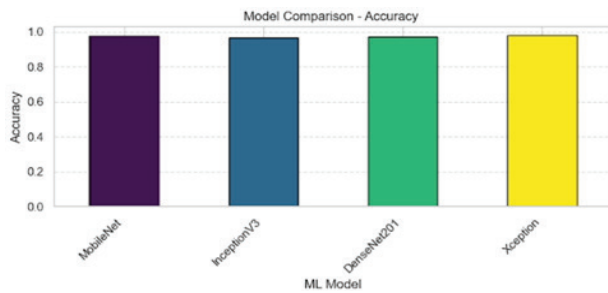


Fig. 2: Accuracy Comparison Graph

Precision: Precision determines the percentage of correctly defined cases of those that are identified as positive. As a result, the precision formula is represented as;

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive} \tag{2}$$

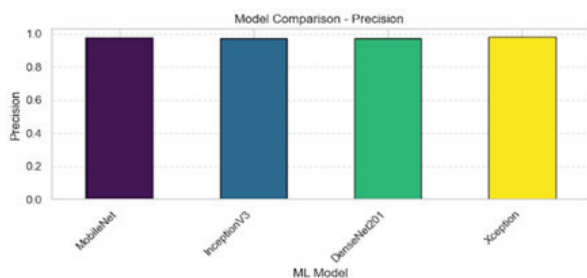


Fig. 3 Precision Comparison Graph

Recall: Recall is a ML measure that evaluated the ability of a model to identify all the relevant examples of a given class. It provides information concerning the effectiveness of a model in detecting instances of a particular class by giving it the proportion of the total number of correctly predicted positive observations to the actual amount of positive observations.

$$Recall = \frac{TP}{TP + FN} \tag{3}$$

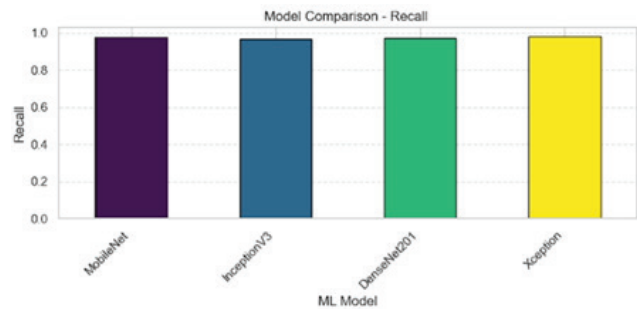


Fig.4 Recall Comparison Graph

F1-Score: The F1 score is a statistic to measure the precision of a ML model. It is a combination of recall and precision of a model. The accuracy measure is used to measure the number of correct predictions that a model makes in a given dataset.

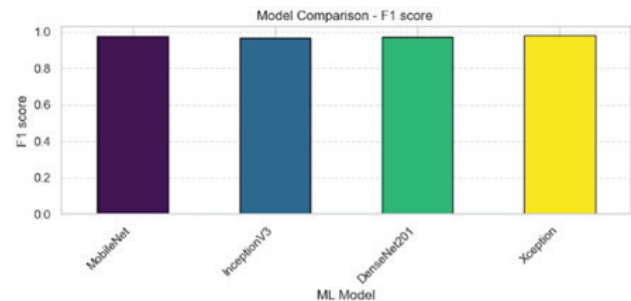


Fig. 5 F1-Score Comparison Graph

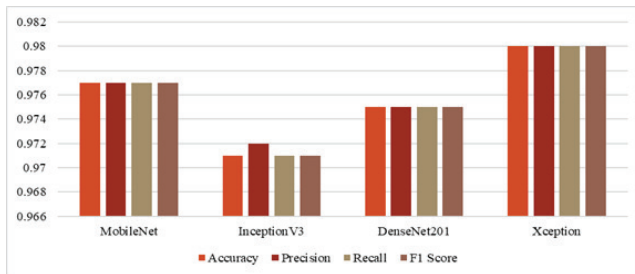
$$F1\ Score = 2 * \frac{Recall * Precision}{Recall + Precision} * 100 \tag{4}$$

Table. 1 Performance Evaluation Table”

ML Model	Accuracy	Precision	Recall	F1 Score
MobileNet	0.977	0.977	0.977	0.977
InceptionV3	0.971	0.972	0.971	0.971
DenseNet201	0.975	0.975	0.975	0.975

Xception	0.980	0.980	0.980	0.980
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The performance of four DL models is outlined in Table 1. Xception achieved maximum accuracy of 0.980, and MobileNet, DenseNet201 and InceptionV3 had strong classification capabilities in terms of precision, recall, and F1-score values.



“Graph.1 Comparison Graph”

Figure 6 shows the relative effectiveness of 4 DL architectures. Xception has the best metrics in accuracy, precision, recall and F1-score, followed by MobileNet and DenseNet201 although InceptionV3 has slightly lower results.

Upload Image for Detection

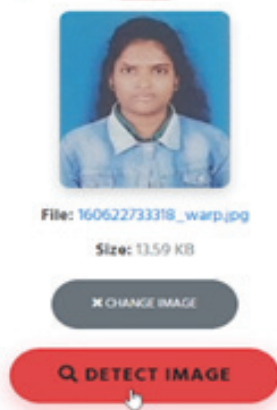


Fig. 7 Upload an Image

Figure 7 shows the web interface that is used to identify images using DF. The image is uploaded, previewed and then the analysis commences using the detection button enabling users to quickly verify image authenticity.

Figure 8 shows the outcome of detection that is generated by the system. The facial image that has been submitted is classified as Fake with a confidence score of 99.6, which shows that the model is very confident in the detection of altered content.

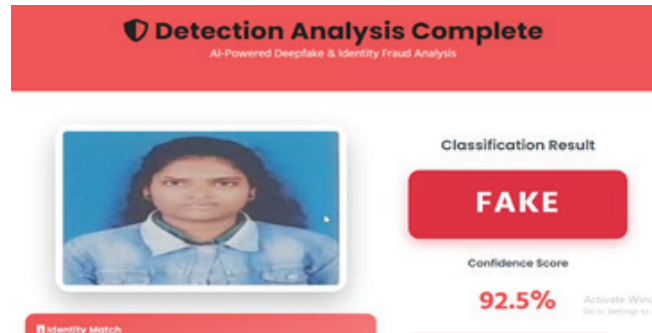


Fig. 8 Predicted Result

Upload Image for Detection

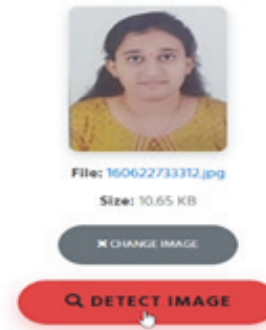


Fig. 9 Upload an Image

Figure 9 shows the interface of the DF detector system upload image, where a user puts a face picture, provides file data and starts the detection procedure by clicking the Detect Image button.

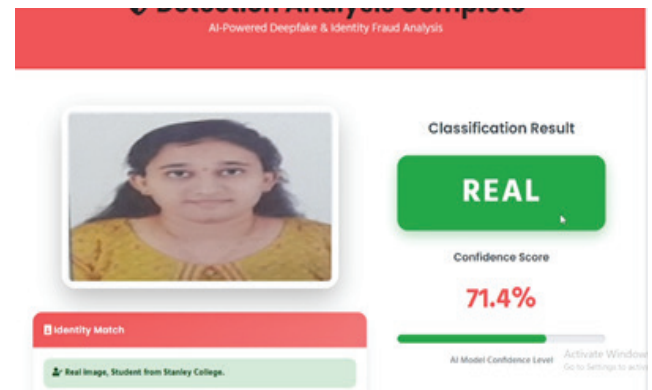


Fig. 10 Predicted Result

Figure 10 shows the output of the DF detection system where a given facial image is classified as REAL with the confidence score being 74.6, which proves the authenticity of the image with the help of the AI-based identity verification model.

CONCLUSION

This research offers a powerful and scalable deep learning-based solution for detecting deepfake images and preventing identity fraud in the digital world. This solution makes use of various CNN models and tests them using comprehensive experimental metrics such as the confusion matrix, classification reports, and training curves.

Among the tested models, the Xception model performs the best with 98.0% accuracy and precision, recall, and F1-score. This is because the Xception model is powerful in detecting slight inconsistencies in images of faces that have been manipulated in some way. In addition, the detailed preprocessing and training strategies improve the overall performance of the models.

The applicability of the trained model through a Flask-based web application allows for real-time detection through image upload and video feed. It is a practical solution that can be applied in various scenarios, including biometric authentication and identity verification.

The limitations of this model are that it is not robust enough to detect extremely advanced GAN-based deepfakes and is dependent on datasets. However, future improvements will be made by using transformer-based models and considering multimodal input sources like videos and audio.

The proposed system is a reliable solution that can be implemented to improve digital security and protect against risks of identity theft using deepfake technology.

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An Analysis of Consumer Awareness and Preference for Eco-Friendly Products in Pudukkottai District

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ABSTRACT

As environmental concerns rise and the demand for responsible consumption increases, sustainable products have become more significant to consumers. This research investigates consumer awareness and preferences regarding sustainable products in the Pudukkottai district. The objective of this study is to evaluate the level of awareness, the factors that influence purchasing decisions, and the degree to which consumers favor eco-friendly alternatives over traditional products. The research relies on primary data gathered through structured questionnaires distributed to consumers across various regions of the Pudukkottai district. Additionally, secondary data from journals, reports, and online resources support the analysis. Descriptive statistics and basic analytical tools are employed to interpret the data. The findings suggest that while a substantial number of consumers are aware of sustainable products, their comprehension of environmental benefits differs. Factors such as price, quality, availability, and brand reputation significantly affect consumer preferences. The results further indicate that although consumers exhibit a favourable attitude towards sustainable products, their actual purchasing behaviour is often constrained by higher prices and limited accessibility. Awareness campaigns and government initiatives are essential in influencing consumer behaviour and promoting eco-friendly choices. The study posits that enhancing awareness, improving affordability, and increasing product availability can greatly enhance the adoption of sustainable products. It also recommends that marketers and policymakers concentrate on education, promotion, and incentives to reinforce sustainable consumption patterns within the district.

KEYWORDS: *Consumer awareness, Sustainable products, Eco-friendly products, Consumer preference, Green marketing.*

INTRODUCTION

In recent decades, concerns regarding the environment have surfaced as one of the most pressing global challenges, affecting not only governments and industries but also the behavior of individual consumers. The rapid pace of industrialization, urbanization,

and population growth has greatly contributed to environmental degradation, which encompasses pollution, climate change, resource depletion, and the loss of biodiversity. These issues have fostered an increasing awareness of the necessity for sustainable development, which focuses on fulfilling current needs without jeopardizing the capacity of future generations

to satisfy their own. In this framework, sustainable products have become progressively significant in the marketplace. Sustainable products, commonly known as eco-friendly or green products, are specifically designed to reduce adverse environmental effects throughout their entire lifecycle. This encompasses the sourcing of raw materials, production methods, packaging, distribution, usage, and disposal. Typically, such products are crafted from renewable resources, require less energy to produce, generate minimal waste, and are either recyclable or biodegradable. Examples include organic food items, reusable bags, energy-efficient appliances, biodegradable packaging materials, and products manufactured from recycled materials. The increasing availability of these products signifies a transition towards more environmentally responsible production and consumption practices. Consumer awareness is essential for the success of sustainable products. Awareness denotes the extent of knowledge and comprehension that consumers have regarding environmental issues and the advantages of utilizing eco-friendly products. Consumers who are well-informed are more inclined to make responsible purchasing choices that aid in environmental conservation. Nevertheless, awareness by itself does not always lead to actual purchasing behavior. A gap frequently exists between consumers' knowledge and their actions, commonly known as the 'attitude-behavior gap.' This discrepancy can be attributed to various factors, including the higher costs of sustainable products, limited availability, insufficient product information, and entrenched consumption habits. In contrast, consumer preference indicates the selections individuals make when choosing products from a range of alternatives. Preferences are influenced by numerous factors, such as personal values, cultural influences, income levels, education, social norms, and marketing tactics. Regarding sustainable products, consumers may favor eco-friendly options due to environmental concerns, health awareness, or ethical considerations. However, practical factors such as affordability, product quality, convenience, and brand trust often significantly influence final purchasing decisions. Green marketing has become a significant strategy utilized by companies to promote sustainable products. This approach encompasses the creation and promotion of products that

are safe for the environment, alongside the application of marketing techniques that emphasize their ecological advantages. Companies are increasingly implementing eco-labels, certifications, and environmentally responsible packaging to appeal to consumers who are environmentally aware. Nevertheless, the success of green marketing is heavily reliant on consumer trust and awareness. Deceptive claims, commonly known as "greenwashing," can adversely affect consumer confidence and impede the expansion of the sustainable products market.

In India, the notion of sustainability has gained traction in recent years, propelled by heightened environmental awareness, government initiatives, and evolving consumer lifestyles. Initiatives that advocate for renewable energy, waste management, and the reduction of plastic have fostered a greater focus on sustainable practices. Consumers, particularly in urban regions, are progressively becoming more aware of the environmental consequences of their choices. However, the degree of awareness and adoption varies considerably across different regions, especially between urban and rural areas. Pudukkottai district, situated in Tamil Nadu, offers a distinctive setting for examining consumer awareness and preferences regarding sustainable products. The district encompasses a blend of urban, semi-urban, and rural populations, each characterized by unique socio-economic traits. Urban consumers may enjoy greater access to information and sustainable products, whereas rural consumers might depend more on traditional and naturally sustainable practices, even if they do not explicitly recognize them as such. Grasping these differences is crucial for formulating effective strategies to encourage sustainable consumption in the area. The significance of this study lies in its effort to address the knowledge gap concerning consumer behavior towards sustainable products at the district level. Although many studies have been carried out in metropolitan areas, there is a relative scarcity of research focusing on smaller districts like Pudukkottai. Investigating consumer awareness and preferences in these regions can yield valuable insights into the challenges and opportunities for enhancing the market for sustainable products. This study aims to assess the level of awareness among consumers in Pudukkottai district regarding sustainable products and to analyze

their preferences and purchasing behaviors. It seeks to identify the factors that influence consumer decisions, including price sensitivity, product availability, quality perception, and environmental concerns. Furthermore, the study examines the impact of demographic variables such as age, education, income, and occupation on shaping consumer attitudes and behaviors.

Comprehending mainly consumer awareness and preferences is crucial for various stakeholders. For policymakers, it aids in crafting effective awareness initiatives and enacting supportive policies that promote sustainable consumption. For businesses, it offers valuable insights into consumer expectations and assists in creating products and marketing strategies that resonate with environmental values. For researchers, it enhances the existing knowledge base regarding consumer behavior and sustainability. Despite the increasing interest in sustainable products, numerous challenges impede their widespread adoption. A significant challenge is the perception that eco-friendly products come with a higher price tag. Many consumers perceive sustainable products as more costly than traditional alternatives, which deters purchases, particularly among price-sensitive demographics. Additionally, the limited availability of these products in local markets, especially in rural and semi-urban regions, poses another challenge. Furthermore, the lack of clear information and understanding regarding the advantages of sustainable products further limits their acceptance.

On the positive side, increasing environmental education and media exposure have started influencing consumer attitudes. Social media platforms, awareness campaigns, and educational institutions play a vital role in spreading information about sustainability and encouraging responsible consumption. Younger consumers, in particular, are more likely to adopt eco-friendly practices due to greater exposure to global environmental issues and trends. Furthermore, traditional practices in regions like Pudukkottai often align with sustainability principles. The use of reusable materials, minimal waste generation, and reliance on natural resources are inherent in many rural lifestyles. Recognizing and integrating these practices with modern sustainable products can create a more effective approach to promoting eco-friendly consumption.

The study of consumer awareness and preference for sustainable products in Pudukkottai district is both relevant and timely. As environmental challenges continue to intensify, the role of consumers in driving sustainable change becomes increasingly important. By understanding their awareness levels, preferences, and the factors influencing their decisions, it is possible to develop strategies that encourage the adoption of sustainable products. This, in turn, contributes to environmental conservation, economic development, and the overall well-being of society.

STATEMENT OF THE PROBLEM

The degradation of the environment and the impacts of climate change have emerged as significant global issues, necessitating an immediate shift towards sustainable consumption practices. In response to this challenge, eco-friendly and sustainable products have been introduced into the marketplace as alternatives to traditional goods. These products aim to minimize environmental harm and encourage responsible resource utilization. Nevertheless, despite their increasing presence, the uptake of sustainable products by consumers is inconsistent, especially in semi-urban and rural areas. In the Pudukkottai district, consumers represent a wide array of socio-economic backgrounds, each with differing levels of education, income, and access to information. While some individuals may possess awareness of environmental challenges and the advantages of sustainable products, others may not have sufficient knowledge or exposure. Even among those who are informed, there frequently exists a disconnect between awareness and actual purchasing behavior. Consumers might demonstrate favorable attitudes towards eco-friendly products, yet may refrain from choosing or buying them due to reasons such as higher prices, limited availability, skepticism regarding product claims, and inadequate promotional initiatives. Furthermore, local markets within the district may not reliably offer a diverse selection of sustainable products, complicating the decision-making process for consumers seeking eco-friendly options. Established consumption patterns and sensitivity to pricing further affect purchasing choices, often leading to a preference for conventional products over sustainable alternatives. Additionally, the success of green marketing and awareness campaigns in shaping consumer behavior at

the district level remains ambiguous. Consequently, the primary issue explored in this research is to comprehend the extent of consumer awareness and inclination towards sustainable products in the Pudukkottai district, as well as to pinpoint the essential factors that affect their buying choices. This study aims to investigate if awareness leads to genuine preference and consumption, while also emphasizing the obstacles that hinder the acceptance of sustainable products among consumers in the district.

LOGICAL BACKGROUND OF THE STUDY

This study is grounded in the increasing significance of sustainability, driven by escalating environmental challenges such as pollution, climate change, and the depletion of resources. Sustainable products have surfaced as a viable alternative to mitigate environmental impact and encourage responsible consumption. The logical basis of this research is rooted in the interplay between consumer awareness, attitudes, and purchasing behaviors. It is widely accepted that a greater awareness of environmental issues fosters a favorable attitude towards eco-friendly products, subsequently shaping consumer preferences.

Nevertheless, a disconnect often arises between awareness and actual purchasing behavior, influenced by factors such as high costs, limited availability, and skepticism regarding product claims. Theories of consumer behavior indicate that personal, social, and economic elements also play a role in purchasing decisions. In the context of the Pudukkottai district, the varying degrees of awareness and accessibility underscore the necessity to examine how these factors impact consumer preferences for sustainable products and their real-world adoption.

REVIEW OF LITERATURE

Philip Kotler and Armstrong (2018) highlighted that consumer purchasing behavior is shaped by cultural, social, personal, and psychological influences. Their research underscores that mere awareness is inadequate; the attitudes and perceptions of consumers significantly impact their preferences. In relation to green products, this implies that even consumers who are environmentally conscious may not consistently convert their knowledge into actual purchases.

A study conducted by Jacquelyn A. Ottman (2011) centered on green marketing and discovered that consumers are becoming increasingly aware of environmental concerns. Nevertheless, the research indicated that a lack of trust in environmental claims and confusion regarding product labels can deter consumers from purchasing sustainable products. This underscores the necessity for clear communication and transparency in the promotion of eco-friendly goods.

Research by John Thøgersen (2010) investigated the attitude-behavior gap in sustainable consumption. The results indicated that while consumers frequently express favorable attitudes towards environmentally friendly products, their actual purchasing choices are swayed by practical considerations such as price, convenience, and availability. This gap is particularly pronounced in developing regions where affordability is a significant factor.

In the context of India, a study by R. K. Srivastava (2012) examined consumer behavior towards green products and found that environmental awareness is on the rise among Indian consumers. However, the research pointed out that price sensitivity and the limited availability of eco-friendly products serve as major obstacles to their adoption. This emphasizes the need for competitive pricing and broader distribution of sustainable products.

ANALYSIS AND DISCUSSION

This study collected primary data through 150 structured questionnaires from consumers across urban, semi-urban, and rural areas of Pudukkottai district. The analysis focuses on consumer awareness, attitudes, and preference towards sustainable products.

Table 1. Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	80	53.3
	Female	70	46.7
Age (Years)	18–25	40	26.7
	26–35	50	33.3
	36–50	45	30
	51+	15	10

Education	School	35	23.3
	Graduate	80	53.3
	Postgraduate	35	23.3
Income (Monthly)	<₹15,000	45	30
	₹15,001–30,000	65	43.3
	>₹30,000	40	26.7

Discussion

The predominant demographic of respondents consists of males, accounting for 53.3%, and primarily belongs to the 26–35 age category, which represents 33.3%. A significant portion of the respondents are graduates, making up 53.3%, while the most substantial income bracket is ₹15,001–30,000 per month, comprising 43.3%. This demographic is characteristic of consumers who are likely to have knowledge of sustainable products.

Table 2. Awareness of Sustainable Products

Question	Yes	No	Not Sure
Are you aware of sustainable/eco-friendly products?	105	30	15
Do you know the environmental benefits of such products?	90	45	15

Discussion

Seventy percent of respondents are familiar with sustainable products; however, only sixty percent comprehend their environmental advantages. This suggests that although awareness is substantial, in-depth understanding is relatively limited.

Respondents were asked to rank factors that influence their preference for sustainable products.

Table 3. Factors Influencing Preference for Sustainable Products

Factor	Very Important	Important	Not Important	Total % Very Important + Important
Price	45	60	45	70%

Quality	60	70	20	86.7%
Availability	50	55	45	70%
Brand Trust	55	65	30	80%
Environmental Concern	40	65	45	70%

Discussion

Quality (86.7%) and brand trust (80%) are the primary factors influencing consumer preference. Additionally, price, availability, and environmental concerns also have considerable impact, suggesting that even consumers who are environmentally aware prioritize practical factors significantly before making a purchase.

Table 4. Frequency of Purchasing Sustainable Products

Frequency	Number of Respondents	Percentage (%)
Always	20	13.3
Often	50	33.3
Sometimes	60	40
Rarely	15	10
Never	5	3.3

Discussion

A majority of consumers (73.3%) occasionally or frequently buy sustainable products. However, only 13.3% make these purchases on a regular basis, indicating a disparity between awareness and habitual buying practices.

Respondents were asked to rate their agreement with the statement: “I prefer eco-friendly products over conventional products.”

Table 5. Attitude towards Sustainable Products

Response	Frequency	Percentage (%)
Strongly Agree	25	16.7
Agree	60	40
Neutral	40	26.7
Disagree	20	13.3
Strongly Disagree	5	3.3

Discussion

56.7% of participants concur or strongly concur that they favor sustainable products, indicating an overall favorable disposition. Nevertheless, data on actual purchasing frequency implies that this positive disposition does not consistently result in corresponding actions.

Respondents identified the main barriers to purchasing sustainable products.

Table 6. Challenges in Buying Sustainable Products

Barrier	Frequency	Percentage (%)
High Price	75	50
Limited Availability	50	33.3
Lack of Awareness	20	13.3
Doubtful Environmental Claims	5	3.3

Discussion

The primary obstacle is price, accounting for 50%, followed by limited availability at 33.3%. This finding is consistent with earlier research that emphasizes economic and accessibility limitations as significant factors contributing to the attitude-behavior gap.

SUGGESTIONS

1. Enhance Awareness Initiatives: Organize workshops, seminars, and community events to inform consumers about the ecological advantages of sustainable products. Utilize social media, local publications, and educational institutions to engage various age demographics.
2. Foster Environmental Education: Incorporate sustainability themes into the curricula of schools and colleges to cultivate responsible consumption behaviors from an early age.
3. Utilize Traditional Practices: Emphasize and incorporate local environmentally friendly customs, such as the use of reusable materials or organic products, into contemporary sustainable product marketing campaigns.

4. Implement Behavioral Nudges: Position sustainable products in prominent areas within stores, adopt bundling techniques, and offer incentives for repeat purchases to promote ongoing eco-conscious decisions.

RECOMMENDATIONS

1. Price Incentives: Implement subsidies, tax breaks, or discount programs to enhance the affordability of sustainable products for consumers who are sensitive to price.
2. Improve Availability: Guarantee that eco-friendly products are accessible in both urban and rural settings through the expansion of retail, e-commerce, and local collaborations.
3. Transparent Marketing: Advocate for trustworthy eco-labels, certifications, and precise product information to alleviate consumer doubts and foster trust.
4. Targeted Campaigns: Create initiatives tailored to specific demographics such as students, working professionals, and rural households to optimize reach and effectiveness.
5. Community Engagement: Motivate local leaders, NGOs, and community organizations to actively endorse green consumption practices.
6. Long-term Monitoring: Regularly evaluate the success of campaigns and policies to modify strategies in response to consumer feedback and market developments.

LIMITATIONS

1. Geographic Scope: This research is confined to the Pudukkottai district, which means that the results may not be applicable to other areas that possess varying socio-economic and cultural contexts.
2. Self-reported Data: The responses collected may be subject to social desirability bias, which could cause participants to exaggerate their level of awareness or their positive attitudes.
3. Sample Size: With a total of 150 respondents, the sample may not adequately reflect the full diversity of the district’s population.
4. Cross-sectional Nature: The study offers a temporal

snapshot; however, evolving market conditions or seasonal influences may affect behaviors in different ways over time.

5. **Producer and Retailer Influence:** The focus of this study is primarily on consumers, and it does not thoroughly examine the impact of manufacturers or distributors in the promotion of sustainable products.

CONCLUSION

The current research on consumer awareness and preferences regarding sustainable products in the Pudukkottai district offers significant insights into the developing trend of eco-friendly consumption within semi-urban and rural areas. The findings of the study reveal that consumer awareness of sustainable products is notably high, with around 70% of participants indicating familiarity with eco-friendly alternatives. Nevertheless, the understanding of the environmental advantages associated with these products is relatively limited, implying that while consumers acknowledge the notion of sustainability, comprehensive knowledge is not yet prevalent. This underscores the necessity for ongoing education and focused awareness initiatives to close the knowledge gap and emphasize the significance of sustainable consumption practices. Additionally, the research underscores a generally favorable attitude among consumers towards sustainable products, with over half of the respondents indicating a preference for eco-friendly options over traditional products. However, actual purchasing behaviors do not completely reflect these attitudes, highlighting a distinct attitude-behavior gap. A mere fraction of consumers consistently purchase sustainable products, while the majority tend to buy them sporadically or rarely. This discrepancy can be linked to practical challenges such as elevated prices, limited availability of products, and doubts regarding the credibility of environmental claims. Factors such as quality, brand trust, and affordability were identified as the most significant influences on consumer preference, indicating that environmental concern alone is insufficient to motivate regular eco-friendly purchases. Demographic factors, such as age, education, and income, significantly influence consumer behavior. Consumers who are younger, more educated, and possess higher incomes tend to be more conscious

of sustainable products and exhibit a greater preference for them. This observation highlights the necessity for strategies tailored to specific demographics in the promotion of eco-friendly consumption. Moreover, traditional practices found in Pudukkottai, including the utilization of reusable materials and locally sourced products, naturally align with the principles of sustainability. By leveraging these cultural practices, the acceptance of modern sustainable products can be enhanced, fostering a sense of continuity between traditional habits and contemporary eco-friendly consumption. The study further underscores the significance of effective marketing and policy interventions. Clear communication, trustworthy eco-labeling, and certifications can bolster consumer trust, while government incentives and subsidies can alleviate cost barriers, making sustainable products more accessible. It is crucial to expand availability in local markets and through e-commerce platforms to ensure that interested consumers can conveniently purchase eco-friendly products. Initiatives for community engagement, spearheaded by local leaders, NGOs, and educational institutions, can reinforce social norms that prioritize sustainability, thereby creating a supportive environment for eco-friendly consumption. In summary, although there is a hopeful level of consumer awareness and favorable attitudes towards sustainable products in the Pudukkottai district, the actual uptake is still constrained by economic, social, and practical obstacles. Tackling these issues necessitates a comprehensive strategy that includes education, marketing, policy support, and community involvement. By executing focused strategies that alleviate price barriers, enhance product accessibility, and build trust, stakeholders can improve the adoption of sustainable products, thereby aiding environmental conservation and encouraging responsible consumption. This research lays the groundwork for additional studies and initiatives, emphasizing both the opportunities and the challenges associated with promoting sustainable consumer behavior in semi-urban and rural areas.

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Farm Tourism as a Catalyst for Sustainable Rural Development: An Empirical Study in Kerala

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ABSTRACT

Farm tourism has emerged as a viable strategy to foster sustainable rural development by merging agricultural practices with tourism-related activities. In Kerala, a state celebrated for its abundant agricultural legacy and picturesque rural scenery, farm tourism presents considerable opportunities to diversify farmers' income sources while maintaining traditional methods and ecological integrity. This research investigates the function of farm tourism as a driving force for sustainable rural development in Kerala through an empirical examination of selected farm tourism sites. The study emphasizes critical aspects such as income generation, job creation, community involvement, environmental sustainability, and cultural preservation. Primary data were obtained from farm proprietors, local inhabitants, and tourists through structured questionnaires and interviews, while secondary data were sourced from governmental reports and tourism literature. The results indicate that farm tourism positively impacts rural livelihoods by generating alternative income sources, curbing migration, and promoting entrepreneurial ventures within local communities. Furthermore, it enhances environmental consciousness through sustainable practices and aids in the preservation of indigenous agricultural customs. Nevertheless, the research also highlights obstacles such as insufficient infrastructure, limited marketing approaches, and inadequate policy backing, which impede the full realization of farm tourism's potential in Kerala. The study concludes that with appropriate planning, collaboration among stakeholders, and government involvement, farm tourism can act as an effective mechanism for achieving sustainable rural development. It suggests strategic initiatives aimed at enhancing capacity building, advancing digital marketing, and reinforcing institutional support to guarantee long-term sustainability and inclusive growth in rural regions.

KEYWORDS: *Farm tourism, Sustainable rural development, Kerala-rural livelihood, Eco-tourism.*

INTRODUCTION

Farm tourism, commonly referred to as agritourism, and has garnered significant attention as a novel approach to fostering sustainable rural development worldwide. It embodies a distinctive intersection of agriculture and tourism, inviting visitors to engage with

rural life, farming practices, local culture, and traditional customs. In developing areas like Kerala, where agriculture has traditionally served as the foundation of the rural economy, farm tourism offers a chance to rejuvenate rural regions while promoting environmental sustainability and socio-economic advancement.

Kerala, often dubbed “God’s Own Country,” is globally recognized for its varied landscapes, which include verdant paddy fields, coconut plantations, spice farms, and serene backwaters. Despite having a robust tourism industry, rural communities in Kerala still encounter obstacles such as diminishing agricultural income, land fragmentation, rural-urban migration, and a scarcity of job opportunities. Traditional farming, once a reliable source of livelihood, is increasingly becoming less viable due to escalating costs, climate fluctuations, and market unpredictability. In this scenario, farm tourism presents a practical alternative that can enhance farmers’ income while maintaining the agrarian lifestyle. The notion of farm tourism is closely aligned with the tenets of sustainable development, which advocate for a harmonious integration of economic advancement, social equity, and environmental stewardship. By welcoming tourists to their farms, farmers can broaden their income streams through activities such as farm stays, guided excursions, harvesting experiences, local food offerings, and the sale of organic goods. This diversification not only bolsters economic resilience but also lessens reliance on traditional agricultural methods. Additionally, farm tourism promotes the implementation of environmentally friendly practices, including organic farming, waste management, and biodiversity conservation, thus contributing to environmental sustainability. From a socio-cultural standpoint, farm tourism significantly contributes to the preservation and promotion of rural traditions, customs, and heritage. Visitors experience local lifestyles, cuisine, festivals, and crafts firsthand, which encourages cultural exchange and appreciation.

Simultaneously, rural communities gain from increased interactions with tourists, resulting in heightened awareness, skill development, and empowerment. Women and youth, in particular, can engage actively in tourism-related activities, thereby improving their economic independence and social standing. The Government of Kerala has acknowledged the potential of farm tourism within its broader strategies for tourism and rural development. Initiatives such as responsible tourism missions, the promotion of village life experiences, and support for homestays have fostered a conducive environment for the advancement of farm tourism. These initiatives are designed to ensure that

tourism benefits local communities while minimizing adverse environmental and cultural effects. Nevertheless, despite these initiatives, the development of farm tourism in Kerala remains inconsistent and encounters various challenges, including inadequate infrastructure, a lack of awareness among farmers, limited access to financing, and insufficient marketing and promotion. Furthermore, the success of farm tourism is heavily reliant on effective collaboration among stakeholders. Farmers, government agencies, tourism operators, local communities, and tourists must collaborate to establish a sustainable and inclusive model. Capacity building and training programs are crucial to equip farmers with essential skills in hospitality management, customer service, and digital marketing. Moreover, leveraging technology, such as online booking platforms and social media, can improve visibility and attract a broader spectrum of tourists. Another vital element of farm tourism is its ability to mitigate rural-urban migration. By generating local job opportunities and enhancing living conditions, farm tourism can motivate rural residents, particularly the youth, to stay in their communities. This, consequently, aids in preserving demographic equilibrium and supports the ongoing practice of agriculture. Additionally, farm tourism can bolster food security by fostering local food systems and promoting sustainable agricultural methods. Despite its many advantages, farm tourism also presents specific challenges that must be addressed to guarantee its long-term viability. Problems such as excessive commercialization, environmental harm, and the commodification of culture may occur if farm tourism is not properly managed. Thus, it is crucial to implement a responsible and community-oriented strategy that emphasizes the welfare of local populations and the environment.

In this regard, the current study intends to investigate farm tourism as a driver for sustainable rural development in Kerala through an empirical lens. It aims to evaluate the economic, social, and environmental effects of farm tourism on rural communities, identify the obstacles encountered by stakeholders, and propose strategies to improve its efficacy. By offering insights into the existing situation and potential of farm tourism in Kerala, the study adds to the expanding knowledge base on sustainable tourism and rural development.

In summary, farm tourism offers a viable route for attaining sustainable rural development in Kerala through the integration of economic diversification, cultural preservation, and environmental conservation. With the right policy support, community involvement, and strategic planning, farm tourism has the capacity to revitalize rural regions into dynamic and resilient ecosystems. As the appetite for authentic and experiential tourism rises, Kerala is well-positioned to become a premier destination for farm tourism, thus guaranteeing inclusive growth and sustainable development for its rural populations.

LOGICAL BACKGROUND

The foundational rationale of this research is anchored in the increasing necessity to tackle the economic, social, and environmental issues confronting rural regions in Kerala. Historically reliant on agriculture, rural populations are facing a rise in diminishing farm revenues, labor shortages, and a trend of migration towards urban areas. Concurrently, there is an escalating interest among tourists for genuine, nature-oriented, and experiential travel. Farm tourism presents itself as a strategic convergence of these two phenomena, providing a sustainable approach that merges agricultural practices with tourism activities. Kerala's robust tourism infrastructure and abundant agrarian legacy create an advantageous environment for the advancement of farm tourism. By broadening income streams and endorsing eco-friendly practices, farm tourism has the potential to improve rural livelihoods while safeguarding cultural and environmental assets. Consequently, this study is fundamentally based on exploring how farm tourism can serve as an effective instrument for sustainable rural development.

SIGNIFICANCE OF THE RESEARCH

The significance of this research is rooted in its emphasis on tackling the urgent issues of rural development and agricultural sustainability in Kerala. Given the decline in farm incomes and the rise in rural-urban migration, there is a pressing need for innovative strategies that can improve livelihoods and economic stability. Farm tourism presents a viable solution by generating alternative income sources while safeguarding cultural heritage and environmental resources. This research

holds importance for policymakers, researchers, and stakeholders as it offers valuable insights into the potential of farm tourism as a sustainable development approach, aiding in the creation of effective policies and the promotion of inclusive rural growth.

REVIEW OF LITERATURE

Nair et al. (2024) concentrated on the environmental aspect of farm tourism, noting that eco-friendly agricultural practices, including organic farming and waste recycling, are encouraged through tourist involvement. The research concluded that farm tourism enhances environmental consciousness among both tourists and local communities, thus fostering long-term sustainability.

Sharma and Kiran (2025) investigated the socio-economic effects of farm tourism in South India, revealing an increase in job opportunities, particularly for women and young people. The study underscored the significance of community engagement in the success of farm tourism projects and its contribution to inclusive rural development.

Thomas and Varghese (2025) examined the marketing obstacles faced by farm tourism in Kerala, identifying a limited online presence, insufficient branding, and ineffective promotional strategies as key challenges. They recommended the use of digital marketing tools and government-backed platforms to improve visibility and draw a larger tourist audience.

George and Paul (2026) assessed the policy frameworks that support rural tourism in Kerala, emphasizing the significance of government initiatives such as responsible tourism missions. Their research suggests that policy backing, infrastructure enhancement, and training initiatives are vital for the sustainable growth of farm tourism.

ANALYSIS AND DISCUSSION

The analysis is based on primary data collected from 120 respondents, including farm owners, local residents, and tourists in selected farm tourism destinations in Kerala. The data were analysed using percentage analysis and mean scores.

Table 1: Demographic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	68	56.7
	Female	52	43.3
Age	Below 25	30	25.0
	25–40	50	41.7
	Above 40	40	33.3
Occupation	Farmer	45	37.5
	Tourist	50	41.7
	Local Resident	25	20.8

Interpretation

The majority of participants are male, comprising 56.7% of the total, with a significant number falling within the 25–40 age range at 41.7%. This suggests a strong engagement from the working demographic. Additionally, a notable percentage of tourists, also at 41.7%, highlights the increasing appeal of farm tourism.

Table 2: Impact of Farm Tourism on Income Generation

Response Level	Frequency	Percentage (%)
Highly Increased	48	40.0
Moderately Increased	50	41.7
No Change	22	18.3

Interpretation

A significant portion of respondents (81.7%) concur that farm tourism has either greatly or moderately boosted their income. This suggests that farm tourism is vital in improving rural livelihoods.

Table 3: Employment Opportunities Created by Farm Tourism

Category	Frequency	Percentage (%)
Significant Increase	55	45.8
Moderate Increase	45	37.5
No Increase	20	16.7

Interpretation

Almost 83.3% of those surveyed noted a rise in job

opportunities. This indicates that farm tourism plays a role in alleviating unemployment and fosters economic growth in rural areas.

Table 4: Environmental Sustainability Practices

Practice	Mean Score (Out of 5)
Organic Farming	4.3
Waste Management	4.1
Water Conservation	3.9
Biodiversity Protection	4.2

Interpretation

The elevated average scores suggest that farm tourism encourages environmentally sustainable practices. Particularly highlighted in farm tourism activities are organic farming and the protection of biodiversity.

Table 5: Challenges Faced in Farm Tourism

Challenges	Frequency	Percentage (%)
Lack of Infrastructure	40	33.3
Poor Marketing	35	29.2
Lack of Government Support	25	20.8
Financial Constraints	20	16.7

Interpretation

The primary challenges recognized include insufficient infrastructure (33.3%) and inadequate marketing (29.2%), both of which impede the advancement of farm tourism. It is crucial to tackle these problems for sustainable development.

SUGGESTIVE RECOMMENDATIONS

- Enhance fundamental rural infrastructure, including roads, transportation, sanitation, and lodging facilities, to ensure a comfortable and accessible experience for visitors.
- Motivate farmers to utilize digital platforms, social media, and online reservation systems to boost visibility and draw both domestic and international tourists.
- Implement training programs for farmers and local

communities focusing on hospitality management, customer service, communication skills, and sustainable agricultural practices.

- Reinforce government initiatives by offering financial support, subsidies, and clear policy frameworks to assist farm tourism enterprises.
- Encourage the active engagement of local communities, particularly women and youth, to promote inclusive growth and fair distribution of benefits.
- Advocate for environmentally friendly practices such as organic farming, waste management, water conservation, and the use of renewable energy to preserve ecological balance.
- Establish a robust brand identity for Kerala farm tourism and broaden offerings to include farm stays, local culinary experiences, cultural activities, and educational tours.
- Promote collaboration among government entities, private tourism operators, and local stakeholders to enhance investment and management efficiency.
- Raise awareness among farmers regarding the advantages of farm tourism and inform tourists about responsible tourism practices.
- Implement a comprehensive monitoring system to evaluate the performance and sustainability of farm tourism initiatives, ensuring long-term viability.

SCOPE OF THE STUDY

This study aims to investigate farm tourism as a means for achieving sustainable rural development in Kerala. It encompasses selected farm tourism locations throughout the state, taking into account the viewpoints of essential stakeholders, including farmers, tourists, and local inhabitants. The primary focus of the study is to evaluate the economic, social, and environmental effects of farm tourism, which include income generation, job creation, community involvement, and the implementation of sustainable practices. The scope is confined to assessing the present condition, advantages, and obstacles of farm tourism within the regional framework of Kerala. Additionally, it examines the influence of government initiatives and marketing strategies in the advancement

of farm tourism. However, the research does not include a comparative analysis with other states or nations. The conclusions drawn are based on primary data gathered during the research period and aim to offer insights for policy development and future investigations in sustainable rural tourism advancement.

LIMITATIONS

The research is subject to specific limitations that must be taken into account when interpreting the results. Firstly, the investigation is limited to particular farm tourism locations in Kerala, which may restrict the applicability of the findings to other areas. Secondly, the sample size is relatively small and derived from convenience sampling, which could lead to sampling bias. Thirdly, the research predominantly relies on primary data gathered through questionnaires and interviews, and the responses may be swayed by personal perceptions or biases of the respondents. Moreover, time limitations constrained the thoroughness of data collection and analysis. The study also lacks a longitudinal perspective, which restricts the capacity to evaluate the long-term effects of farm tourism. Additionally, variations in government policies, seasonal influences, and external economic factors were not thoroughly examined. Notwithstanding these limitations, the research offers significant insights into the contribution of farm tourism to sustainable rural development.

CONCLUDING OBSERVATIONS

Farm tourism has emerged as a practical and sustainable method for rural development in Kerala by successfully merging agriculture with tourism. The research indicates that farm tourism plays a crucial role in income diversification, job creation, and enhancing rural livelihoods overall. Furthermore, it significantly contributes to environmental sustainability by promoting eco-friendly farming methods and conserving natural resources. It also aids in the preservation of cultural heritage and traditional ways of life in rural communities while providing tourists with genuine experiences. Nevertheless, the complete potential of farm tourism has not yet been fully realized due to obstacles such as inadequate infrastructure, limited marketing initiatives, and a lack of sufficient policy support. It is vital to tackle these challenges through

strategic planning, collaboration among stakeholders, and government involvement to foster its development. In summary, farm tourism presents considerable potential as a driver for sustainable rural development in Kerala, ensuring a harmonious balance of economic, social, and environmental advancement.

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An Integrated Web-Based Framework for Secure Multi-Pass Data Sanitization and IT Asset Lifecycle Management

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ABSTRACT

The increasing trend of utilizing digital infrastructures in modern organizations has resulted in a substantial increase in the number of outdated IT assets that contain critical information. Improper handling of storage media results in data leakage, unauthorized data recovery, and violation of regulations. Conventional deletion methods, such as formatting, are not adequate to ensure complete data removal. Data can be reconstructed using various techniques. This paper proposes a web-based solution for secure multi-pass data cleaning and IT asset management using Java technology. This solution offers role-based user authentication, asset registration, identity verification, and multi-pass overwrite. The system manages the execution of deletion processes and generates audit reports to verify the success of data removal. The experimental results of this solution show that it offers improved security, traceability, and reduced human intervention compared to conventional methods. This solution offers an efficient, reliable, and traceable solution for secure digital asset disposal.

KEYWORDS: *Secure data wiping, Multi-pass data sanitization, IT asset lifecycle Management, Media sanitization, Cybersecurity, Role-based access control, Audit logging, Data remanence, Secure erasure, Compliance reporting, Traceability.*

INTRODUCTION

The growing use of digital technology in contemporary businesses has led to a substantial rise in the disposal of end-of-life information technology assets like hard drives, laptops, and storage devices. These devices tend to store confidential business as well as individual data. Inadequate deletion of data or disposal of devices can cause serious security threats, data breaches, and failure to meet regulatory requirements. Conventional file deletion and disk formatting methods are only capable of deleting logical file pointers, which can be restored using forensic software to access the data. Therefore, media sanitization has become an essential requirement for businesses.

Existing literature and best practices for media sanitization recommend multi-pass overwrite and standardized sanitization procedures to counter data remanence. Although various standalone secure media wiping tools have been designed, most of them work independently without being integrated with enterprise asset management systems. Likewise, most IT asset management solutions are designed to track and monitor inventory and lifecycles only and do not have inherent verified data destruction and auditing capabilities.

This deficiency underlines the importance of an integrated approach that can combine the secure data sanitization process with the IT asset lifecycle management process. To address this identified

deficiency, the study aims to propose an integrated web-based solution for secure multi-pass data sanitization as well as IT asset lifecycle management through Java technology. The proposed solution will aim to guarantee the execution of the wiping process, access control, as well as compliance reporting. It is hypothesized that the integration of asset management with an established data sanitization process will aim to minimize data risks while improving traceability and security.

METHODOLOGY

This research work uses a system development and experimental validation methodology in designing, developing, and testing an integrated web-based system for secure multi-pass data sanitization and IT asset lifecycle management. This is because the methodology guarantees reproducibility, modularity, and the use of tests.

The system development life cycle was done through a series of structured steps. These steps included the analysis of the system's requirements, designing, development of the system's modules, and tests on the developed system. First, the requirements analysis was done based on the general risks associated with improper disposal of IT assets and the problem of data remanence. The designing of a three-tier web-based system was done.

In the implementation phase of the proposed framework, individual modules such as authentication, asset registration, identity verification, secure wipe, and report generation were implemented using Java technology. In addition to that, special attention has been provided to implement a secure wipe engine in which a multi-pass overwrite method is utilized to ensure that the probability of retrieving the data from the wiped area is minimal. The overall process of wiping is tracked for audit and trace purposes.

In addition to that, validation of the proposed framework is carried out through simulations of the system in the environment of an enterprise with sample asset data and a wipe process. Various test cases were carried out through varying the number of passes for the overwrite process and user roles in order to validate the robustness of the system. Parameters such as wipe success rate, accuracy of verification, implementation of access

control, and consistency of audit trails were utilized in order to measure the performance of the system, and the result is compared with the conventional deletion method in order to validate the efficacy of the proposed framework.

Research Design

The research uses a structured design and implementation approach to design and test the proposed framework.

The research methodology is divided into five stages for clarity and ease of understanding.

Requirement Analysis and System Modeling

In this stage, the functional and security requirements were determined based on the general problems associated with the disposal of IT assets and the risks of data remanence. The requirements of the stakeholders, including secure access control, data wiping, asset tracing, and audit trail, were analyzed. Use case scenarios and system models were developed based on the requirements to determine the scope of the system and the workflow.

Framework Architecture Design

The framework architecture was designed using a three-tier web approach to make the framework modular, scalable, and secure. The framework design provides for the separation of the presentation, application, and data tiers, which can be developed independently. The design also takes into account the security aspects of the framework, including authentication, role-based access control, and secure logging.

Module-Level Development

Individual functional modules such as authentication, asset registration, identity verification, secure wiping engine, and report generation were developed using Java-based technologies. The modules were developed and unit-tested independently before integrating them to ensure functional correctness and reduce system defects.

Controlled Testing and Validation

The system was tested in a simulated enterprise setup. Various test scenarios were performed by changing user roles, asset types, and overwrite pass settings

Comparative Performance Evaluation

The proposed system was compared with the traditional deletion and formatting approach. The evaluation parameters for the proposed approach were risk associated with the data, level of automation, audit traceability, and effectiveness of access control. This phase ensures that the proposed system meets the objective of providing a secure, auditable, and scalable solution to mitigate the risks associated with the data.

System Architecture Design

The system is developed using a 3-tier architecture:

Presentation Layer

User interaction and display. This layer is implemented with HTML, CSS, and JavaScript to create a user-friendly interface to interact with the assets and perform the wiping operation.

Application Layer

This layer is implemented with Java and Servlet/JSP or Spring Boot. The functionalities implemented in this layer include:

- Authentication logic

- Authorization validation

- Wipe control

- Logging

- Report generation

3.Data Layer

The MySQL database holds:

- User credentials
- Asset information
- Wipe status logs

The principle of separation of concerns has been followed, which allows for scalability, maintainability, and the safe transfer of data.

RESULTS/FINDINGS

The integrated web-based framework that was created was then tested for functionality, sanitization, access control, and its efficiency in a controlled environment. From the results, it can be seen that the created framework is reliable and consistent and has

achieved its purpose in IT asset disposal. In order to ensure complete validation, the system was tested for a number of cycles in different conditions. The reliability of the system was tested by confirming whether the authentication process was properly executed, whether changes were made in the registration process for the assets, and whether the process to wipe the data was initiated. Inconsistencies were not found in the sessions, database synchronizations, and integrations.

The process of sanitization was tested by logically confirming whether data was present after the process was executed. This was done by confirming whether data that was previously stored for testing was not retrieved or accessed. The stable execution of the multiple pass overwrite mechanism was observed in all tests. The effectiveness of access control was also tested by simulating an attempt to access the system without authority. The unauthorized access was denied by the role-based authentication module.

Functional Validation

All the functions of the core module have been performed as expected in the test case scenario. The authentication module has performed its expected function of implementing a role-based access control system, which has prevented unauthorized wipe operations from taking place. The asset registration module has performed its expected function of accurate asset lifecycle tracking, while the wiping engine has performed its expected function of performing overwrite operations without system failure.

Performance Evaluation

From the performance analysis, it was evident that the time taken for a wipe operation was proportional to the number of overwrite passes carried out. The responsiveness of the system, however, remained consistent for different configurations of the system. The modular design of the system ensured that the user interface did not get affected during a wipe operation.

Comparative Findings

After comparing the suggested framework with the existing methods of deleting the files, the following changes have been identified:

Parameter	Traditional Deletion	Proposed Framework
Data Recovery Risk	High	Minimal
Audit Capability	Not Available	Automated Logs
Access Control	Limited	Role-Based Control
Asset Traceability	Manual	Centralized Tracking
Compliance Support	Weak	Strong

The results show that the suggested framework minimizes the risk of exposing the residual data significantly.

Security Impact

With the inclusion of the identity verification, the use of the multi-pass overwrite techniques according to the guidelines of the National Institute of Standards and Technology, the reliability of the system is enhanced. The results confirm the hypothesis that the inclusion of the asset management with the verified techniques for sanitizing the data is more secure than the existing tool for deleting the files.

FIGURES

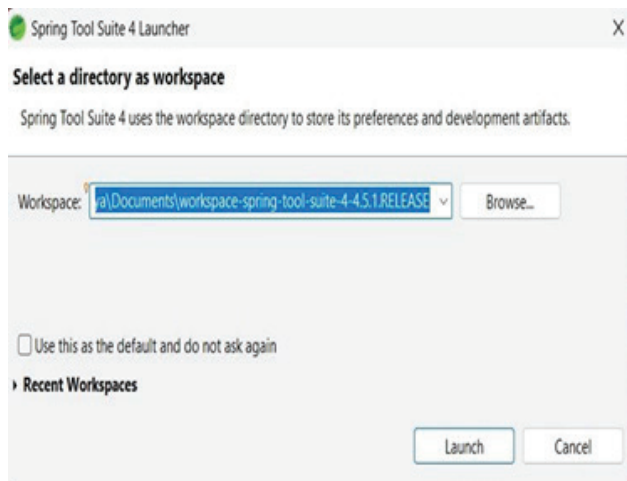


Fig. 1: Development Environment Setup

Spring Tool Suite (STS) is used for setting up the development environment and workspace for developing and managing the Java-based IT Asset Management System.

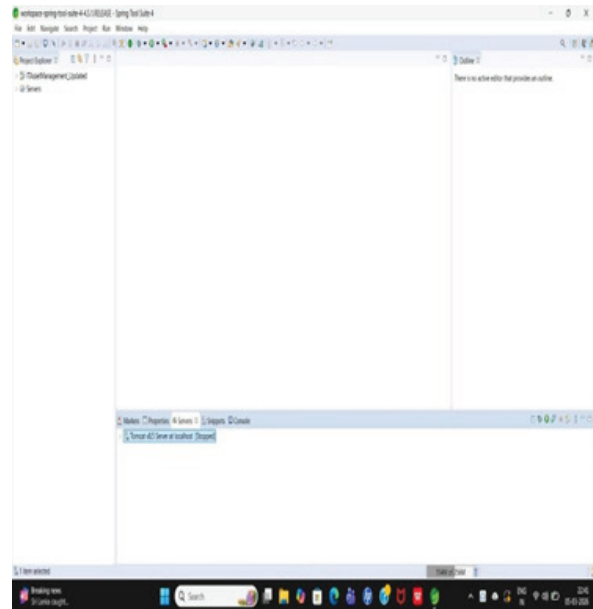


Fig. 2: Spring Tool Suite IDE Interface

The above figure shows the main interface of Spring Tool Suite IDE, where a programmer writes their code, manages their project files, configures their server, and monitors their application system.

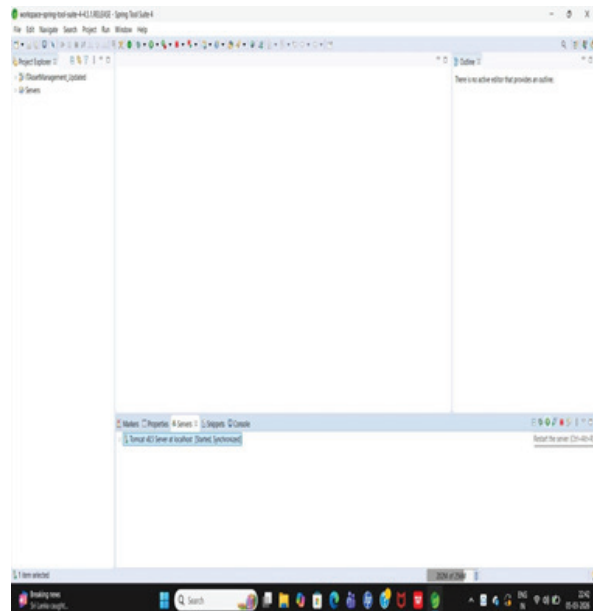


Fig. 3: Server Configuration and Project Deployment

The above screenshot shows a server configuration for running and testing the IT Asset Management System on a server in the development environment.



Fig. 4: Application Running on Local Server

As depicted in the above screenshot, the IT Asset Management System is successfully implemented on a local server and is accessible through a local browser with the localhost URL on port 2025.

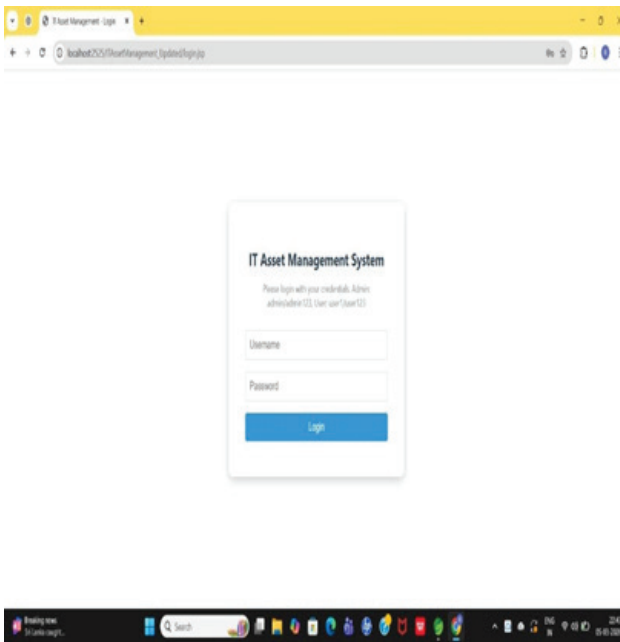


Fig. 5: IT Asset Management System Login Page

The above screenshot indicates the interface for users to input their username and password for authorized access.

As depicted in the above screenshot, the IT Asset Management System displays the Admin Dashboard that shows the statistics for the assets and allows the administrator to perform various operations on users, assets, audit trails, and reports for easy management

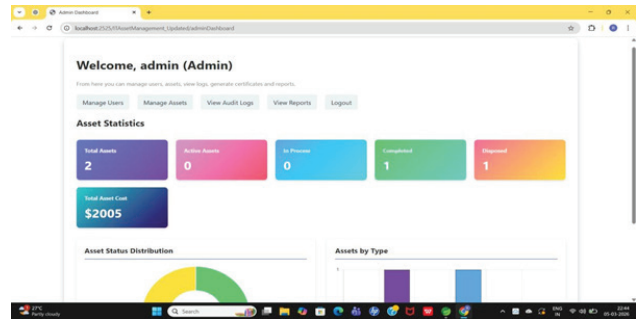
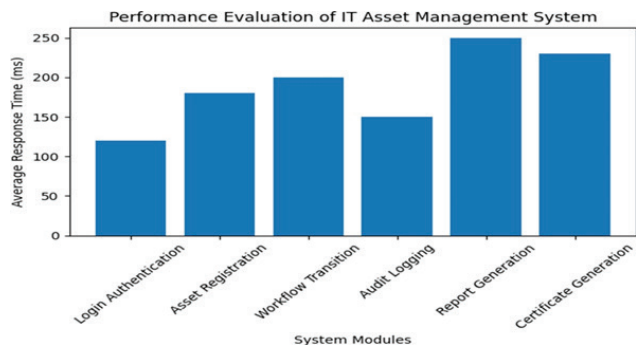


Fig. 6: Admin Dashboard of IT Asset Management System



Fig. 7: Dashboard Visualization Showing Asset Status Distribution and Assets by Type

The above figure depicts the graphical representation of the IT Asset Management and Tracking System. The donut chart is used to show the distribution of the assets based on the various stages such as Active, In Process, Completed, and Disposed. The bar chart is used to show the number of assets based on the various types such as Desktop, Laptop, Server, Storage, and Printer...



Performance Evaluation

The performance of the proposed IT Asset Management and Tracking System was evaluated based on the response time of key functional modules in the system. The tests were conducted after the deployment of the system, and the average response time for each operation, such as login authentication, asset registration, update

of the workflow, audit logging, report generation, and certificate generation, was recorded. The evaluation results showed that the authentication and logging modules responded faster, while report and certificate generation required slightly more time due to database and document operations.

DISCUSSION

As seen from the results obtained from this research, it is clear that the integration of multi-pass data sanitization security with IT asset lifecycle management is a comprehensive solution to disposing of digital assets. This is because this solution integrates data destruction techniques with administrative governance mechanisms. The next section will be a discussion of the research results in terms of security, governance, system limitations, and research extensions.

Interpretation of Results

The experimental results obtained verified the reliability of the framework in terms of secure wipe operation results as well as accurate lifecycle management. The consistent results obtained from executing multi-pass overwrite operations verified the stability of the data sanitization operation within this framework. The experimental results obtained verified the hypothesis of reducing residual data exposure risks with asset management integrated with verified data destruction techniques.

Security Implications

From a cybersecurity perspective, the framework enhances the level of security for the data by incorporating the overwrite process, which conforms to the conceptual guidelines provided by the National Institute of Standards and Technology. This enhances the reliability of the process.

In addition, the use of role-based access control ensures that the wiping process cannot be carried out without authorization, which controls the risks associated with data loss. This ensures that the user, timestamp, and wipe settings are automatically logged.

Operational and Governance Impact

Other than cybersecurity, this system is important in enhancing the governance of organizations. This is

because, with a single system to manage asset tracking, disposing of assets is done in a transparent manner. This eliminates the need to have documentation. Additionally, the system allows for audit-ready reports, which is important in enhancing compliance. The loop is closed with this system in terms of asset tracking and sanitization verification.

Limitations

While the results are encouraging, they are based on a simulated state and not an actual live enterprise environment. The high concurrency workload test did not perform an in-depth test on performance. Additionally, although the multi-pass overwriting technique is effective on magnetic disk drives, newer disk drives such as solid-state disks require hardware assistance for erasure.

Future Directions

Possible future research could include the addition of hardware level secure erase functionality, improving the efficiency of the wipe operation in an enterprise environment, and the addition of intelligent risk-based asset prioritization functionality. Expanding the support of different media could also be used to enhance the strength of the framework.

CONCLUSION

In the present study, a new integrated web-based solution for secure multi-pass data sanitization, as well as its asset management, was proposed. The importance of the proposed solution lies in the fact that the threat of data exposure is on the rise due to the improper disposal of digital storage media. In order to overcome the aforementioned problem, the proposed solution is based on an integrated web-based solution for secure multi-pass data sanitization as well as its asset management. By the systematic implementation of the proposed solution, it was experimentally proven that the proposed solution is reliable in terms of ensuring the stability and transparency of the solution. The integration of the technical data destruction with the management is the primary difference of the proposed solution compared with the conventional standalone solutions for data deletion.

The main findings of the research are as follows:

1. Strengthened Data Sanitization Mechanism

The proposed mechanism of using the multi-pass overwrite technique ensures that the entire data storage media is replaced systematically. The chances of the reconstruction of the deleted data are minimized. The proposed mechanism is more systematic compared with the conventional method of deleting the data or using the disk formatting method.

2. Improved security governance

With role-based access control in place, only authorized personnel will be allowed to execute this wipe operation. This will prevent accidental as well as malicious wiping of information. Each wipe operation will be recorded in terms of user id, timestamp, and configuration parameters to ensure internal audit compliance.

3. Enhanced lifecycle transparency

The asset tracking module will enable continuous monitoring of its assets from the time of registration to the time of disposal. This will minimize the dependency on documentation during this process. This will also enable automated report generation to improve compliance readiness.

4. System stability and scalability

The three-tier modular structure ensures stability in the integration of the application, presentation, and data layers. The consistency of the system's performance has been confirmed with experimental tests conducted to evaluate the performance in multiple wipe cycle scenarios. The framework has been designed to be scalable to meet the requirements of an enterprise environment.

5. Limitations and future enhancements

Although the model worked satisfactorily within a simulated environment, it is suggested that it be tested within a real-world environment. Future enhancements that could be made to this model could be of interest, such as the inclusion of features such as solid-state drive sanitization methods, hardware-based secure erase methods, concurrency improvements, and the inclusion of blockchain audit trails.

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Impact of Social Media Advertising on Consumer Purchase Decisions among College Students in Kozhikode

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ABSTRACT

Social media advertising has become a significant force shaping consumer behavior, especially among college students who are very active on digital platforms. In recent years, platforms like Instagram, YouTube, and Facebook have revolutionized traditional marketing methods by providing personalized, interactive, and visually captivating promotional content. In this context, the current study investigates the effect of social media advertising on the purchasing decisions of college students in the Kozhikode district. The research emphasizes critical elements such as advertisement content, exposure frequency, endorsements from influencers, peer reviews, and the perceived credibility of online advertisements. Primary data is gathered from college students through a structured questionnaire, and suitable statistical methods are utilized to examine the connection between social media advertising and decision-making in purchases. The results reveal that visually attractive content, relatable influencers, and favorable user-generated reviews significantly impact students' preferences and buying intentions. Furthermore, social media advertisements are shown to enhance brand awareness and influence attitudes more effectively than traditional media among the youth demographic. Nevertheless, the study also points out issues related to deceptive advertisements and information overload, which could adversely impact trust and decision-making. In summary, the research concludes that social media advertising is vital in shaping consumer purchase decisions among college students in Kozhikode, establishing it as a crucial strategy for marketers aiming at this demographic. The study offers valuable insights for businesses to create more effective and ethical digital marketing campaigns.

KEYWORDS: *Social media advertising, Purchase decision, College students, Consumer behaviour, Kozhikode district.*

INTRODUCTION

The swift advancement of digital technology has revolutionized the manner in which businesses engage with consumers, leading to the development

of innovative marketing strategies that are more interactive, personalized, and extensive compared to traditional approaches. Among these strategies, social media advertising has risen to prominence, exerting

a considerable influence on consumer behavior worldwide. Platforms such as Instagram, Facebook, YouTube, Twitter (X), and Snapchat have become essential components of daily life, particularly for younger demographics. College students, in particular, constitute a highly active group on these platforms, rendering them a vital target audience for marketers. In this digital age, comprehending how social media advertising affects the purchasing decisions of college students is crucial for both academic inquiry and practical marketing strategies. Social media advertising is defined as the utilization of social networking platforms to promote products, services, or brands through either paid or organic content. In contrast to traditional advertising methods, social media marketing facilitates two-way communication between brands and consumers, fostering interaction, feedback, and engagement. This interactive characteristic enhances the efficacy of advertisements by rendering them more relatable and engaging. Elements such as likes, shares, comments, and reviews foster a sense of community and trust, which significantly influences consumer choices. Furthermore, algorithms employed by social media platforms enable advertisers to target specific demographics, interests, and behaviors, thereby amplifying the relevance and effectiveness of advertisements.

In the realm of college students, social media serves a crucial function not only as a source of entertainment but also as a key medium for information and communication. Students often depend on social media to discover new products, evaluate options, read reviews, and obtain recommendations from peers and influencers. The impact of social media advertising on this demographic is heightened by their exposure to influencer marketing, where individuals with significant online followings endorse products in a more personal and genuine way. Influencers frequently act as a conduit between brands and consumers, rendering advertisements less commercial and more credible. Consequently, students are more inclined to be influenced by endorsements from influencers and content generated by users rather than by conventional advertisements. Kozhikode district, situated in the state of Kerala, offers a distinctive backdrop for this research. Renowned for its educational institutions and

a substantial population of tech-savvy youth, Kozhikode has experienced a notable rise in internet access and smartphone adoption in recent years. This has resulted in a significant increase in social media engagement among college students, establishing it as an optimal setting to investigate the effects of digital marketing strategies. The cultural and socio-economic diversity of the district further enhances the significance of the study, as it facilitates a thorough understanding of how various factors shape consumer behavior within this group. The consumer decision-making process is intricate and encompasses several stages, including the recognition of needs, information gathering, evaluation of alternatives, the decision to purchase, and post-purchase behavior. Social media advertising has the capacity to impact each of these stages. For example, visually attractive advertisements and trending content can raise awareness and ignite interest in a product. Reviews and testimonials found on social media platforms assist in the collection of information and evaluation, while targeted ads can directly encourage purchase decisions. Furthermore, the sharing of experiences after a purchase further affects other consumers, establishing a continuous cycle of information and influence. In spite of its many benefits, social media advertising also poses certain challenges. Excessive exposure to advertisements can result in information overload, leading to confusion and diminishing the effectiveness of marketing messages. Additionally, the existence of misleading or exaggerated advertisements raises issues regarding credibility and consumer trust. College students, despite being digitally savvy, may still be susceptible to such problems, especially when swayed by trends or peer pressure. Consequently, it is essential to critically assess both the positive and negative effects of social media advertising on their purchasing decisions. This research aims to investigate the degree to which social media advertising affects the buying behavior of college students in the Kozhikode district. It seeks to pinpoint the primary factors that influence purchase decisions, such as the quality of content, frequency of exposure, the impact of influencers, and peer reviews. Moreover, the study endeavors to comprehend the level of awareness and perception among students regarding social media advertisements and their capacity to make informed choices. By exploring these elements, the research contributes to a more profound understanding

of consumer behavior in the digital era. In summary, social media advertising has transformed the marketing environment, providing businesses with innovative avenues to engage with consumers in impactful manners. For college students in Kozhikode, social media serves not only as a medium for social engagement but also as a considerable factor influencing their buying decisions. As the digital landscape progresses, it is essential for marketers to implement strategies that are both effective and ethically sound, focusing on the consumer. Consequently, this study offers important insights into how social media advertising affects purchasing decisions and underscores the necessity for responsible marketing practices in the digital age.

REVIEW OF LITERATURE

Thomas and George (2024) explored the effects of user-generated content and determined that reviews, testimonials, and peer recommendations exert a greater influence on purchasing decisions compared to advertisements created by brands, particularly among college students.

Ali and Karthik (2024) investigated the psychological elements affecting online purchasing behavior and discovered that the fear of missing out (FOMO), social validation, and trend-following behavior are significant motivators of impulsive buying among young individuals.

Suresh and Pillai (2025) carried out research in Kerala that concentrated on digital marketing strategies and found that interactive content, including reels, stories, and live sessions, greatly improves consumer engagement and affects purchasing choices.

Fernandes and Roy (2025) examined ethical issues in social media advertising and revealed that deceptive advertisements and a lack of transparency in influencer promotions can adversely affect consumer trust and long-term brand loyalty.

LOGICAL BACKGROUND OF THE STUDY

The transition of marketing from traditional methods to digital platforms has significantly transformed the

manner in which consumers engage with brands. With the extensive use of smartphones and the availability of affordable internet, social media has become a vital component of everyday life, particularly among college students. This transformation has opened up new avenues for marketers to connect with and influence consumers through targeted and interactive advertising. In contrast to traditional media, social media platforms facilitate real-time interaction, personalized content distribution, and communication driven by peers, rendering them exceptionally effective in shaping consumer perceptions and purchasing choices. The theoretical framework of this study is based on consumer behavior models such as the AIDA model (Attention, Interest, Desire, Action) and the Theory of Planned Behaviour, which elucidate how external stimuli, such as advertisements, affect attitudes, intentions, and actual buying behavior. Social media advertising captures attention with engaging content, fosters interest through information and interaction, generates desire via influencer endorsements and peer validation, and ultimately drives purchase actions. Moreover, the principle of social proof is pivotal, as individuals often depend on the opinions and experiences of others when making purchasing decisions. In the realm of college students, the process of decision-making is significantly shaped by various factors including peer influence, current trends, brand reputation, and exposure to digital media. Social media platforms serve as a crucial source of information and validation, where students actively pursue reviews, recommendations, and feedback prior to making purchases. Moreover, the growing impact of influencers and user-generated content introduces an additional layer of credibility and relatability to advertisements, thereby enhancing their persuasive effectiveness. Consequently, the foundational premise of this study is to comprehend how social media advertising operates as a stimulus that influences cognitive, emotional, and behavioral responses, ultimately affecting the purchasing decisions of college students in the Kozhikode district.

ANALYSIS AND DISCUSSION

The analysis is based on a sample of 120 college students from Kozhikode district. The data was analyzed using percentage analysis and basic descriptive interpretation.

Table 1: Frequency of Social Media Usage

Usage Frequency	No. of Respondents	Percentage (%)
Less than 1 hour	10	8.3%
1–3 hours	35	29.2%
3–5 hours	45	37.5%
More than 5 hours	30	25.0%
Total	120	100%

Interpretation

A significant portion of respondents (37.5%) dedicates 3–5 hours each day to social media, while 25% allocate over 5 hours. This suggests a considerable level of engagement with social media platforms, thereby heightening the chances of being swayed by advertisements.

Table 2: Most Preferred Social Media Platform

Platform	Respondents	Percentage (%)
Instagram	50	41.7%
YouTube	35	29.2%
Facebook	20	16.7%
Others	15	12.5%
Total	120	100%

Interpretation

Instagram stands out as the leading platform with a preference rate of 41.7%, closely followed by YouTube. This indicates that content that is visual and video-oriented significantly impacts students' purchasing choices.

Table 3: Influence of Social Media Advertisements on Purchase Decision

Response	Respondents	Percentage (%)
Highly Influenced	40	33.3%
Moderately Influenced	55	45.8%
Slightly Influenced	15	12.5%
Not Influenced	10	8.3%
Total	120	100%

Interpretation

A significant portion (45.8%) is moderately affected, whereas 33.3% are greatly influenced by advertisements on social media. This clearly demonstrates that social media exerts a considerable influence on the purchasing behavior of college students.

Table 4: Factors Influencing Purchase Decisions

Factor	Respondents	Percentage (%)
Influencer Endorsements	30	25.0%
Peer Reviews	35	29.2%
Advertisement Content	40	33.3%
Brand Image	15	12.5%
Total	120	100%

Interpretation

Promotional material (33.3%) and customer feedback (29.2%) are the primary influential elements. This indicates that both innovative presentation and social endorsement play a crucial role in influencing purchasing choices.

Table 5: Purchase After Viewing Social Media Ads

Response	Respondents	Percentage (%)
Yes	75	62.5%
No	45	37.5%
Total	120	100%

Interpretation

A considerable majority (62.5%) have engaged in purchases following their exposure to advertisements on social media, demonstrating the efficacy of digital marketing tactics.

Overall Discussion

The results distinctly indicate that social media advertising significantly impacts the purchasing choices of college students in the Kozhikode district. High levels of engagement with social media platforms lead to increased advertisement exposure, thus amplifying their effectiveness. Platforms such as Instagram and YouTube are particularly prominent due to their visual attractiveness and interactive content formats. The research further emphasizes that students are influenced

not only by advertisements but also by peer reviews and endorsements from influencers, which contribute to credibility and relatability. The fact that most respondents report being either moderately or highly influenced suggests that social media advertising plays a vital role in shaping consumer attitudes and behaviors. Nevertheless, the existence of a small fraction of respondents who remain unaffected implies that elements like skepticism, brand loyalty, or awareness might also be influential. In summary, the analysis verifies that social media has evolved into a formidable marketing instrument capable of profoundly impacting the purchasing decisions of the youth.

FURTHER DIRECTIONS OF RESEARCH

The current study offers significant insights into how social media advertising affects the purchasing decisions of college students in the Kozhikode district, while simultaneously paving the way for numerous future research opportunities. Subsequent studies could broaden the geographical focus by incorporating various districts or states, thereby enhancing the understanding of regional differences in consumer behavior. Comparative analyses between urban and rural students might also uncover variations in social media usage and the effectiveness of advertising. Furthermore, cross-cultural or international studies could assist in recognizing global trends alongside local influences in digital marketing. Additional research could concentrate on platform-specific analysis, investigating how distinct social media platforms like Instagram, YouTube, Snapchat, and newer platforms uniquely affect consumer choices. Given that each platform employs different content formats and algorithms, comprehending their individual impacts would provide marketers with more profound insights. Another crucial avenue is to examine the psychological and behavioural factors that affect purchasing decisions, including fear of missing out (FOMO), impulsive buying tendencies, digital addiction, and emotional involvement. Integrating behavioral theories and sophisticated models such as Structural Equation Modeling (SEM) could enhance the analytical rigor of future investigations. Researchers might also explore the long-term impacts of social media advertising focusing on aspects like brand loyalty, customer retention, and

satisfaction after purchase. While the present study emphasizes immediate purchasing decisions, gaining insights into long-term consumer relationships would yield a more comprehensive perspective.

SUGGESTIVE RECOMMENDATIONS

In light of the study's findings, a number of actionable recommendations can be made for marketers, businesses, and policymakers aimed at improving the efficacy of social media advertising and fostering responsible consumer engagement among college students in the Kozhikode district. To begin with, marketers ought to prioritize the development of high-quality, visually captivating, and engaging content. Given that students are particularly drawn to creative visuals, short videos, reels, and interactive posts, brands should allocate resources towards content that is both informative and entertaining. A combination of clear messaging and aesthetic presentation can greatly enhance consumer attention and engagement. Furthermore, businesses should strategically utilize influencer marketing. Partnering with relatable and credible influencers who connect with the student demographic can bolster trust and authenticity. Nonetheless, it is essential to maintain transparency in influencer promotions to prevent misleading consumers. Moreover, there should be a strong focus on user-generated content and peer reviews. Motivating customers to share their experiences, reviews, and feedback can create social proof, which significantly impacts purchase decisions. Highlighting positive testimonials and ratings can further reinforce brand credibility. Another key recommendation is the implementation of personalized and targeted advertising. By harnessing data analytics and platform algorithms, marketers can present advertisements that align with the interests, preferences, and behaviours of college students. This approach enhances the relevance and effectiveness of advertisements while minimizing unnecessary information overload. Lastly, companies must uphold ethical advertising practices. Steering clear of exaggerated claims, ensuring the accuracy of information, and respecting consumer privacy are vital for cultivating long-term trust. Transparency in advertising not only safeguards consumers but also bolsters brand reputation.

CONCLUDING OBSERVATIONS

The swift advancement of digital technology has profoundly altered the marketing landscape, with social media emerging as a formidable platform that influences consumer behavior in unprecedented manners. The current research on the effects of social media advertising on the purchasing decisions of college students in the Kozhikode district offers valuable insights into how digital engagement shapes contemporary buying behaviors, especially within the youth demographic. A significant finding of the research is that social media has become a fundamental aspect of students' everyday lives, functioning not only as a means of communication but also as a primary source of information, entertainment, and product exploration. The substantial engagement observed on platforms like Instagram and YouTube suggests that students are frequently exposed to diverse advertising formats, including sponsored posts, influencer endorsements, and user-generated content. This ongoing exposure markedly heightens the probability of advertisements affecting their perceptions, preferences, and ultimately their purchasing choices. The research indicates that social media advertising is pivotal in cultivating awareness and interest among college students. Visually engaging content, innovative storytelling, and interactive formats such as reels and short videos effectively seize attention and leave a lasting impact. In contrast to traditional advertising, which typically employs a one-way communication model, social media facilitates two-way interaction, enabling consumers to connect with brands, express their views, and seek clarification. This interactive characteristic enhances the efficacy of advertisements by promoting a sense of involvement and connection. Another significant observation is the considerable impact of social proof on consumer behavior. Peer reviews, ratings, comments, and recommendations from friends or online communities play a crucial role in shaping purchase decisions. Students often depend on the experiences of others prior to making a purchase, underscoring the importance of trust and credibility in social media advertising. Likewise, influencer marketing has surfaced as a particularly effective strategy, as influencers are viewed as relatable and trustworthy sources of information. Their endorsements frequently bridge the divide between

brands and consumers, rendering advertisements more authentic and less promotional. The findings further reveal that while a significant number of students are swayed by social media advertisements, the extent of this influence varies. Some students respond strongly to advertisements and are more inclined to make impulsive purchases, motivated by trends, emotional appeal, or fear of missing out (FOMO). Conversely, others take a more cautious stance, meticulously assessing product information, comparing alternatives, and reviewing feedback before arriving at a decision. This variation indicates that consumer behavior is intricate and shaped by numerous factors, including individual preferences, financial limitations, and levels of digital awareness. In addition to its beneficial effects, the study also brings to light certain challenges linked to social media advertising. A significant concern is the problem of information overload, where excessive exposure to advertisements can result in confusion and diminished attention. Moreover, misleading advertisements and a lack of transparency, especially in influencer promotions, can adversely impact consumer trust. Although students are typically adept with technology, they may still be susceptible to persuasive marketing strategies, particularly when advertisements are crafted to elicit emotional reactions. The study emphasizes the necessity of ethical and responsible advertising practices. Companies must guarantee that their promotional content is accurate, transparent, and considerate of consumer privacy. Establishing long-term relationships with consumers necessitates trust, which can only be cultivated through honest communication and consistent value delivery. Marketers should also prioritize the creation of meaningful and engaging content rather than simply promoting products, as this method is more likely to resonate with the student demographic. From a wider viewpoint, the study underscores the requirement for enhanced digital literacy among college students. It is crucial to educate students on how social media advertising operates, how to discern credible information, and how to make informed purchasing choices in today's digital landscape. Educational institutions and policymakers can significantly contribute to fostering such awareness, thereby empowering students to become responsible consumers. The study's findings are especially pertinent

for businesses aiming at the youth market in the Kozhikode district. By comprehending the preferences, behaviors, and expectations of college students, marketers can formulate more effective strategies that align with the needs of this demographic. The focus should be on personalization, engagement, and authenticity, as these elements have been recognized as key influencers of purchasing decisions. In summary, social media advertising significantly influences the purchasing decisions of college students, affecting not only their buying habits but also their perceptions of brands and decision-making processes. It has revolutionized the conventional consumer decision-making model into a more dynamic and interactive experience. Although it provides various opportunities for businesses to engage with consumers, it also introduces challenges that need to be tackled through ethical practices and informed consumer behavior. The research ultimately highlights that the future of marketing depends on achieving a balance between innovation, engagement, and responsibility, ensuring that both businesses and consumers gain from the advancing digital landscape.

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RULA based Ergonomic Risk Assessment of Sikki Handicraft Artisans

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ABSTRACT

Sikki is an ancient craft of northern Bihar, especially in districts of Madhubani, Darbhanga, and Sitamarhi. Women artisans usually make useful and decorative items with golden sikki grass by weaving and cut-and-paste. They use many local tools, most of which were originally prepared for other tasks but are modified to adapt for sikki work. The process requires labor, continuous sitting on the floor, repetition of similar movements, and awkward postures. This could lead to problems related to the shoulder, arms, and spine. The present study investigates the ergonomic risks in sikki work using RULA. The method comprises field observations, questionnaires, and input from artisans in the Rampur, Jaynagar, and Raiyam clusters in Madhubani. The results indicated that in most of the activities, the RULA scores fall between 6 and 7, indicating high severity of ergonomic hazards. The high strain on wrists and fingers is caused by tools like takua, blade, BP handle, scissors, and thread cutter. Wire work and activities associated with hasua require more strength and pose a danger of injury. Extended cross-legged sitting positions on the floor contribute towards achieving a high score for strain on the trunk and neck. These factors in ergonomic working conditions tend to influence the health of artisans, their performances, and thus the future of the craft. The study proposes various solutions, such as the redesigning of the tools for better ergonomics, improvement in workstations, and safe work habits, which include variation in tasks, short rest periods, and stretching exercises. The addition of ergonomic thinking to tool and process design will lead to better workers' well-being, help protect the craft, and improve comfort and safety as well as productivity.

KEYWORDS: *Sikki craft, Hand tools, Ergonomics, RULA, Posture analysis, Sustainable livelihoods.*

INTRODUCTION

Sikki craft in Madhubani, Bihar is a traditional handicraft, especially among women artisans. They work with the fine golden grass known as "sikki". The sikki is collected from the marshy areas of the region and dried and then split into small strands. These strands are coiled and woven together using a needle-like tool made of metal and with a wooden handle called a "takua". Artisans in Madhubani also engage with the cut-and-paste technique of Sikki craft, in which finely cut grass motif pieces are pasted to paper or board to make elaborate decorative designs. The artisans generally construct items such as boxes, baskets, dolls, and ritual items; colorful natural or synthetic thread is used to add

embellishments. Sikki craft is an expression of culture; many of the sikki objects are the item of use in festivals, family occasions and household rituals. In addition to these uses, sikki weaving provides livelihoods and contributes to the experience of cultural heritage (Mehta & Kumar, 2022, Bhandari et al., 2020). Sikki craft, though highly traditional and culturally significant, consists of labor-intensive processes, which impose excessive physical burden on artisans. Long hours of sitting on the floor, cumulative hand movements, strained wrist postures, and hard gripping of tools tend to cause pain, fatigue, and chronic musculoskeletal disorders. As most artisans are working in informal environments without ergonomic assistance, their

health and productivity are continuously exposed to threats. Thus, ergonomic factors are needed to redesign tools, optimize seating and workstation organization, and encourage safer work habits. These interventions not only serve to safeguard artisans' health but also ensure the continuity and sustainability of this heritage craft for generations to come (Karuppiyah et al., 2020).

LITERATURE REVIEW

The ergonomic assessment of using tools and body posture while working in handicrafts or the informal sector is important for the health, productivity, and long-term livelihood of artisans. Unlike in an industrial setting, artisans often work in unregulated settings using traditional, ergonomically poor tools and postures. Some of these may include sitting on the floor for prolonged periods, repetitive movements of the hands, awkward angles of the wrist, and excessive gripping force. This may ultimately increase the risk of developing musculoskeletal disorders, fatigue, and inefficient performance. Ergonomic assessments are valuable for mapping out the important tool use and body postures, as well as the potential risks, and then reducing the risks with better tool design, seating, and ergonomic awareness of safer working postures. These interventions can help prevent artisans from suffering chronic pain or injuries and will also promote comfort, efficient work output, and the artisans' ability to be creative (Mukhopadhyay & Srivastava, 2010; Pasupuleti, 2024). The informal sector is the most negligible amount of healthcare access and social protection, which means that it becomes imperative for our professions to create freely available ergonomics strategy in order to preserve artisans livelihoods, improve work output quality, and to ensure that those crafts and crafts persons that are extinguished do not needlessly impose further harm upon artisans' well-being, and safeguarding their right to manage their own craft. Assessing ergonomic risk in handicrafts and the informal sector uses various tools and techniques to assess posture, tool use, and workload (Jadhav et al., 2020). Observational tools such as RULA (Rapid Upper Limb Assessment), REBA (Rapid Entire Body Assessment) and OWAS (Ovako Working Posture Analysis System) assess postural risks, strain on muscles, and load on the entire body. These tools also include checklists or questionnaires of self-reported discomfort and prevalence of injury for

artisans. More precise and direct measuring techniques include goniometers, inclinometers, and force sensors are used to assess joint angles, grip strength and measures of repetitive action. More recently, digital tools have allowed for posture assessment such as video-recording software for posture analysis, and motion capture to provide objective specifics about biomechanical movement. These tools help to identify ergonomic risk level and provide recommendations related to the design of tools, workstation arrangements and alternate postures. Using these tools with artisans is crucial to preventing musculoskeletal disorders and to improving the health and productivity of artisans in the informal sector. The Rapid Upper Limb Assessment (RULA) is a fairly common ergonomic risk assessment method that can be used to evaluate posture, force, and muscular activity related to the tasks of the upper limb. RULA is particularly useful for evaluating manual labour in handicrafts and tool-based work, where repetitive and static postures are common (Kee, 2022). The RULA assessment procedure involves observing the body positions of the worker (i.e. neck, trunk, upper arms, lower arms, and wrists) performing the task. Based on the observed postures, a score is assigned to each posture based on the amount of deviation away from the neutral position. Each observed posture also accounts for the extent of muscle use, repetition, and external load. The upper limb postures are summed into a score; the neck, trunk, and legs summed into a second score; and combined into a Group A: upper limb, and Group B: neck, trunk, legs score. The scores yielded two summed scores that can be processed into a risk score of 1 (negligible risk) to 7 (very high risk). The level of risk indicates the need for urgency for ergonomic intervention. RULA is a means to facilitate the identification of where harmful postures occurred, determine how to modify the hand tool design, workstation and work methods in order to reduce risk (McAtamney & Nigel Corlett, 1993).

Research on the RULA in craft sectors is limited (Kumar & Kamath, 2019), and there is almost no research involving sikki artisans in Madhubani, specifically. The gaps noted here are: (1) contextually validating the RULA for floor-sitting, cross-legged postures, and low-height work surfaces typical of sikki weaving; (2) analyzing the tools which articulates the link between

wrist deviation, pinch force, and patterns of micro-breaks with RULA scores; (3) studies tracking pain, productivity, and acceptance of ergonomics changes; (4) intervention trials testing low-cost development of tools, seating support, or workflow and reporting pre/post RULA change; (5) considering the variability in tasks (weaving compared to cut-and-paste), seasonality; and (6) mixed methods studies combining RULA with ethnographic approach, not just for feasibility, but affordability, culture and fit. If we can respond to these gaps, it would provide practice-oriented, locally relevant ergonomics advice for some or all of the sikki handicraft livelihood. The research aims to contextually validate the RULA for floor-sitting, cross-legged postures, and low-height work surfaces typical of Sikki weaving and analyse the tools which articulates the link between wrist deviation, pinch force, and patterns of micro-breaks with RULA scores.

METHODOLOGY

A qualitative and interpretive methodology was implemented to understand the postures and tool use practices of artisans engaged in sikki crafts. Participant observations and surveys of 65 artisans at Rampur, Jaynagar, and Raiyam craft clusters were carried out in the Madhubani district for six months during 2024. The postures of artisans, movements using tools, and tasks completed were systematically recorded and documented through photographs and videos allowing for large scale ergonomic analysis. Participatory engagements with artisans and their family members gave a sound understanding about artisans’ daily routines, health problems related to craft work and tool use, and socio-cultural dimensions of their craft practice. Secondary research was also conducted to investigate published primary research studies on ergonomics in handicrafts, occupational health and tool design from the informal economy to place fieldwork findings into a larger, scholarly research context. The RULA (Rapid Upper Limb Assessment) framework was applied to systematically analyse the ergonomic risks where postures and tool use were concerned. Based on the ergonomic deficiencies detected, suggestive measures and ergonomic recommendations were made to reduce the risk of strain, improve usability of the tools, and promote safer methods of working for artisans (Mukhopadhyay & Srivastava, 2010). RULA (Rapid

Upper Limb Assessment) scoring system assesses ergonomic risk by classifying evaluations as being part of two different groups: Group A, which is for the upper limbs such as the arm, forearm, and wrist, and Group B, which includes the neck, trunk, and legs. The system also considers use of muscles and the forces or loads involved in tasks as outlined in figure 1 (McAtamney and Corlett, 1993).

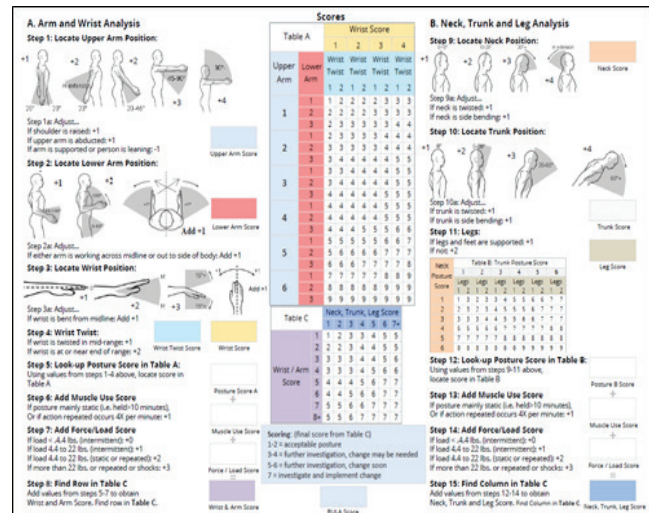


Fig. 1: RULA Assessment Worksheet (<https://ergo-plus.com/rula-assessment-tool-guide/> accessed as on 04/09/2025)

FINDINGS AND ANALYSIS

Sikki weaving begins with collecting sikki grass, which is sun-dried and has the flower head removed- leaving fine golden strands. Once collected, the strands are moistened to create flexibility, coiled, and stitched with a takua. The coiling is bound and shaped with bright colored threads, and a variety of objects can be made such as baskets, boxes, toys, or ritual items. It is important to work uniformly as the strands are quite delicate. In sikki cut-and-paste method , the grass is flattened and cut into strips or motifs with small scissors. The cut pieces are carefully assembled and pasted with glue onto a surface made from paper, cardboard, or wood to create flowers, animals, or geometric shapes. Many decorative objects are produced such as wall hangings or greeting cards and accessories. Both methods require simple traditional tools and patience with skill (Bhandari et al., 2020). Figure 2 shows some of the tools, the tool-use practices and implied.



Fig. 2 Pictures Showing Tool Use Practice and Posture of Sikki Craft Artisans

body postures while making sikki products. A careful observation of the processes followed by the artisans highlights the tasks and the postures used while working with the tools:

A. Takua- The takua is used to coil, stitch, and bind strips of golden grass to create decorative and functional items. The craft is precise and the posture used by the artisans is typical for a craft process, impacting the comfort and effectiveness of work use of the tool. Often, the craftsmen work while sitting on the floor leaning forward bending their trunk. Their neck is flexed forward for accurate fine visual control. Shoulders are elevated with their elbows flexed through 90 - 120 degree angles while performing the task. Wrists are often deviating while using the takua for fine movement.

The posture also includes pinching by fingers and thumbs.

- B. Blade - The task of preparing sikki involves the use of a blade to split, cut, or smooth the grass before it is coiled for use. Artisans sit cross-legged, which provides stability and comfort. They work holding a blade with one hand while the other holds strips of grass, allowing for necessary adjustment. The wrists facilitate the contour of the grass and the unique movements of the task by using flexion, extension and deviations. Both hands perform pinch and pull action on the thin grass repeatedly to keep cohesion in their repetitive process. Flexibility of movement is supported by flexing the neck and bending the trunk forward which helps in attention to details.
- C. BP handle with blade-The BP handle is designed to be precise for cutting, trimming and shaping sikki grass. Artisans tend to sit on the floor mat with their legs crossed in a stable and flexible pose. One hand is used to hold the BP handle in firm grip, while the other holds the grass that is being cut. When cutting, the wrist undergoes flexion and extension as well as lateral deviation to ensure precise movements. The fingers and thumb apply a firm pinch by exerting repetitive small forces to maintain control of the cutting tool. The neck is bent forward at an angle of more than 20 degrees to keep visual attention on the task, while the trunk is flexed forward to improve reach and accuracy. The legs are in a stable sitting position and provide stability needed for this intricate work.
- D. Wire handling- Thin metal wire is used to tie, tighten, or frame sikki grass products. While performing this activity in a sitting posture with legs crossed, one hand is occupied with firmly gripping the product in position, and the other hand carries out the delicate movements of pulling, twisting, or winding the wire around sikki grass. The finger and thumb are repeatedly making forceful grasping and pinching movements on the slender wire, which may cause finger strain in the long run. The wrist experiences a combination of flexion and extension, in addition to radial and ulnar deviation, especially on the twisting movements. In order to have an eye

on their work, craftsmen tend to bend forward at more than 20 degrees, which, when combined with a bent forward trunk, tends to cause discomfort.

- E. Hasua- The hasua tool is utilized mainly for the cutting and trimming of sikki grass, prior to the weaving/cut-paste process. In the use of the hasua, the tool is held firmly in one’s hand, with the grass pressed or pulled against the sharp edge, allowing for precision in each cut. The wrist of the artisan demonstrates a flexion and extension, with lateral movements, as they cut through the material. A firm grasp is held on the narrow handle of the hasua, with fingers and thumb being used to control it. The neck is bent forward at a more than 20-degree angle, while the forward bend of the trunk serves to steady the grass under operation.
- F. Scissors - The activity of cutting, trimming, and shaping thin strands of sikki grass requires the use of scissors, which demands patience, attention, and precision. They maintain sitting posture on the floor mat, in order to be more stable and in control. One hand is used to grasp and support the grass, while the other hand performs the cutting using the scissors in a routine cycle of pinching and squeezing. This movement activates the fingers and the thumb in a repetitive rhythm, allowing for the cutting action. The wrist displays minor flexion and extension, as well as some deviation, which differs with the angle needed to cut effectively. In order to get a close visual inspection of the task, the neck is forward bent.
- G. Thread cutter- The thread cutter is used mostly to trim threads or cut grass bindings in the final stages by artisans in a seated position, with knees

crossed on the floor mat. The tool is held between the fingers and in the palm, with one hand pulling the thread and the other performing the cutting action. This movement is accompanied by gentle flexion and extension of the wrist, with periodic lateral deviation to add to the precision. The thumb and fingers move in brief, repetitive squeezing or pushing motions. The neck is usually bent forward to allow clear vision of the work in hand. The trunk is held in a forward-flexed position.

- H. Floor mat- During most of the craft operations the artisans tend to assume a sitting cross-legged or kneeling position on a floor mat for long hours, which tends to cause physical fatigue. The trunk is usually bent forward at a 20 to 60 degree angle in order to obtain access to materials, while the neck is flexed forward at an angle of more than 20 degrees to concentrate on the product’s fine details. The shoulders are lightened, and the arms are not supported, all adding to a posture that can be demanding and difficult. Elbows are flexed between 90 and 120 degrees, often in an asymmetrical manner, further complicating the physical dynamics of the task. The wrists flex and deviate, further complicating the movement involved. Legs remain stationary for the most part. This extended static position, added to the heavy repetition of finger and hand movements, highlights the physical strain imposed upon the artisan in the delicate art of sikki craft. RULA method has been used to assess the ergonomic hazards related to tool usage and posture in sikki handicraft artisans in Madhubani. The evaluation showed uniformly high - risk scores for most tasks (Table 1, Figure 3). The findings has been summarised in table 1 as follows:

Table 1: RULA Assessment Scores

Group A – Upper Limb		Group B – Neck, Trunk, Legs	
Posture Analysis	Score	Posture Analysis	Score
1. While working with takua			
Upper Arm: Flexion 20-45° (due to raised/ unsupported arm while working close to body).	2-3	Neck: Flexed >20°, often twisted.	3
Lower Arm: Often >100° or <60° depending on material handling.	2-3	Trunk: Bent forward 20–60°, minimal support.	3
Wrist: Bent/extended, deviated and repetitive.	3-4	Legs: Sitting cross-legged, and supported.	1

Wrist twist: Frequent pronation/supination.	1-2	Muscle use: Prolonged static sitting.	+1
Muscle use: Sustained posture, repetitive.	+1	Force/load: Minimal.	0
Force/load: Moderate, repetitive fine force.	+1		
Total score	~ 6-7	Total score	5
Final RULA score (combining Group A and Group B) = 6-7, indicating a high risk level.			
2. While working with blade			
Upper Arm: Arm lifted but generally closer to torso (~20-45° flexion).	2-3	Neck: Flexion >20°, often static.	3-4
Lower Arm: Often <60° or >100° depending on cutting angle.	2	Trunk: Flexed 20-60° forward.	3-4
Wrist: Flexion/extension, side deviation while cutting.	3-4	Legs: Sitting cross-legged or low stool, not well supported.	1-2
Wrist twist: Frequent pronation/supination when adjusting grip.	1-2	Muscle use: Sustained posture.	+1
Muscle use: Repetitive and sustained.	+1		
Force/load: Moderate pinching, pushing with blade.	+1		
Total score	~ 6-7	Total score	~5-6
Final RULA score (combining Group A and Group B) = 6-7, indicating a high risk level.			
3. While working with BP handle			
Upper Arm: Typically 20-45° flexion (arm held near torso).	2-3	Neck: Flexion >20°, static posture	3-4
Lower Arm: Often <60° or >100° depending on cutting angle.	2	Trunk: Bent forward 20-60°.	3-4
Wrist: Significant flexion/extension, deviation	3-4	Legs: Cross-legged or low stool without full support.	1-2
Wrist twist: Frequent pronation/supination (turning grass strips).	1-2	Muscle use: Static sitting posture.	+1
Muscle use: High repetition, static grip.	+1		
Force/load: Moderate, as precision cutting requires steady but repetitive force.	+1		
Total score	~ 6-7	Total score	~5-6
Final RULA score (combining Group A and Group B) = 6-7, indicating a high risk level.			
4. While handling wire			
Upper Arm: Raised close to torso, ~20-45° flexion.	2-3	Neck: Flexed >20°, static posture.	3-4
Lower Arm: Often outside neutral (too open/closed depending on pulling angle).	2	Trunk: Forward flexion 20-60°, no back support.	3-4
Wrist: Repeated flexion/extension, deviation while twisting wire.	3-4	Legs: Sitting cross-legged or low stool, stability but poor support.	1-2
Wrist twist: Frequent pronation/supination (wire winding).	2	Muscle use: Static posture, sustained.	+1
Muscle use: Repetitive, prolonged static grip.	+1		
Force/load: High, wire is stiff, requires force to bend/twist.	+2		
Total score	~7	Total score	~5-6
Final RULA score (combining Group A and Group B) = 7 (in forceful twisting tasks), indicating a very high risk level.			
5. While working with hasua			
Upper Arm: Often raised 20-45° during cutting.	2-3	Neck: Flexed forward >20°, static.	3-4

Lower Arm: Forearm angle may fall outside neutral depending on cutting force.	2	Trunk: Forward flexion 20–60°, unsupported.	3–4
Wrist: Repeated flexion/ extension, ulnar deviation when slicing.	3–4	Legs: Sitting cross-legged or low stool, limited support.	1–2
Wrist twist: Frequent pronation/supination to adjust grass position.	1–2	Muscle use: Prolonged static sitting.	+1
Muscle use: Repetitive and sustained.	+1		
Force/load: Moderate-to-high, especially when cutting thick bundles.	+2		
Total score	~7	Total score	~5–6
Final RULA score (combining Group A and Group B) = 7 indicating a very high risk level.			
6. While working with scissors			
Upper Arm: Slightly raised, ~20–45° flexion.	2–3	Neck: Flexed forward >20°, static.	3–4
Lower Arm: Often outside ideal 60–100° range depending on material position.	2	Trunk: Leaning forward 20–60°, unsupported.	3–4
Wrist: Mild flexion/extension, deviation.	2–3	Legs: Sitting cross-legged or low stool, poor support.	1–2
Wrist twist: Occasional pronation/supination while adjusting cutting.	1	Muscle use: Static posture, prolonged.	+1
Muscle use: Repetitive scissor action, sustained for long periods.	+1		
Force/load: Moderate, cutting dry/stiff Sikki grass requires grip force.	+1		
Total score	~5–6	Total score	~5–6
Final RULA score (combining Group A and Group B) = 6 indicating a high risk level.			
7. While working with thread cutter			
Upper Arm: Slightly raised (20–45° flexion).	2	Neck: Flexion >20°, prolonged.	3–4
Lower Arm: Often within ~60–100°, neutral range.	1–2	Trunk: Forward flexion 20–60°.	3
Wrist: Mild flexion/extension, occasional deviation.	2–3	Legs: Cross-legged or low stool, limited support.	1–2
Wrist twist: Minimal rotation.	1	Muscle use: Static sitting posture.	+1
Muscle use: Repetitive snipping motion, but lighter than scissors.	+1		
Force/load: Low to moderate (thread is light, but frequency is high).	+1		
Total score	~4–5	Total score	~5–6
Final RULA score (combining Group A and Group B) = 5-6 indicating a medium– high risk level.			
8. While working in sitting posture on a floor mat			
Upper Arm: Flexion ~20–45°, often unsupported.	3	Neck: Flexed >20°, static for long periods.	3–4
Lower Arm: Often outside neutral 60–100° range.	2	Trunk: Flexion 20–60° (stooping forward).	3–4
Wrist: Flexion/extension, ulnar deviation.	3–4	Legs: Sitting cross-legged/unsupported, poor circulation, restricted movement.	2
Wrist twist: Frequent pronation/supination (tool handling).	1–2	Muscle use: Prolonged static sitting posture.	+1
Muscle use: Repetitive + static.	+1		
Force/load: Light materials, but repetitive fine force.	+1		
Total score	~6–7	Total score	~6
Final RULA score (combining Group A and Group B) = 7 indicating a very high risk level.			

The risk level of different tasks presents a range of hazards with each activity, with wire handling found to be the most significant risk factor. This high risk arises from the process, combining force applied, repetitive action, and the likelihood of wrist strain, which can cause severe long-term damage. This is closely followed by hasua’s task, where there is high-force cutting and associated risks of unsafe handling of blades. Sitting posture also has a risk score because of the constant flexion of the trunk and neck combined with the static positioning of sitting for prolonged periods. The takua, blade, and BP handle pose a risk level of 6 to 7 since it entails repetitive wrist and finger actions that build up strain. Scissors are less dangerous but still pose a risk because they entail repetitive pinch strain and are therefore of moderate risk. The thread cutter, while being the least dangerous of all tools with a score of 5 to 6, remains medium-high risk due to the repetitive motion involved in its handling, for which ergonomic practice needs to be followed in all these tasks to avoid possible harm. Figure 3 shows a visual risk chart comparing all the tools and weaving posture using RULA scores. This makes it clear that wire handling, hasua, and weaving posture carry the highest ergonomic risk and needs immediate intervention. The takua, blade and BP handle also falls in the high risk category thus intervention for ergonomic modification is needed soon. While scissors and thread cutter pose relatively lower but significant risk, the improvements would be beneficial for their long term use.

Table 3: Comparative Ergonomic Risk Interpretation

Activity / Tool	Risk Level	Interpretation
Takua (Awl)	High	Urgent changes needed (handle redesign, better support)
Blade	High	High strain on wrist/fingers, redesign and posture change needed
BP Handle with Blade	High	High risk for wrist/finger strain, cut hazard
Wire Handling	Very High	Highest risk, immediate intervention required
Hasua (Curved Sickle)	Very High	High grip force, unsafe exposed blade
Scissors	High	Risk of finger fatigue and neck strain
Thread Cutter	Medium–High	Lower than scissors, but cumulative risk present
Weaving (Floor Sitting)	Very High	Posture itself is highly risky, workstation redesign needed

Table 3 shows interpretation of risk along with the posture and tool use practice of sikki handicraft workers in terms of RULA scores. In general, the results emphasize that tool ergonomics as well as working posture are essential factors in addressing musculoskeletal risk. Interventions for ergonomic and safer tool design and workstation adaptation will help minimize long-term health hazards for artisans.

DISCUSSION

In sikki craft thus, each tool and posture has unique ergonomic hazards. The takua leads to wrist deviation and finger stress from its thin/slender handle, and the blade and BP handle result in wrist fatigue, finger stress, and neck/trunk flexion from low work surfaces. Handling wire has the highest risk, which involves high force and repetitive twisting that stresses wrists and fingers, which in turn create cuts and compression injuries. The hasua contributes additional risks with aggressive slicing, wrist fatigue, and risk of inadvertent cuts from its exposed blade. Scissors cause thumb and finger fatigue with repeated squeezing, tight loops risking tendinitis and trigger finger, and the thread cutter strains fingers with repeated snipping and strained

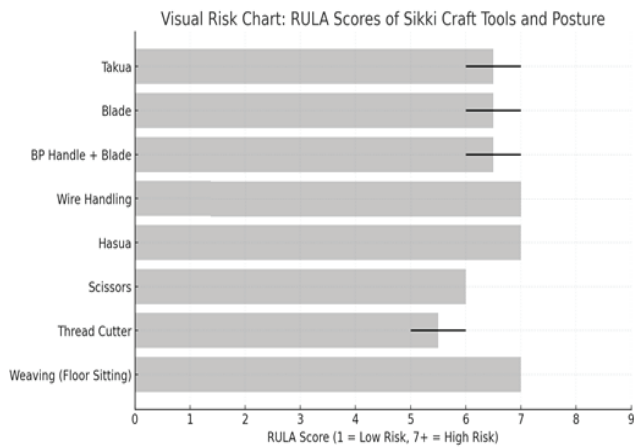


Fig. 3: Visual Risk Chart

posture. Besides the tools, the floor-sitting weaving posture itself is also extremely harmful, contributing to neck, trunk, and limb strain, limited circulation, and chronic musculoskeletal disorder. All of these risks emphasize the necessity for immediate ergonomic tool redesign, posture aids, and workstation enhancement (Kim, 2022; Naz et al., 2015; Okubo, 2015). This study further supports that tool design and working posture represent significant musculoskeletal strain sources for sikki artisans (Matsumoto, 2023). The high RULA score is concordant with previous research conducted on other handicraft and weaving workers' musculoskeletal disorders, indicating that awkward working postures, repetitive work tasks, and non-ergonomic tools are known, contributing factors (Mahmood et al., 2021; Das & Singh, 2021). In the context of floor-sitting, which is a culturally embedded posture, the ergonomics risk for artisans is compounded due to the sustained trunk flexion and static posture. Likewise, tools with thin metal handles and sharp exposed blades increase hand force, discomfort, and safety hazards (Mallampalli & Pal, 2021). The need for ergonomic design intervention is critical and supported by internationally recognized human-centred design process standards and work system design process (Biddle & Roberts, 2004, Mukhopadhyay, 2023). Sikki craft is an important traditional practice of the region and its sustainability is essential for long term employment of the local youth. It enhances the earning capability of artisans particularly the women artisans. So far, ergonomics has been a very neglected aspect of the entire design and production ecosystem of the sikki craft community. Providing an assessment of risk associated with the tool use and posture among the artisans will help create a good working environment and wellbeing of the entire community.

CONCLUSION AND RECOMMENDATIONS

The RULA-based ergonomic risk assessment indicates the potential for high to very high ergonomic risks (scores 6–7) with sikki craft artisans across nearly all tools and work practices. The traditional tools utilized, such as takua, blade, BP handle, hasua, scissors and thread cutter, were all observed to put stresses on the

wrists, fingers, arms and trunk, and, handling wire and weaving on floor mats appeared to be the most hazardous practices of the artisans due to repetitive force, awkward postures and unsafe handling. Findings show that risk is not isolated to tools, but also compounded by artisans' controlling postures and workstation configurations. As a result, sustainable interventions are viewed as tool modification (for example, safer grips, force reducers, and protective aids) and workstation modification (for example, raised work surfaces, seating supports, and task rotation). Along with information on safe work practices, these interventions present an opportunity for manageable risk reduction of musculoskeletal disorders, improving artisan wellbeing, and increasing health and productive capacity of the Sikki handicraft sector.

Recommendations for ergonomic re-design of tools and workstation interventions include the following:

- [1] For takua, a rubber or soft grip, as well as a thicker handle is recommended to reduce pinch force and wrist deviation during use.
- [2] For Blade, a casing, or small handle focusing on a thicker, non-slip rubberized grip is recommended to decrease pinch force. It may also be worth considering a safer design for the blade, such as a fixed blade and guard.
- [3] With regards to the BP handle, there is a need for a thicker and ergonomic handle made of rubber or soft plastic, to help distribute pinch stress and a little bit of contour added to the handle will assist in finger support. Using a fixed and guarded holder for the blade portion will also be a safer method to manage this tool.
- [4] In relation to wire handling, it would be beneficial to implement a small tool that resembles a plier with a padded handle to eliminate holding wire by twisting, and subsequently reduce injury potential. Protectors like rubber finger caps or gloves should be issued to limit cuts and applied compression on the fingers.
- [5] To improve usability and safety while using hasua, the inclusion of a thicker cushioned handle is recommended which provides a better grip resulting in improved user comfort during prolonged use.

Cut resistant gloves or guards will further protect users from injury.

- [6] In designing scissors, bigger ergonomic loop handles and a soft grip is recommended to relieve finger stress. It is also important to consider utilizing spring-assisted mechanisms to alleviate the constant pinch force required repeatedly.
- [7] In the case of thread cutters, employing designs with an ergonomic handle, like thicker handles with padded surfaces, will enhance user comfort. Spring-action designs may reduce the repetitive pinch force involved in using them, and thereby the potential for fatigue.
- [8] To make sitting posture on a mat more ergonomic, some improvements at the workstation can be made. A low-height table or a raised platform can raise the work to eye level a great deal, thus reducing neck and trunk flexion. Incorporating floor seating facilities, with a cushioned mat or an ergonomic mini seat and backrest or a little stool, will ease spinal and leg fatigue.
- [9] To limit strain and fatigue, artisans should follow good work practices such as task rotation, and regular hand/wrist stretching, which together improve comfort, safety, and productivity. Task rotation, wherein workers switch between weaving, trimming, cutting-pasting and finishing, can assist in spreading physical demands evenly.
- [10] Micro-breaks every 30 to 45 minutes helps avoid stiffness. Artisans should shift their leg positions to prevent circulation problems and maintain a healthier and productive work environment.

Sikki craft's survival will be ensured only by implementing required ergonomic and occupational health provisions at the earliest. Methods like RULA can be used to analyze the health hazards faced by artisans in other crafts also. Training programs for tool usage and safe practices should be implemented to instill awareness and minimize injury risks. Ergonomic tools should be designed carefully to maintain the essence, authenticity, and traditional nature of the craft.

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Measuring Patient Satisfaction in Health Tourism: An Empirical Study of Healthcare Services in the Malabar Region of Kerala

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ABSTRACT

Health tourism has become a notable segment within the global tourism sector, with Kerala recognized as one of the premier destinations in India, attributed to its sophisticated healthcare infrastructure, proficient medical professionals, and traditional wellness practices. The Malabar region, which includes districts such as Kozhikode, Malappuram, and Kannur, has experienced a consistent rise in both domestic and international medical tourists. This study seeks to evaluate patient satisfaction in health tourism by examining the quality, accessibility, affordability, and overall experience of healthcare services in this area. The research employs an empirical methodology, gathering primary data from patients who have utilized medical services in selected hospitals throughout the Malabar region. Essential factors such as service quality, staff responsiveness, treatment efficacy, infrastructure, and post-treatment care are analyzed to ascertain their impact on patient satisfaction. Additionally, secondary data from journals, reports, and government publications bolster the analysis. The results indicate that patient satisfaction is significantly affected by the professionalism of healthcare providers, cost-effectiveness, and the combination of modern medicine with traditional Ayurvedic treatments. Nonetheless, challenges such as language barriers, waiting periods, and the absence of standardized international accreditation in certain facilities were also noted. The study concludes that improving service quality, implementing patient-centric strategies, and enhancing healthcare infrastructure can greatly elevate the overall health tourism experience in the Malabar region. The research offers valuable insights for policymakers, healthcare providers, and tourism stakeholders to foster sustainable development in health tourism.

KEYWORDS: *Health tourism, Patient satisfaction, Medical facilities, Kerala Malabar region, Healthcare service quality.*

INTRODUCTION

Health tourism, commonly known as medical tourism, has experienced significant growth in recent decades as more individuals travel internationally to obtain affordable, high-quality healthcare services.

This trend is influenced by various factors, such as increasing healthcare expenses in developed nations, extended waiting times for medical treatments, and the presence of advanced medical technologies in developing countries. India has become a leading destination for health tourism, providing a blend

of world-class medical expertise and cost-effective treatment alternatives. Within India, Kerala stands out due to its strong healthcare system and its reputation for holistic wellness practices. Kerala's healthcare model is frequently regarded as one of the finest in the nation, marked by high literacy rates, a robust public health infrastructure, and a well-established private healthcare sector. The state is globally acknowledged not only for its modern medical facilities but also for its traditional medicinal systems, especially Ayurveda. This unique combination positions Kerala as a favored destination for health tourists in search of both curative and wellness-focused treatments. The Malabar region, situated in the northern part of Kerala, encompasses districts such as Kozhikode, Malappuram, and Kannur. Over the years, this area has evolved into a vital center for healthcare services, drawing patients from neighboring states as well as international visitors, particularly from the Middle East and Africa. The availability of multi-specialty hospitals, proficient healthcare professionals, and comparatively lower treatment costs than those found in metropolitan areas have all played a role in the expansion of health tourism in this region. Patient satisfaction is essential in assessing the success and sustainability of health tourism. It is a multifaceted concept that includes various elements of healthcare delivery, such as service quality, communication, responsiveness, infrastructure, and the overall patient experience. Patients who are satisfied are more inclined to recommend healthcare facilities to others, thus improving the reputation and competitiveness of the destination. On the other hand, dissatisfaction can result in negative word-of-mouth and impede the sector's growth. In the realm of health tourism, patient satisfaction is even more critical, as patients are not merely consumers of healthcare services but also tourists who evaluate their entire experience, which encompasses travel, accommodation, and cultural factors. Consequently, healthcare providers must implement a comprehensive approach that caters to both the medical and non-medical needs of patients. Aspects such as ease of access, availability of information, cultural sensitivity, and post-treatment support are crucial in influencing patient perceptions. The Malabar region offers a distinctive opportunity to investigate patient satisfaction within health tourism.

Although it has experienced significant advancements in healthcare infrastructure, there is a pressing need to systematically assess service quality and pinpoint areas for enhancement. This study aims to address this gap by exploring the primary factors influencing patient satisfaction and evaluating how well healthcare facilities in the region fulfill the expectations of health tourists. Moreover, the escalating competition among healthcare destinations on both national and international fronts necessitates ongoing enhancements in service delivery. Nations such as Thailand, Malaysia, and Singapore have positioned themselves as premier medical tourism centers by prioritizing quality assurance, accreditation, and patient-focused services. For Kerala, particularly the Malabar region, to maintain its competitive edge, it is crucial to comprehend patient expectations and tailor healthcare services accordingly. This research employs an empirical methodology to assess patient satisfaction, concentrating on essential aspects such as quality of care, staff conduct, infrastructure, affordability, and overall experience. Through the examination of patient feedback, the study aims to offer actionable insights that can assist healthcare providers in refining their services and improving patient outcomes. Furthermore, the research contributes to the wider conversation on sustainable health tourism by emphasizing the necessity of balancing economic development with quality healthcare delivery. As the demand for health tourism continues to grow, it is vital to ensure that the expansion of healthcare services does not jeopardize patient safety and satisfaction. In summary, this study highlights the importance of patient satisfaction as a key measure of success in health tourism. By concentrating on the Malabar region of Kerala, the research offers a localized viewpoint that can guide policy decisions and strategic planning. The results are anticipated to benefit healthcare institutions, tourism authorities, and policymakers in their endeavors to promote Kerala as a premier destination for health tourism.

REVIEW OF LITERATURE

Sharma et al. (2023) investigated the significance of hospital accreditation and quality standards within the realm of medical tourism. Their findings indicated that hospitals with international accreditation generally provide higher levels of patient satisfaction, attributed

to their compliance with standardized procedures, enhanced safety protocols, and superior service delivery systems.

World Health Organization (2023) underscored the importance of patient-centered care as a core element of healthcare quality. The report pointed out that honoring patient preferences, providing timely care, and ensuring effective communication are essential for improving satisfaction, particularly in the context of cross-border healthcare services.

Nair et al. (2024) conducted an analysis of healthcare service quality in South India through the lens of the SERVQUAL model, concluding that reliability, responsiveness, and assurance are the key factors influencing patient satisfaction. Additionally, the study highlighted the crucial role of well-trained healthcare personnel in achieving favorable patient outcomes.

Joseph and Mathew (2025) carried out a region-specific investigation in the Malabar region and noted that improvements in hospital infrastructure, the availability of multi-specialty services, and the adoption of modern medical technologies have led to increased patient satisfaction. Nonetheless, deficiencies in post-treatment care and follow-up services were recognized as areas requiring enhancement.

Sreedharan (2025) concentrated on Ayurvedic and wellness tourism in Kerala, discovering that the combination of traditional healing methods with contemporary medical treatments boosts patient satisfaction, especially among international tourists in search of holistic care.

Gupta and Reddy (2026) underscored the significance of cost transparency and minimized waiting times in enhancing patient satisfaction. Their research highlighted that concealed costs and delays adversely influence the perception of healthcare services among medical tourists.

Rahman et al. (2026) investigated the experiences of international patients in Indian hospitals and concluded that while affordability and clinical outcomes are notable advantages, language barriers and the absence of cultural support services can affect overall satisfaction levels.

LOGICAL BACKGROUND OF THE STUDY

Health tourism has emerged as a strategic sector within the global healthcare and tourism industries, propelled by a growing demand for affordable, high-quality medical services across international borders. Nations such as India have gained recognition due to their cost advantages, skilled healthcare professionals, and advanced medical infrastructure. In India, Kerala has established itself as a premier destination, providing a distinctive blend of contemporary medical care and traditional healing practices like Ayurveda. The Malabar region of Kerala, which includes districts such as Kozhikode, Malappuram, and Kannur, has witnessed significant growth in healthcare facilities, including multi-specialty hospitals and wellness centers. This expansion has drawn both domestic and international patients, especially from areas where healthcare expenses are elevated or services are scarce. As competition among medical tourism destinations escalates, ensuring high levels of patient satisfaction is vital for sustaining growth and retaining a competitive advantage. Patient satisfaction is widely acknowledged as a crucial measure of healthcare quality and effectiveness. It is shaped by various factors, including service quality, staff conduct, treatment results, infrastructure, affordability, and the overall patient experience. In the realm of health tourism, satisfaction encompasses not only clinical care but also non-medical elements such as hospitality, accessibility, and post-treatment assistance. Despite the swift growth of healthcare services in the Malabar region, there is a notable absence of comprehensive empirical research evaluating patient satisfaction in this particular context. Gaining insights into patient perceptions is essential for pinpointing deficiencies in service delivery and enhancing healthcare standards. Consequently, this study is fundamentally based on the necessity to assess how well medical facilities in the Malabar region fulfill patient expectations and contribute to the broader advancement of health tourism.

IMPORTANCE OF THE STUDY

This research is of considerable significance within the expanding health tourism sector, especially in the Malabar region of Kerala. As health tourism increasingly contributes to economic growth, it is crucial to

comprehend patient satisfaction to guarantee the quality and sustainability of healthcare services. To begin with, the study offers important insights into the elements that affect patient satisfaction, including service quality, infrastructure, costs, and staff conduct. Recognizing these elements enables healthcare providers to enhance their services and implement patient-centered strategies, thus improving overall healthcare delivery. Moreover, the research is vital for policymakers and governmental bodies, as it provides empirical data that can aid in the development of effective strategies to foster health tourism. By grasping patient expectations and experiences, authorities can create policies focused on enhancing infrastructure, accreditation standards, and international competitiveness. Additionally, the study enriches the academic domain by addressing the existing gap in literature concerning the Malabar region. Although numerous studies have investigated medical tourism in India and Kerala, there is a scarcity of research specifically analyzing patient satisfaction in this area, making this study a significant contribution to the current body of knowledge. Furthermore, the research is advantageous for hospital administrators and healthcare organizations, as it underscores areas that need enhancement, such as waiting times, communication, and post-treatment care. Improving these factors can result in higher patient retention rates, favorable word-of-mouth, and a more robust reputation in the global health tourism arena. Lastly, the research is crucial for patients and health tourists, as it highlights the significance of quality care and overall experience. By addressing the identified deficiencies, healthcare providers can ensure safer, more effective, and satisfactory treatment experiences.

ANALYSIS AND DISCUSSION

The analysis is based on primary data collected from 120 patients who availed healthcare services in selected medical facilities in the Malabar region of Kerala. Statistical tools such as percentage analysis and mean score analysis are used.

Table 1: Demographic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	68	56.7

	Female	52	43.3
Age	Below 30	30	25.0
	31-50	55	45.8
	Above 50	35	29.2
Type of Patient	Domestic	82	68.3
	International	38	31.7

Interpretation

The majority of respondents are male, comprising 56.7% of the sample, and predominantly belong to the age group of 31-50 years, which accounts for 45.8%. Domestic patients constitute the majority of the sample, suggesting that regional healthcare services are extensively utilized by local populations, while international patients also represent a notable segment.

Table 2: Patient Satisfaction with Service Quality

Satisfaction Level	Frequency	Percentage (%)
Highly Satisfied	48	40.0
Satisfied	52	43.3
Neutral	12	10.0
Dissatisfied	8	6.7
Total	120	100

Interpretation

A significant portion of respondents, specifically 83.3%, indicated that they are either satisfied or highly satisfied with the quality of service provided. This reflects positively on the performance of healthcare facilities in the Malabar region in terms of delivering quality services; however, the existence of a small percentage of dissatisfied patients points to potential areas for enhancement.

Table 3: Factors Influencing Patient Satisfaction (Mean Score Analysis)

Factors	Mean Score (out of 5)	Rank
Doctor Competence	4.6	I
Staff Behavior	4.4	II
Infrastructure	4.2	III
Cost of Treatment	4.1	IV
Waiting Time	3.6	V

Interpretation

Doctor competence is identified as the most critical factor affecting patient satisfaction, followed closely by staff behavior and infrastructure. Conversely, waiting time received the lowest mean score, highlighting that delays in service delivery continue to be a concern for patients.

Table 4: Satisfaction with Non-Clinical Services

Services	Satisfied (%)	Not Satisfied (%)
Accommodation	78	22
Food Services	72	28
Travel Assistance	65	35
Language Support	60	40

Interpretation

Although accommodation and food services achieve relatively high satisfaction ratings, travel assistance and language support exhibit lower levels of satisfaction. This underscores the necessity for improved support services, particularly for international patients.

Table 5: Overall Patient Satisfaction

Level	Frequency	Percentage (%)
High	50	41.7
Moderate	54	45.0
Low	16	13.3

Interpretation

The majority of patients report moderate to high levels of satisfaction, indicating a generally favorable perception of healthcare services. Nevertheless, the presence of 13.3% of patients expressing low satisfaction suggests that certain service deficiencies still persist.

SUGGESTIVE RECOMMENDATIONS

1. Improve waiting time management through efficient scheduling systems.
2. Enhance doctor–patient communication to build trust and satisfaction.
3. Provide multilingual support services for international patients.
4. Strengthen post-treatment follow-up and care services.

5. Upgrade hospital infrastructure with advanced medical technologies.
6. Ensure transparency in treatment costs and billing processes.
7. Train staff in patient-centered care and hospitality management.
8. Develop integrated travel and accommodation assistance for health tourists.
9. Increase adoption of digital health services such as telemedicine.
10. Promote international accreditation to enhance global credibility.
11. Improve coordination between tourism and healthcare sectors.
12. Focus on personalized treatment plans to meet patient expectations.
13. Enhance hygiene and sanitation standards across all facilities.
14. Establish dedicated help desks for foreign patients.
15. Conduct regular patient feedback surveys for continuous improvement.

FURTHER DIRECTION OF RESEARCH

Future research on health tourism and patient satisfaction can be expanded in several meaningful directions to deepen understanding and improve practical outcomes.

1. Comparative studies can be conducted between the Malabar region and other leading medical tourism destinations such as Chennai, Mumbai, or international hubs like Thailand and Malaysia.
2. Longitudinal studies may be undertaken to examine changes in patient satisfaction over time and assess the long-term impact of healthcare improvements.
3. Future research can focus specifically on international patients to better understand cross-cultural expectations, language barriers, and service preferences.
4. An in-depth analysis of the role of digital health technologies, including telemedicine and AI-based services, can be explored in enhancing patient satisfaction.

5. Studies can investigate the relationship between hospital accreditation (such as NABH or JCI) and patient satisfaction levels.
6. Research may be extended to examine the economic impact of health tourism on regional development and local communities.
7. Further studies can explore patient loyalty, revisit intention, and word-of-mouth behavior in the context of medical tourism.
8. Qualitative research approaches, such as interviews and case studies, can provide deeper insights into patient experiences and perceptions.
9. Future work can analyze the integration of traditional systems like Ayurveda with modern medicine and its effect on satisfaction levels.
10. Research can also focus on identifying specific challenges faced by smaller healthcare facilities in competing with large multi-specialty hospitals.

CONCLUDING OBSERVATIONS

The present study highlights that patient satisfaction is a critical determinant in the success and sustainability of health tourism in the Malabar region of Kerala. The findings indicate that the region has made significant progress in developing healthcare infrastructure and delivering quality medical services, thereby attracting both domestic and international patients. High levels of satisfaction were observed particularly in relation to doctor competence, treatment effectiveness, and the professionalism of healthcare staff, which serve as key strengths of the region. At the same time, the study reveals that certain non-clinical aspects require further attention. Issues such as waiting time, language barriers, limited travel assistance, and gaps in post-treatment care were identified as factors that can negatively influence patient experience. Since health tourism involves both medical and hospitality components, addressing these areas is essential for providing a holistic and satisfactory experience to patients. The study also underscores the importance of affordability and accessibility in shaping patient perceptions. Competitive pricing, combined with quality care, positions the Malabar region as a promising destination in the global health tourism market. However, with increasing competition from other national and international destinations, continuous improvement in service delivery and adoption of global

standards is necessary. Overall, the research concludes that while the Malabar region demonstrates strong potential and performance in health tourism, a more patient-centric and integrated approach is required to enhance satisfaction levels further. Strengthening both clinical excellence and supportive services will not only improve patient outcomes but also contribute to the long-term growth and global recognition of Kerala as a leading health tourism destination.

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Title

Should be as far as possible precise and confined to the contents in the manuscript.

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A single paragraph with a maximum of 200-250 words. Should comprise of important aims/objectives, results of the work and conclusions presented in the manuscript. Reader should easily understand and get a clear idea of what has been achieved and covered in the manuscript. Avoid the detailed information on the methodology followed.

Keywords

At the end of the abstract, in a separate line provide 4-6 familiar terms as keywords.

Introduction

Explain the background or past and present scenario of the problem under investigation. Start with general, then focus on to the research area. Make sure that all relevant materials or sources used as references must be cited in the text in sequential order and listed under references /bibliography in order as they appear.

Literature Review/Survey

Provide broad definitions and discussions of the topic and incorporate views of others (literature review) into the discussion to support, refute or demonstrate your position on the topic. Make sure that all relevant materials or sources used as references must be cited in the text and listed under references /bibliography in order as they appear within square brackets like [1, 2] at appropriate places.

Methodology

Provide the details of the materials or questionnaire used and the description of the standard experimental procedures and methods followed throughout the research work or survey. Make sure that all relevant materials or sources used as references are cited and listed. While doing the experiments/survey, adverse results if any obtained no need to present in the article. Make sure that all relevant materials or sources used as references must be cited in the text in sequential order within square brackets like [1, 2] and listed under references /bibliography.

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Acknowledgement

Authors can take the opportunity to acknowledge the persons who supported/encouraged in successfully completing the research work or survey and also the funding agencies.

References

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Journal Articles

Author 1 Name, Author 2 Name and Author 3 Name (Year), *Title of the Article*, *Title of the Journal Title in Italic*, Publisher Name, Publisher City Name, year. For example,

1. Bocky M Nat, Dolphin P Gem, Mcrath H. Sam (2021), "*Transforming Education Through Tech Age*", International Jour. of Sustainable Technologies, Vol. 47, No.03, Pp 56-65.
2. Bilroth N. Creen, Jingle M.S, Richy K. Mount (2023). *Embracing the Emerging Trends*, Int. Jour. of Engineering and Technologies 25(2): 35-42.

Conf. Proceedings

James F. Kennedy and Raj N. Cramp "*Studies on Recycling of Treated Waste from CETP for Green Belt Development*" at International Conference on "Special Conference on Water Quality" organized by the ABC College of Engineering & Technology, New Delhi, during 01-03 July2023.

Books

Author 1 Name, Author 2 Name and Author 3 Name, *Title of the Journal Title in Italic*, Publisher Name, Publisher City Name, year. For example,

Y. M. Bapu and S.M. Sastry, "*A Text Book on Machine Learning*", Indian Society for Technical Education, New Delhi, 2023.

Theses

Ph.D Scholar Name, Title of the Ph.D thesis, Name of the University, year.

Patent

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