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From the Desk of the Chief Editor

The NEHU Journal is primarily focussed on research and review work based on contemporary multidisciplinary topics and covers various academic domains, including science and technology, social sciences, humanities, economics, and management.As we reflect on the purpose and vision of this journal, we recognize that the value of multidisciplinary research lies not only in the coexistence of diverse disciplines but in the conversations they create. Interdisciplinarity invites us to see complexity not as a barrier but as a resource. It reminds us that knowledge is not static but dynamic, shaped continuously by interactions between people, environments, and ideas. This issue, like those before it, is a testament to our commitment to fostering such interactions.

The papers collected in *The NEHU Journal XXIII No 1 (2025)* offers a unique opportunity to explore cutting-edge research and innovative ideas that could lead to a paradigm shift in management practices.This issue features a collection of 11 rigorously peer-reviewed articles and research papers that cover various aspects, including fostering sustainable development, artificial intelligence in modern management, customer relationships, evolving educational landscape, education in transition, advanced learning tools, etc. These contributions represent significant advancements in the field and provide valuable insights for academics, practitioners, and students alike. Each article in this volume exemplifies how the convergence of different academic traditions can illuminate issues that might otherwise remain obscured when approached in isolation.This journal has traditions that keep it interesting and special, and these will continue.

This editorial would be incomplete without acknowledging the broader challenges that shape academic research today. I would like to extend our deepest appreciation to all the authors for their insightful contributions, the diligent external referees for their rigorous peer-review process, and the entire editorial board for their tireless efforts. Their dedication ensures the quality and relevance that our readership expects.

Looking ahead, we envision *The NEHU Journal* expanding its reach through digital accessibility, increased collaboration with scholars and institutions across India and abroad, and the continued promotion of research that resonates with contemporary societal concerns. We aim to strengthen our editorial processes, encourage thematic issues that address emerging global challenges, and involve a broader network of reviewers and contributors. As the academic world becomes more interconnected, our journal must evolve in ways that enhance its relevance, impact, and academic integrity. Above all, we hope they will encourage scholars to embrace the power of interdisciplinarity in understanding and addressing the complex challenges of our time.

Prof. Fameline K. Marak
Chief Editor

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Economic Empowerment through Homestay Tourism: A Case Study of Rural Communities in West Garo Hills District

Dimchi T Sangma*, Sunildro L.S. Akoijam

Department of Management,
North-Eastern Hill University , Tura Campus, Meghalaya-794002, India
**Corresponding author:sangma441@gmail.com*

Abstract

Homestay tourism has become a powerful tool for rural development, providing long-term jobs for people in poor regions and giving tourists a more profound understanding of the culture. In the West Garo Hills District of Meghalaya, India, which is known for its beautiful scenery and rich indigenous culture, homestay programs have become a popular way to promote community-based tourism. This study investigates the economic impacts of homestay on the livelihoods of rural families in this district using a descriptive research methodology. Primary data was obtained from homestay operators through personal interviews conducted in selected villages. The results show that homestay tourism significantly boosts household income, encourages people to start their businesses, and increases the demand for goods and services made in the area. Many of the respondents who participated said that the money they make from homestays helps them pay for things like food, school, health care, and savings. This makes their homes more self-sufficient and stable financially. The study, on the other hand, finds that there are big problems that could slow down economic growth, like inadequate infrastructure, not enough training, bad marketing, and seasonal changes. The study suggests that lawmakers and tourism associations should take certain steps to improve the infrastructure, provide training for homestay operators, and come up with full marketing plans. To make homestay tourism more sustainable and help it grow, these steps are needed so that local communities can fully benefit from the district's economic opportunities.

Keywords: homestay tourism, economic impact, community based tourism, rural development

Introduction

Homestay tourism is a new type of community tourism. It allows travelers to enjoy the local culture and helps host communities earn money. Studies show that homestays provide real opportunities to experience local culture, allowing visitors to see rural life, customs, and traditions in a friendly setting (Kafle, 2023; Regmi et al., 2023). Homestay offers genuine travel experiences and improves community well-being by involving locals in participation and decision-making. This model strengthens communities by blending hospitality with cultural preservation and encouraging responsible travel practices (Gautam, 2025). This tourism strategy is an efficient driver of socioeconomic development in rural areas, supporting local economies and providing employment possibilities while conserving indigenous forests and lowering infrastructural expenses (Kafle, 2023; Yasami et al., 2017). It

supports community empowerment and helps preserve local culture. Researchers have found that homestay tourism makes a significant difference in reducing poverty and boosting economic freedom. In fact, stakeholders reported higher incomes as a result of tourism (Goswami et al., 2025).

Homestay tourism has great potential in India because of its rich natural and cultural history, however there are problems with service delivery and infrastructure (Bhan, 2014). The Northeast region, especially Meghalaya, shows this potential with its special tribal culture, beautiful landscapes, and rich ecology (Dkhar & Biswas, 2025). The Garo, Khasi, and Jaintia Hills region, which is part of the Indo-Burma biodiversity hotspot, is particularly biodiverse, with unique agricultural practices, such as shifting cultivation and sacred grove conservation systems created by local tribes. This region's matrilineal communities and mixed cultural traditions create unique tourist attractions (Singh, 2010). Community participation is very important in nature-based tourism in Meghalaya. Local involvement is essential for achieving sustainable development goals that support economic strength, social inclusion, and environmental health (Kumar, 2024). The success of homestay tourism depends on everyone working together. This includes local governments, community members, homestay operators, and NGOs all of which play a role in implementing sustainable practices (Suardana et al., 2024). Despite the possibility of homestay tourism for sustainable community development, it faces major obstacles in both rural and mountainous areas. Inadequate infrastructure, limited financial resources, and poor marketing tactics are major hurdles to the development of sustainable tourism (Bhutio et al., 2022; Kafle, 2023; Matris, 2023).However, problems such as poor infrastructure, changes in seasons, and weak regulations need to be addressed with specific policies and training efforts to make the most of homestay tourism for sustainable growth in rural areas (Tiwari, 2025; Shah et al., 2025).

Interest in community-based tourism such as homestays, has increased recently, but there are still significant research gaps. Many studies have focused on popular tourist spots, leaving remote areas such as the West Garo Hills, unnoticed. This area presents unique challenges and opportunities for community involvement and local ownership. Additionally, there has been little focus on how homestay tourism boosts economic empowerment in areas with poor infrastructure and rich cultural diversity, such as Garo Hills.

Therefore, this study investigates how homestay tourism contributes to the economic empowerment of rural communities in the West Garo Hills District of Meghalaya. Specifically, it seeks to:

- What are the economic benefits of homestay tourism for rural households in West Garo Hills District?
- What major challenges do homestay operators face in running and sustaining their enterprises?

  Objectives of the study:-
  - To assess the economic impact of homestay tourism on the livelihood of rural households in the West Garo hills Districts
  - To identify the key challenges faced by homestay operators in sustaining their business.

Literature Review

Homestay Tourism As Community Based Entrepreneurship

According to Kafle (2023), homestay tourism is a type of lodging in which tourists stay with local families and learn about their culture, customs, and hospitality. This concept allows visitors to immerse themselves in genuine local culture while receiving food, accommodation, and cultural events from host communities (Wijesundara & Gnanapala, 2016). As an alternative to traditional hotels, homestay tourism is popular in remote areas and helps protect forests and keep costs low, while also boosting local economies (Kafle, 2023). As an alternative form of accommodation, homestay travel has changed significantly since early days. The idea has basic features in common with its original forms and has evolved due to different social factors, such as religious beliefs, financial motivations, cultural exchanges, environmental concerns, and goals for sustainable tourism development (Yasami et al., 2017). In Malaysia, homestay tourism was developed from basic "bed and breakfast" options for long-term visitors to an official national tourism product by 1995 (Ramele et al., 2017). Regional development patterns exhibit clear evolutionary stages, as evidenced in China's Mogan Mountain area, which underwent initial development (2007-2011), rapid growth (2012-2015), and maturation (2016-present). These stages are influenced by geographical conditions, transportation access, tourism organization mechanisms, policy impacts, and community engagement (Long et al., 2018). Modern homestay tourism promotes rural socioeconomic development by providing tourists with authentic cultural experiences in home-like settings, while also promoting poverty reduction and sustainable tourism activities (Yasami et al., 2017; Singh, 2014).

Homestay tourism is a type of community-based alternative tourism that allows visitors to experience authentic local culture while staying with the host family. For developing nations with little infrastructure but a wealth of cultural history, homestays are ideal sustainable tourist products (Acharya & Halpenny, 2013). In India, especially in the Indian Himalayan Region, homestays are encouraged as a way to promote sustainable tourism. They help support local traditions and culture, while also providing economic benefits (Thakur et al., 2023). Research has shown that homestays can help promote gender equality by providing income opportunities for women and supporting community development in economic, environmental, and social areas (Acharya & Halpenny, 2013). However, implementation encounters major problems, such as incorrect use of ideas, lack of community leadership, poor marketing skills, and insufficient involvement from stakeholders (Wijesundara & Gnanapala, 2016).

According to Lynch (1999) and Niu Wei (2019), homestays are a unique type of accommodation that is run by families and offer small-scale cultural exchanges in residential areas. Homestays provide visitors with a more genuine taste of the local culture than impersonal hotels do by facilitating one-on-one interactions between hosts and visitors in a warm and welcoming environment (Yasami et al., 2017). Important features are small operations with special pricing, close relationships between hosts and guests, and strong connections with the local culture and environment (Wei, 2019). Homestays help guests adapt to new cultures by letting them join local celebrations and customs, becoming part of

community life (Rawal, 2023). Historical evolution indicates that homestays have consistently offered alternative lodging experiences, motivated by the pursuit of authentic cultural interactions, environmental consciousness, and sustainable tourism development, thus differentiating them from conventional chain hotels (Yasami et al., 2017).

Community-Based Tourism (CBT) has become a method of sustainable development that focuses on involving the community, empowering its members, and using planning processes that start at the grassroots level. Rico and Peterek (2024) suggest that CBT is a way to implement sustainable tourism that involves the community and encourages development using local knowledge and available resources. This theoretical foundation focuses on the connection between participation and empowerment. However, Gutierrez (2023) showed that this relationship was complex. He suggests a new model in which communities need to be empowered first to participate effectively, and ongoing interaction can enhance both participation and empowerment. Research on this topic has increased significantly since 2015, particularly in developing countries, with prevalent themes including community engagement, stakeholder collaboration, and sustainability (Tuyen et al., 2025).

Homestay tourism is emerging as an important concept in India's hospitality sector, with enormous potential for long-term development. According to research, homestays bring economic benefits by reducing poverty, diversifying livelihoods, and empowering local economies, particularly in rural and hilly communities (Kulshreshtha & Kulshrestha, 2019; Lakhera et al., 2024). The idea combines traditional Indian values like “Atithi Devo Bhava” (Guest is God) and “Vasudhaiva Kutumbakam” (The World is One Family), promoting social sustainability and the preservation of culture (Lakhera et al., 2024). Homestay tourism has positive effects on social, economic, and environmental aspects, especially in the Indian Himalayan Region. It helps achieve sustainable development goals and preserves cultural heritage (Sanyal et al., 2023).

Homestay Tourism and Economic Empowerment

Homestay tourism has become an important way to boost the economy, especially in rural areas, by providing people with more ways to make money and make their homes financially more stable. In Malaysia, homestay programs that highlight regional customs and culture have become symbols of rural tourism. These programs aim not only to promote cultural interchange but also to provide additional income and job opportunities in rural communities. This has encouraged more people to participate in homestay tourism and improve their economic status (Pusiran & Xiao, 2013). In Lamjung District, Nepal, homestay operators have seen a steady rise in income and expenses, with many covering their everyday expenses through earnings from homestays (Magar, 2021). These initiatives help economic development in several ways, such as creating jobs, supporting women entrepreneurs, encouraging people to return to their hometowns, building infrastructure, and enhancing living standards (Agarwal & Mehra, 2019; Magar, 2021). According to Regmi et al. (2023), homestay tourism helps reduce poverty, while conserving local customs and culture. Pokhrel and Mahat (2025) found that family member’s health and education outcomes improved as a result of these economic benefits, which means that more people can afford to obtain those

services. In addition to creating direct jobs, homestay tourism encourages the creation of indirect jobs in industries such as local craft, food services, and transportation. China's Mogan Mountain homestay agglomeration is an excellent example of how homestay companies can improve local tourism resources, boost the tourism industry, and create extra jobs (Long et al., 2018). The homestay model provides an opportunity for individuals and families to work for themselves using their homes and local cultural resources. This form of self-employment is clearly seen in the Indian state of Uttarakhand, where homestays and collaborative consumption have helped promote rural sustainability (Kataria et al., 2023). Homestay tourism has become an important way to help women gain economic independence and to support sustainable development in different communities. Studies show that homestay programs help women earn extra income, improve family relationships, and enhance their social influence (Quang et al., 2023). In India, homestay programs have provided job opportunities for 90% of local women and have helped with environmental protection and cultural preservation (Chakraborty, 2019). In Nepal, homestays offer great opportunities for women, helping the community grow and supporting gender equality. Women-operated homestays in Barpak have helped them earn money and participate in tourism development (Acharya and Halpenny, 2013).

Homestay Tourism as a Driver of Rural Entrepreneurship

Homestay tourism has become an important factor in rural entrepreneurship, functioning as a micro-business that offers sustainable job opportunities in rural and tribal areas. People from small villages usually run these programs with little government help. These include agricultural, cultural, and recreational tourist activities (Zamani-Farahani, 2011). The effect of entrepreneurship is especially significant for rural women, who gain psychological, social, and economic skills by running homestay businesses, resulting in socioeconomic empowerment (Singh et al., 2020). According to Chatterjee et al. (2024), homestays act as catalysts for the promotion of regional art, culture, and customs while shifting resources from urban to rural areas through skillfully implemented marketing methods. In Nepal, homestay programs give rural women the opportunity to receive technical and vocational training. However, they face problems because many of them do not have much schooling or know how to read and write, therefore the programs need to be tailored to their needs, and ongoing support is needed (Kanel et al., 2021). Homestay success requires property owners to build skills in management routines and operational capacities, while technology development and transaction management continue to be areas for improvement (Priyatiningsih, 2022). Trust and group action are two important forms of social capital in community-based tourism development that enable locals to successfully participate in homestay programs (Pramanik et al., 2019). The homestay program in Malaysia uses women's social skills and cultural exchanges to help reduce poverty in rural areas and to promote business ownership among indigenous people (Osman & Bakar, 2014). These studies collectively illustrate how homestay tourism incorporates local social institutions, traditional knowledge, and community ownership to promote rural entrepreneurship and sustainable development.

Homestay Tourism in Meghalaya and Northeast India

Homestay tourism in Northeast India has become an important alternative tourism model that offers various advantages for local communities. Research in Arunachal Pradesh indicates that the quality of homestay services positively influences tourist satisfaction, with lodging, facilities, and services being significant variables (Lungtan & Thappa, 2024). The future of homestay tourism in this region has several different aspects. First, it provides a practical tourism model that is in line with development goals. Homestay tourism is important because it helps local communities by promoting economic, social, cultural, and environmental sustainability (Basak et al., 2021). Northeast India's cultural and ecological advantages make homestay tourism more beneficial. These qualities make homestays a good alternative to hotels for guests seeking authentic experience. Homestays enhance tourists' experiences and allow communities to promote their cultures (Acharya & Halpenny, 2013). According to Dutta and Mukhopadhyay (2024), homestay tourism in the Darjeeling Hills is a sustainable way to deal with overtourism because it sends tourists to less-visited areas while still following responsible tourism practices.

Meghalaya has great potential for tourism because of its natural features, such as waterfalls, caves, living root bridges, and a variety of plants and animals (Peinlang, 2019; Nayak & Mishra, 2013; Sarkar et al., 2024). Nature-based tourism has a significant effect on local jobs and income, particularly in helping women involved in tourism. Studies show that it has great potential for boosting the state economy (De & Devi, 2010). According to studies conducted in the state, indigenous traditions and matrilineal society of Meghalaya have a profound impact on homestay tourism, even if they do not have the resources they need, the women in this matriarchal community are self-assured and receptive to visitors' request for cultural tour (Kharkongor et al., 2018). Many women have become successful stakeholders in the tourism industry since the matrilineal structure encourages them to become entrepreneurs (Dutta, 2023). Government support is important for sustainable tourism growth, especially in encouraging community-based tourism and homestays (Lyngdoh, 2022; Suharyanto et al., 2019).

Challenges and Constraints in Homestay Tourism Development

Homestay tourism development encounters important challenges in various regions, limiting its ability to serve as a sustainable rural development strategy. In India's Kumaon region, the main constraints include a lack of money, poor road networks, insufficient leisure activities for youngsters, and inadequate skill development (Singh & Kamruddin, 2024). Homestay tourism encounters an important infrastructure challenge that limits its growth in various countries. In Sri Lanka, homestay operations face challenges owing to insufficient facilities and communication issues, as well as problems such as the absence of formal management systems and a lack of industry awareness (Wijesundara & Gnanapala, 2016). Similarly, Nepal's homestay industry faces major problems such as unclear rules, insufficient infrastructure, and insufficient training (Kafle, 2023). The Sikkim and Darjeeling hill regions face similar challenges, as homestays struggle with limited financial support, marketing issues, and poor solid waste management, which affect the development of sustainable tourism (Bhutio et al., 2022). Yong et al. (2024) highlight that homestay entrepreneurs in

Sabah, Malaysia, face challenges related to advertising, insufficient training, and limited community involvement. Despite these obstacles, homestay tourism holds potential for preserving cultural heritage, fostering local and economic growth, and standardizing tourism.

Research design and Methodology

Research Design

This research uses a descriptive design to examine Economic Empowerment through Homestay Tourism, focusing on rural communities in the West Garo Hills District. In order to provide a clear and accurate picture of the present situation and difficulties linked with homestay tourism in the West Garo Hills district, a descriptive approach is considered suitable because it allows for the systematic description of the study population's characteristics, behaviors, and perceptions.

Study area

This research focuses on Tura, the district headquarters of the West Garo Hills in Meghalaya. Tura, located in the foothills of the Nokrek range, serves as a cultural and administrative center with a population of 74,858 according to the 2011 Census, primarily consisting of the indigenous Garo community. The region is characterized by its natural features, including waterfalls such as Rongbangdare and Pelgadare, as well as streams like the Ganol River. Tura Peak (872 m) is a significant landmark, recognized for its historical importance and popularity as a trekking destination.

Tura was chosen for this research because of its significance as a gateway to key regional tourist destinations, including Balpakram National Park and Siju Cave. This strategic location, combined with its lively local culture, makes it and its surrounding rural villages suitable for the development of homestay tourism, giving a perfect framework for investigating its economic consequences on local households.

Research instrument

This study used a quantitative method. Primary data was gathered from homestay operators through schedule. The schedule was developed by modifying items and constructs derived from prior research. The instrument comprises two sections: the initial section gathers data on respondent’s demographic and household characteristics, including age, gender, educational attainment, family size, and previous occupation. The second section included statements and questions pertaining to the study’s primary variables, including income generation, the economic impact of homestay, entrepreneurial activities, and perceived challenges. A five-point Likert scale, ranging from Strongly Disagree to Strongly Agree, was employed to assess attitudes and perceptions across various items.

Sampling plan

Data were gathered from ten homestay operators in the chosen villages of the West Garo Hills District. Purposive and snowball sampling techniques were utilized in combination. Participants were initially identified through local tourism associations and community leaders, employing purposive sampling methods. These participants then played a key role in

snowball sampling, which uncovered additional homestay operators in the vicinity. As a result, the sample includes a significant number of the active homestay entrepreneurs in the study area.

Tool and techniques for data analysis

Descriptive statistics in Excel were used to examine the study's data. In order to summarize the respondents socio-demographic and livelihood related factors, percentage analysis and frequency distribution were used. To determine the degree of agreement or disagreement with statements regarding economic benefits and challenges, mean score analysis was used to the Likert-scale responses. Tabulation and graphing tools like pie charts were used to make the results easy to understand. Using these approaches, the researcher was able to uncover common trends, assess the economic contributions of homestay, and draw relevant conclusions about their role in empowering rural households in West Garo Hills District.

Results

Table 1: Demographic and Business Profile of Homestay Operators

Variable	Category	Frequency	Percentage
Year of operation	1993	1	10%
	2019	1	10%
	2021	4	40%
	2022	2	20%
	2023	2	20%
Sex of respondents	Male	7	70%
	Female	3	30%
Primary occupation before homestay	Agriculture	4	40%
	Business	3	30%
	Teacher	1	10%
	Government employee	1	10%
	Cabin crew	1	10%
Nature of operation	Full time	6	60%
	Part time	4	40%

The table shows the demographic and business profile of the respondents. Data shows that most homestays (40%) started in 2021, showing increased interest in tourism business recently. Most operators are male (70%), and females make up 30%, indicating that homestay ownership is mainly male in the study area. Before starting their homestay ventures, most respondents (40%) worked in agriculture, followed by those in business (30%). The remaining respondents were in teaching, government service, and other professions (10% each). Sixty percent of respondents run their homestays full-time, while forty percent do so part-time. This shows that homestay tourism is both a main and extra source of income for local business owners.

Table 2: Income Contribution of Homestay to Total Household Income

Variable	Range/ category	Mean
Average monthly income from Homestay	20,000 – 80,000	48,000
Average household income from other sources	30,000 – 3,00,000	79,000

Respondents earn an average of ₹48,000 each month from their homestay businesses. Their average monthly income from other sources is ₹79,000.

This shows that homestays offer extra income, but other income sources make up a bigger part of household earnings. This highlights homestay tourism as both a main and additional way for host families to earn a living.

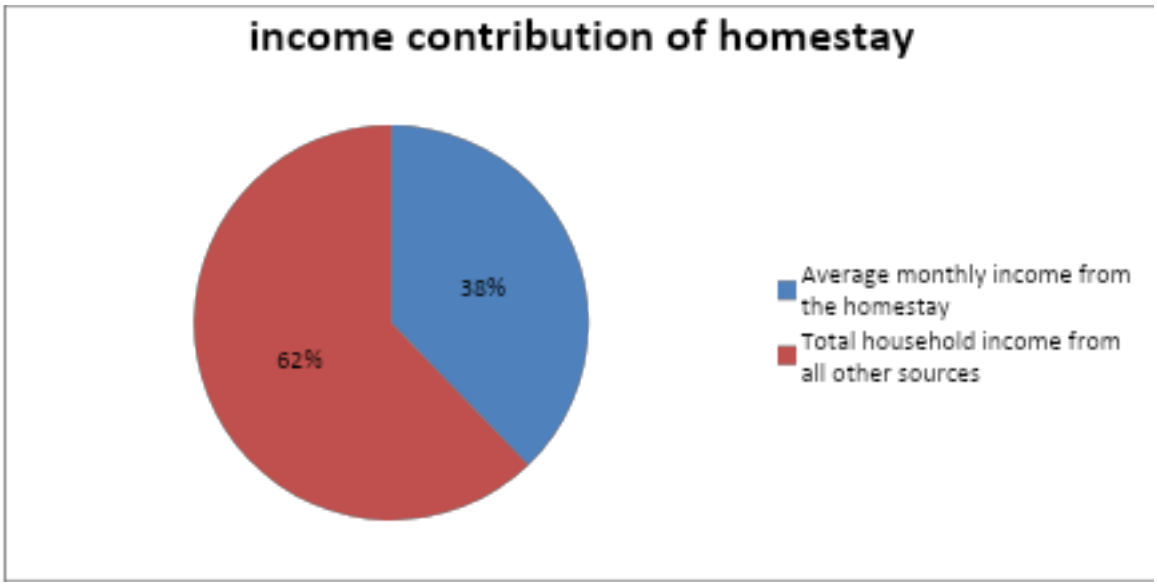

Figure 1: income contribution of homestay to total household income

The chart indicates that 38% of total household income is from homestay operations, while 62% comes from other sources like agriculture or business. Homestay tourism is an important extra income source for local families. The findings show that tourism entrepreneurship is important for improving rural livelihoods and helping community-based economic development.

Table 3: Frequency summary for usage of homestay income

Category of use	Frequency	% of respondent
Children's education	10	17.24
Healthcare	10	17.24
House improvement	8	13.78
Savings	10	17.24
Reinvestment in business	10	17.24
Purchasing assets	1	1.72
Daily household expenses	9	15.52

The table indicates that a large portion of homestay income goes to children's education, healthcare, savings, and business reinvestment, each accounting for 17.24%. Daily household expenses account for 15.52 percent, while home improvement accounts for 13.78 percent. Only a small number of respondents (1.72%) use their income to buy assets. Homestay earnings mainly help family welfare and business growth.

Table 4: Perception of economic impact

Statement	Strongly agree	Agree	Neutral	Total	Mean score
Created new employment opportunities for people	6	4	0	10	6.57
Improved family's standard of living	4	6	0	10	6.29
Homestay income is reliable	5	4	1	10	6.29
Frequently purchase local goods	6	4	0	10	6.57

The findings reveal that respondents have a positive impression of the economic impact of homestay tourism. Most strongly agree that homestays have produced new job opportunities and encouraged regular purchasing of local items, with a mean score of 6.57. Respondents also agree that homestay income is dependable and has raised their family's standard of living, with a mean score of 6.29. The findings show that homestay operations greatly help local jobs, household well-being, and community economy.

Table 5: Challenges in Sustaining Homestay Tourism

Statement	Strongly agree	Agree	Neutral	Disagree	Total	Mean score
Infrastructure issues	4	5	1	0	10	4.30
Finance	4	6	0	0	10	4.40
Seasonality	3	6	1	0	10	4.20
Difficult in marketing	3	5	2	0	10	4.10
High competition	1	4	5	0	10	3.60
Communication barriers	0	4	5	1	10	3.30
High operation costs	0	6	4	0	10	3.60
Lack of training	0	3	6	1	10	3.20
Limited government support	0	2	5	3	10	2.90

The results show that the main challenges for homestay operators are financial issues (mean = 4.40) and infrastructure problems (mean = 4.30). Other major issues are seasonality (4.20) and challenges in marketing (4.10). Moderate challenges like high competition (3.60) and high operating costs (3.60) impact homestay operations. At the same time, communication barriers (3.30), lack of training (3.20), and limited government support (2.90) are seen as less

important. The results show that financial issues, bad infrastructure, and seasonal demand are the main barriers to the growth of homestay tourism in the area.

Discussion

This study shows that homestay tourism in the West Garo Hills District is essential for rural economic growth, but it also encounters major challenges that could impact its future sustainability. The data supports existing literature that views homestays as an effective means for socio-economic development (Kafle, 2023; Goswami et al., 2025). It also confirms the ongoing challenges related to infrastructure and market access in rural areas (Bhutio et al., 2022; Kafle, 2023).

The significant economic impact is clear. Homestays contribute, on average, 38% of total household income, which is strong evidence of their transformative role. This is consistent with research from Nepal and Malaysia, which shows that homestays have offered important additional and main income, helping to reduce poverty and improve financial stability (Magar, 2021; Pusiran & Xiao, 2013). This economic dependence is not just about money; the use of income shows a clear enhancement in human development indicators. The distribution of earnings for children's education, healthcare, and savings highlights how homestay tourism supports sustainable livelihoods, reflecting the findings of Pokhrel and Mahat (2025) on better health and education results. Also, the fact that everyone put money back into the business shows that people are willing to take risks and are committed to long-term growth, not just survival.

The study confirms that homestays contribute to local economic development. Operators often buy goods from local shops and farms, which shows a strong positive impact on the local economy by stimulating other sectors. This finding aligns with Long et al. (2018), who noted the development of indirect jobs in supporting industries in China's Mogan Mountain. Homestays have been seen as having “created new employment opportunities” and “improved the family's standard of living”. This supports their role as a community-based entrepreneurship model, allowing locals to use their homes and culture for economic benefit (Chatterjee et al., 2024; Singh et al., 2020).

While the homestay model shows great potential for community-based tourism, its sustainability is threatened by key challenges such as financial issues, poor infrastructure, seasonality, and marketing difficulties. This finding matches research from the Himalayan region and Sri Lanka, which shows that bad roads, unreliable utilities, and weak marketing are major problems (Bhutio et al., 2022; Wijesundara & Gnanapala, 2016). Households depend on homestay income (38%), making them very vulnerable to low and irregular tourist numbers, which require strategic action. Operators felt confident in their interpersonal skills and saw communication barriers as less important. However, they viewed the “lack of training” and “limited government support” as less critical issues. This contradiction shows that operators may not yet understand how formal training in hospitality, financial management, and digital marketing can immediately alleviate their core marketing and competition issues. This reveals a significant gap where government and NGO initiatives might bring enormous value by not only offering support but also demonstrating tangible results.

Conclusion and implication

This study shows how homestay tourism helps improve rural livelihoods and boosts economic empowerment in the West Garo Hills district of Meghalaya. Results show that income from homestay operations makes up about 38% of total household income, suggesting that homestay tourism is a key source of financial support for local families. Homestay tourism not only generates income but also creates jobs, improves living standards, and promotes local goods, which helps the local economy.

The study highlights several challenges that limit the sustainable growth of homestay tourism. Key constraints are financial issues, bad infrastructure, high costs, strong competition, seasonal tourist flows, and limited marketing knowledge among operators. Additionally, lack of government support and poor training in hospitality management limit the potential of homestay businesses. To support long-term and community-based tourist growth in the region, targeted policy interventions, increased capacity-building and digital marketing campaigns, and enhanced infrastructural development are required.

Limitation and future directions of research

This study offers important insights into how homestay tourism can boost economic empowerment in the West Garo Hills district, but it is essential to recognize some limitations. The sample size was small and focused on a few chosen homestay operators, which might not capture the opinions of all stakeholders in the area. The study mainly used self-reported data, which could be affected by the respondents' own views or biases.

Furthermore, the study concentrated on the economic aspects of homestay tourism, without delving thoroughly into the social, cultural, and environmental issues. Despite these limitations, the findings provide an important foundation for understanding how homestay tourism affects rural livelihoods and provide guidance for further in-depth and comparative research.

Future research could build on this work by comparing homestay tourism in various areas of Meghalaya or the wider Northeastern states. Studies might also look into how satisfied tourists are, the effects on gender empowerment, and the lasting social, economic, and environmental effects of homestay tourism. Moreover, exploring how government policies, community connections, and sustainable practices influence the homestay tourism sector could offer important insights for its improvement.

In conclusion, the results show that homestay tourism can greatly help rural development and empower communities, as long as we tackle the structural and institutional issues effectively.

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Perception of University Students towards the Use of ChatGPT in Learning and Academic Activities

Phalguni Kongjengbam*

School of Management, Khongnangthaba University,
Imphal-East, Manipur-795010, India
**Corresponding author: phalgunik521@gmail.com*

Abstract

AI tools like ChatGPT have become increasingly popular among the University students with the rapid advancement of artificial intelligence (AI) technologies. This paper tries to study the perception of students toward the use of ChatGPT in learning and academic activities. The primary objective of the study is to understand how students perceive ChatGPT and what are its benefits and challenges. Data were collected through questionnaires from a sample of university students. Students perceived that using ChatGPT provides them with various information, it also saves time and also helps in providing personalized tutoring services. The study also shows some barriers which are associated with the use of ChatGPT. The insights of the study will further contribute to ongoing discussion on the responsible use of AI in the learning and academic activities.

Keywords: ChatGPT, University students, perception, learning, artificial intelligence.

Introduction

Across the various sectors, artificial intelligence (AI) has evolved rapidly into a transformative force. With open AI's in learning and education ChatGPT is emerging as one of the most significant innovations. An AI based language model like ChatGPT is able to answer questions, generate human-like text and perform different Natural Language Processing (NLP) activities. Its rapid use in higher educational activities has stimulated both enthusiasm and concern among educators, researchers and students. ChatGPT offers a variety of opportunities such as self-directed learning, enhancing academic productivity and self-directed learning. Whereas on the other hand it raises ethical concerns which include the overall academic integrity, plagiarism and the genuineness of student learning. In recent years, Universities students have witnessed a rise in student's use of ChatGPT for academic purposes such as preparation of examination, summarizing content, programming and essay writing (Lipman & Distler, 2023).The models accessibility and versatility have made ChatGPT into a powerful aid in education, although it has blurred the difference between academic dishonesty and legitimate learning. Some scholars caution that the misuse of ChatGPT undermines the authentic cognitive engagement and could devalue the educational quality (Bozkurt & Sharma, 2020). By considering the different perspectives of AI in education, it is necessary to study how University students perceive the use of ChatGPT as a tool in their academic and learning activities. Integration of AI tools responsibly into higher

education systems requires a proper understanding of students' perception so that it further helps the educators and policymakers in designing effective guidelines. This paper seeks to explore the student's perception toward ChatGPT, the utilization of it in academic and learning activities.

Review of Literature

Uses of ChatGPT in Learning and Academic activities

ChatGPT has expanded its original application in a wide area which include a variety of educational and professional applications, such as language translation, text summarization and programming. Lipman and Distler (2023) highlighted the initial concern which centred on the fear towards academic dishonesty, however users soon recognized the ChatGPT's broader capabilities which include assisting in content creation and computer code. Several functional domains of ChatGPT have been identified by Barari and Kumar (2023) which include e-commerce application, chatbot development, and code debugging and poetry generation. ChatGPT because of its adaptability has made it a key asset for those students who are engaged in tasks which require problem solving, creativity and computational thinking.

ChatGPT has been used to support learning in programming and computer science in the educational context. Malinka et al. (2023) studied ChatGPT's effectiveness in undertaking programming related assessments and assignments.Their findings shows that ChatGPT can successfully optimize, debug and generate code, thus for students learning computational subjects it serves as an educational aid. Further they have also highlighted the importance of human oversight in AI assisted learning, as a limitation which exists in solving the complex numerical problem. These studies have shown that ChatGPT acts as a companion in supporting the different academic disciplines.

Challenges and Ethical Concerns

Despite its advantage, the integration of ChatGPT into learning and academic activities also shows pedagogical and ethical challenges. Bozkurt and Sharma (2020) highlighted that ChatGPT increases vulnerabilities and threatens academic integrity by enabling students to do assignments or examinations. Such wrong utilization diminishes the importance of academic learning and also creates a gap between those students who do not have access to AI tools and those who have access to AI tools. Sometimes, plagiarism detection software fails to recognize the AI generated work making it difficult for the educators (Lipman & Distler, 2023).

The role of AI in higher education remains divided. Some institutions resist the use of AI because of their concerns regarding the assessment fairness and authenticity while some others advocate that the integration of AI will act as a tool for innovation. Hirsh-Pasek and Blinkoff (2023) highlighted that when educational system emphasizes grades over knowledge acquisition, ChatGPT poses risk.Thus, in order to ensure learning objective that focuses on understanding instead of performance metrics, the ethical use of AI in education necessitates reconsideration of pedagogical approaches.

Perception and Adaptation of ChatGPT

Among university students the perception of ChatGPT is developed by their awareness of both the advantages and disadvantages. Students started to recognize ChatGPT as a learning companion which helps them in enhancing their comprehension and efficiency and it has become more embedded in academic routines. The findings of CTVNewsOttawa.ca (as cited in Lipman & Distler, 2023) shows that people's perception towards the AI generated contents differs significantly-many of the individuals find it difficult to differentiate between AI-generated text and handwritten text.

Overall the literature recognizes an increased tension between integrity and innovation in AI-driven education. While ChatGPT offers rooms for improving academic productivity and learning experiences it also challenges traditional concepts of effort and assessment.

Research Gap

Artificial Intelligence tools like ChatGPT have received an important attention in the academic context, however most of the existing studies have focused their studies on the technical abilities, pedagogical challenges and potential risk of academic dishonesty Bozkurt & Sharma, 2020; Lipman & Distler, 2023). Limited research has studied the perception of university students who are the active users of ChatGPT for academic and learning purposes, especially in the context of a developing country like India. The existing literature on ChatGPT shows both scepticism and enthusiasm in respect to the ChatGPT's integration in higher level education, however it lacks insights into how to balance its perceived barriers and benefits. These study gaps call for a systematic exploration of perception of university students towards ChatGPT by emphasizing its ease of use, usefulness and associated cognitive and ethical concerns. Addressing this gap will guide the policymakers and educators by contributing to evidence based understanding in the responsible adoption of AI technologies in academic settings.

Statement of the Problem

The educational landscape has been transformed by the rapid advancement of AI technologies with the introduction of tools such as ChatGPT which help in generating human-like responses, instant access to information and help in academic activities such as writing assistance, summarization and problem solving. Apart from the capabilities to enhance academic efficiency and student learning, there is also a critical question which concerns the authenticity, over-reliance on automated systems and plagiarism. Therefore there is a need to examine the perception of University students towards ChatGPT and to identify its barriers, benefits and how it influences the overall academic arrangement. These will further help in providing a valuable insight for integrating AI into higher education responsibly and will help in designing a policy that promotes meaningful and ethical use of ChatGPT in academic settings.

Research Questions

The study seek to address the following research questions based on the identified gaps:

- In learning and academic activities what is the perception of the university students towards the use of ChatGPT?
- What are the benefits of using ChatGPT among the University students?
- When using ChatGPT what are the Challenges and barriers students experience?

Objective of the study

1. To study the students' perception on the use of ChatGPT as a tool in learning and academic activities.
2. To study the students' perception on the barriers and benefits of using ChatGPT as a learning tool among the students of the university.

Research Methodology

This study uses a descriptive research design which aims to provide an understanding of the perception of the university students towards the use of ChatGPT and the barriers and benefits associated with it in the academic and learning activities. The findings will serve as a foundation for more extensive research in the future. The target population of the research includes the students of Manipur University. The study includes a sample of 160 Manipur University students who are using ChatGPT for learning and academic activities. The participants of the study are selected through a random sampling technique.

For this study a customized questionnaire was used which is based on the previous research done by Zhai (2022), Else (2023), Baker (2021), Dhawan & Batra (2021), Mintz (2023) and Eaton et.al (2021). The questionnaire consists of two sections; the first section includes the demographic profile of the respondent and the second part of the questionnaire consists of the general perception of the university students towards ChatGPT, its benefits and barriers. A 5 point likert scale was used ranging from 5 (Strongly agree) to 1 (Strongly Disagree).The data collected was analysed by using SPSS software.

Analysis and Discussions

Demographic profile of the respondent

Table 1 shows the genders of the respondent that are included in the study. In order to ensure a perfect gender parity in the sample both male (50%) and female (50%) are equally selected among the 160 participants. The finding of the study highlights that the study are not biased regarding any particular gender.

Table 1: Gender of the respondent

Gender	Number of Students	Percentage (%)
Female	80	50.0
Male	80	50.0
Total	160	100.0

Source: Primary data

Table 2 shows the distribution of the university students based on the device that they use while accessing the ChatGPT. 43.1% of the student that is majority of the students use mobile

phones to access ChatGPT whereas 38.8% of the student uses ChatGPT in both mobile phones and laptops. However 18.1 % of the students use ChatGPT only on laptops. The findings highlight that the most preferred device for using ChatGPT is mobile phones.

Table 2: Distribution of the University Students based on Use of ChatGPT in Devices

Use of ChatGPT in device	Number of Students	Percentage (%)
Mobile phone	69	43.1
Laptop	29	18.1
both	62	38.8
Total	160	100.0

Source: Primary data

Table 3 indicates the distribution of the students in accordance with their level of education. 73.8% are pursuing a master degree whereas 26.3% are admitted in Ph.D. programs. This shows that the majority of the sample under study consist of postgraduate students.

Table 3: Level of Education

Level of education	Number of Students	Percentage (%)
Master Degree	118	73.8
PhD	42	26.3
Total	160	100.0

Source: Primary data

Table 4 represents the distribution of 160 students across the different academic disciplines. The highest respondent is from the Statistics department with 15.0% followed by mass communication with 13.8% and 12.5% are MBA students. Out of the total sample MCA students account for 11.9% whereas 10.6% are PhD scholars. Comparatively fewer students are from the departments such as Adult and Continuing Education with 10.0%, Life science (Botany) accounts for 6.3%. The lowest portion of the students is observed in the department of Political Science with 4.4%.

Table 4: Academic discipline Wise Distribution

Academic Discipline	Number of Students	Percentage
PhD	17	10.6
Political science	7	4.4
Mass communication	22	13.8
MBA	20	12.5
MCA	19	11.9
Statistics	24	15.0
Life SC Botany	10	6.3
Adult and continuing education	16	10.0
Geography	10	6.3
Education	15	9.4
Total	160	100.0

Source: Primary data

Reliability statistics

Table 5 highlights the reliability statistics of the three constructs i.e. General perception, benefits and barriers. Cronbach alpha value of 0.676 shows a moderate level of internal consistency which is acceptable in the exploratory and preliminary studies. A Cronbach's alpha value of 0.786 in the benefit scale highlights a good internal consistency. A moderate level of reliability with the Cronbach alpha value of 0.670 is observed in the barrier scale. The result shows that the instruments used are adequately reliable and among the three constructs the benefit scale shows the strongest internal consistency.

Table 5: **Reliability Statistics**

Items	**Cronbach's Alpha**	**Cronbach's Alpha Based on Standardized Items**	**Number of Items**
General Perception	0.641	0.676	6
Benefits	0.784	0.786	7
Barriers	0.518	0.670	7

Source: Author's calculations

General perception of the ChatGPT

Table 6 shows the findings on the general perception of ChatGPT. The finding indicates that the respondents have a positive view towards the ChatGPT. The highest mean score is seen in the statement "ChatGPT is easy to use" with the mean score of 4.47 and SD (Standard Deviation) of 0.624 highlighting that most of the students agreed that ChatGPT is convenient to use. A high mean score is also seen in the statement "ChatGPT can give answers quickly" with the mean score of 4.25 and SD of 0.727 indicating that suggesting that the respondent agrees with ChatGPT efficiency in providing answers.

Table 6: General perception of ChatGPT

General perception	**Mean**	**Std. Deviation**
ChatGPT is easy to use	4.47	0.624
ChatGPT can give answers quickly	4.25	0.727
ChatGPT makes me lazy to think	3.64	0.993
ChatGPT has functioned as a search engine	3.86	0.792
ChatGPT can be used with various input languages	3.69	0.754
ChatGPT is a useful tool for study	4.04	0.764

Source: Author's calculations

The analysis shows a relatively high mean of 4.04 and SD of 0.764 is observed for the statement "ChatGPT is a useful tool for study" indicating that the respondents consider its value in academic and learning tasks. However a lower mean of 3.64 and SD of 0.993 is recorded for the statement "ChatGPT makes me lazy to think" highlighting that some of the respondents feel that ChatGPT reduces the requirement of effortful thinking while the other respondent did not consider ChatGPT in that way. Further a moderately high mean score is

seen for the statement “ChatGPT has a function as a search engine” with the mean of 3.86 and SD of 0.754 and the statement “ChatGPT can be used with various input languages” recorded a mean of 3.69 and SD of 0.754 indicating that the respondents are aware of the multiple use of the ChatGPT. The overall results highlight that the respondent of the study perceived ChatGPT positively and recognized its usefulness.

Table 7 shows a one-sample t-test, it is conducted to do a general comparison of the general perception of ChatGPT with the test value of 3. The result of $t(159) = 26.615$, $p < 0.001$ shows a statistically significant difference. The general perception score is higher than the neutral value indicated by the mean difference of 1.219. The findings of the test show a highly positive perception about ChatGPT indicating a strong agreement in case of its ease of use, usefulness and overall effectiveness.

Table 7: One-Sample Test (test value=3)

One sample test						
	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
General perception	26.615	159	<0.001	1.219	1.13	1.31

Source: Self calculation by the researcher.

Perception on the benefits of using ChatGPT in learning and academic activities

Table 8 highlights the analysis of the perceived benefits of ChatGPT showing that respondents viewed ChatGPT as an advantageous tool for academic and learning purposes. The highest mean score of 4.16 and standard deviation (SD) of 0.708 highlights that most of the respondents agreed with the statement “ChatGPT can help students save time”. The statement “ChatGPT can provide information in diverse fields” also received a relatively high mean of 3.93 and SD of 0.770 indicating that ChatGPT respondent’s recognition of the ChatGPT having a broad informational capacity in multiple subject areas. Similarly a mean score of 3.87 and SD of 0.680 in the statement “ChatGPT can illuminate ideas in writing and improve efficiency” and a mean score of 3.78 and SD of 0.806 in the statement “ChatGPT can help students better understand theories and concepts” got a moderate high mean scores, highlighting that many users of ChatGPT found it as helpful tool for increasing academic productivity and comprehension.

Table 8: Benefits of using ChatGPT

Benefits of using ChatGPT	Mean	Std. Deviation
ChatGPT can help student save time	4.16	0.708
ChatGPT can provide information in diverse fields	3.93	0.770
ChatGPT can translate learning materials into different languages	3.69	0.832
ChatGPT can help students better understand theories and concepts	3.78	0.806
ChatGPT can illuminate ideas in writing and improve efficiency	3.87	0.680
ChatGPT can provide personalized tutoring and feedback	3.72	0.778
ChatGPT can offer personalized and adaptive learning experiences	3.69	0.779

A slightly lower mean value is observed in the statement “ChatGPT can provide personalized tutoring and feedback”, “ChatGPT can offer personalized and adaptive learning experiences” and “ChatGPT can translate learning materials into different languages” with the mean score of 3.72, 3.69, 3.69 and SD of 0.778, 0.779, 0.832 respectively indicating a moderate agreement with the statements among the respondents. The result shows that overall the respondent perceived ChatGPT to act as an educational tool that helps them in saving time, improve learning efficiency and further gives access to diverse information.

Table 9 indicates a one-sample t-test, it was conducted with the test value of 3 to compare the mean score of perceived benefits of ChatGPT. t (159) = 1.632, p = 0.105 shows that the results are not statistically significant. The perceived benefits score was slightly higher than the neutral value with the mean difference of 0.119, although the difference was not significant.

Respondents generally view ChatGPT as beneficial but the perceptions of the respondent are not strong enough to be statistically significant, they were only moderately positive.

Table 9: One-Sample Test (test value=3)

One-Sample Test						
	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Benefits	1.632	159	.105	.119	-.02	.26

Source: Self calculation by the researcher

Perception on the barriers of using ChatGPT in learning and academic activities

Table 10 shows the perceived barrier of ChatGPT highlighting that respondents have moderate concern over the potential drawbacks and limitations of ChatGPT. The highest mean score is observed in the statement “ChatGPT is unable to cite sources accurately” with the mean score of 3.57 and Standard deviation (SD) of 2.537 indicating that accuracy of the citation remains an issue whereas the high standard deviation shows a variation in responses. A relatively high mean score is seen for the statement “ChatGPT can provide inaccurate or false references” with the mean score of 3.56 and SD of 0.815 and statement “ChatGPT can provide unreliable information” with the mean score of 3.54 and SD of 0.800 shows that respondents are aware of lack of source of reliability and occasional inaccuracies.

Table 10: Barriers of using ChatGPT

Barriers of using ChatGPT	**Mean**	**Std. Deviation**
ChatGPT can provide unreliable information	3.54	.800
ChatGPT can provide inaccurate or false references	3.56	.815
ChatGPT is unable to cite sources accurately	3.57	2.537
ChatGPT is unable to replace words or use idioms wisely	3.15	.779
ChatGPT responses weaken after several paragraphs	3.25	.965
ChatGPT cannot assess the reliability of sources	3.28	.745
ChatGPT can exhibit logical errors or contradictions.	3.43	.758

The above table shows a moderate level of agreement is observed in the statement "ChatGPT can exhibit logical errors or contradictions" with the mean score of 3.43 and the SD of 0.758 and in the statement "ChatGPT cannot assess the reliability of sources" highlights a mean score of 3.28 and the SD of 0.745 it indicates that respondent recognize the potential limitation and flaws in the source. Lower mean of 3.25 and the SD of 0.965 is observed for the statement "ChatGPT responses weaken after several paragraphs" and a mean score of 3.15 and the SD of 0.779 for the statement "ChatGPT is unable to replace words or use idioms wisely" indicating that these issues under study are were less perceived by the respondent as a barrier. The finding shows that respondents know the weakness of the ChatGPT mainly related with the reliability and accuracy of its citations and information. Instead of strongly negative respondents shows a moderate concern.

Table 11 shows a one sample t-test with the test value of 3 to compare the mean score of perceived barriers of ChatGPT. t (159) = -2.537, p = 0.012 shows a statistically significant difference. The score of the perceived barrier was significantly lower than the neutral value indicated by the mean difference of -0.144. This highlights that respondents disagreed with the statement which describes the barriers indicating that the respondent did not perceive major difficulties or obstacles in using ChatGPT. The findings show that the users of the ChatGPT experienced few barriers while using ChatGPT in their learning and academic activities.

Table 11: One-Sample Test (test value=3)

One-Sample Test						
	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Barriers	-2.537	159	.012	-.144	-.26	-.03

Source: Authors' calculation

Mean score of general perception, benefits and barriers of using ChatGPT

Table 12 shows that the highest mean is recorded with the general perception of ChatGPT with the mean score of 4.22 and The Standard Deviation (SD) of 0.579. An overall favourable attitude is seen in the analysis of respondents towards the ChatGPT indicating that they strongly agreed with the usefulness and ease of use of the ChatGPT. Mean score of 3.12 and the SD of 0.921 shows that the perceived benefits of ChatGPT were above the neutral value of three indicating that respondents recognized its advantages moderately although there is variation in the response which is reflected by the higher standard deviation.

Table 12: Mean score of general perception, benefits and barriers of using ChatGPT

Items	Mean	Std. Deviation
General Perceptions of ChatGPT	4.22	0.579
Benefits of ChatGPT	3.12	0.921
Barriers of ChatGPT	2.85	0.711
General Mean of ChatGPT	3.396	0.825

A lower mean is observed in the barriers to use of ChatGPT with the mean score of 2.85 and the SD of 0.711 indicating that the users of the ChatGPT generally disagreed with the statements which describe the limitation or difficulties in using the ChatGPT for academic and learning activities. It is confirmed that respondents held a general positive perception of the ChatGPT with the overall mean score of 3.40 and the SD of 0.825. This finding collectively highlights that some respondents showed moderate perception with regards to its specific advantages while a wide number of the respondents consider ChatGPT as a user-friendly and beneficial platform.

Table 13 shows a one –sample t-test which is conducted with a test value of 3 to compare the general mean perception of ChatGPT. Here t(159) = -2.012, p = 0.046 indicating a statistically significant difference. The general perception was slightly lower than the neutral value with the mean difference of -0.131. Thus it can be concluded that overall perception towards the ChatGPT is less positive and they did not strongly favour ChatGPT.

Table 13: One-Sample Test (test value=3)

One-Sample Test						
	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
General Mean	-2.012	159	.046	-.13125	-.2601	-.0024

Source: Self calculation by the researcher

Findings

The finding of the study shows that university students have a positive perception towards the use of ChatGPT in academic and learning activities. The descriptive analysis shows that ChatGPt act as an important tool as most of the respondent agreed that ChatGPT is easy to use with the mean score of 4.47 and the SD of 0.624, it provides quick answers with the mean score of 4.25 and SD of 0.727 and it also serve as useful tool for study with the mean score of 4.04 and SD of 0.764. The one-sample t-test suggest a strong positive attitude toward ChatGPT as the general perception of ChatGPT was significantly higher than the neutral value ($t(159) = 26.615$, $p < .001$)

In the perceived benefits , respondent recognize ChatGPT ability to save time with the mean score of 4.16 and SD of 0.708, provide information across diverse fields with the mean score of 3.93 and the SD of 0.770 and enhances writing and comprehension with the mean score of 3.87 and SD of 0.680. The one-sample t-test highlighted that their views with the ChatGPT is moderately positive.

In the barriers the results highlight that respondents have moderate concern about citation accuracy and reliability. The highest mean score is received for the statement “ChatGPT is unable to cite sources accurately” with the mean score of 3.57 and SD of 2.537 and “ChatGPT can provide inaccurate or false references” with the mean score of 3.56 and SD of 0.815. The one-sample *t*-test shows that while using ChatGPT students did not have major obstacles.

Limitations of the study

- The study was limited only to 160 students of Manipur University, Manipur. And it may not represent the perception of students from other universities or other regions.
- Data was collected for a specific period of time and perception of the student may change as ChatGPT is evolving.

Conclusions

The findings of the study shows that university students perceive ChatGPt as an beneficial and accessible learning tool, these findings align with the previous research which showed AI's ability in helping self-directed and personalized learning (Malinka et al., 2023; Lipman & Distler, 2023).

The study identifies a dual perception of ChatGPT as both a potential source of cognitive and ethical risk as well as an empowering educational tool. It concludes that ChatGPT is a support tool for academic and learning activities. Students appreciate its quick response time, ease of use and helpful in accessing diverse information. Students acknowledge that ChatGPT has certain limitations such as reliability concerns and citation inaccuracies but this barrier is not considered by the students as significant discouragement while using ChatGPT.

The result shows that ChatGPT offers students a platform for efficient, personalized and interactive learning. Although, ethical and responsible use of ChatGPT remains important to ensure that without compromising academic integrity, students benefit from AI tools.

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The Influence of Artificial Intelligence and Entrepreneurship Education on Enhancing the Entrepreneurial Intentions of Female Students in the Universities of Manipur

Thokchom Belinda Devi*, Kiirii Onand Monsang

Department of Commerce, Dhanamanjuri University,
Imphal, Manipur-795001, India
**Corresponding author: belindathokchom123@gmail.com*

Abstract

This study explores the intersection of entrepreneurship education (EE), artificial intelligence (AI), and the entrepreneurial intentions (EI) of female university students in Manipur, India—a region where women's participation in entrepreneurship remains limited due to socio-cultural, financial, and structural barriers. Grounded in the Theory of Planned Behavior, the research investigates how factors such as attitude, gender stereotyping, fear of unemployment, and lack of finance influence entrepreneurial intention, while also examining the moderating role of AI in the relationship between EE and EI. A cross-sectional quantitative survey was conducted with 100 female students enrolled in entrepreneurship-related programs across universities in Manipur. Data were analysed using multiple regression and moderation analysis via Hayes' PROCESS macro. Results indicate that attitude, EE, gender stereotypes, and fear of unemployment significantly and positively influence EI, whereas lack of finance has a negative effect. Notably, AI significantly moderates the relationship between EE and EI, amplifying the positive effect of education on entrepreneurial aspirations. These findings underscore the transformative potential of integrating AI into entrepreneurship education to enhance its effectiveness and inclusivity. The study contributes empirical insights to the discourse on gendered entrepreneurship, digital innovation in education, and policy design for women's economic empowerment in emerging regions.

Keywords: Entrepreneurial intention, women entrepreneurship, entrepreneurship education, artificial intelligence, Manipur, gender stereotyping, higher education

Introduction

Entrepreneurship is a prime driver of economic development, enabling new business development, the creation of revenue streams, and increased community integration. The relationship between entrepreneurship and economic development is both deep and intricate, with the two arenas having similar goals and working complementarily to form a cycle of community. This methodology is an effective strategy for self-employment in the face of current unemployment issues and spurs the development of women's roles in society. In poorer countries, women have traditionally been responsible for maintaining family stability and helping in economic development. They are underrepresented in decision-making at the national level because of religious and cultural prejudices (Vlasenko, 2023). Cultural

stereotypes and biases can pose problems for women who want to pursue entrepreneurial ventures. A number of factors and determinants have been looked at for their strong impact on women's entrepreneurial intentions. Entrepreneurial actions cannot be undertaken without entrepreneurial intention (Bird, 1988). Substantial studies have proved that education in entrepreneurship greatly enhances entrepreneurial intentions among students (Zhao et al., 2005; Souitaris et al., 2007). Universities facilitate entrepreneurial ecosystems through incubators, accelerators, co-working space, and access to investors and mentors (Guerrero et al., 2016). They shape entrepreneurial intention through curriculum design, experiential education, and access to role models. Nabi et al. (2017) also point out that entrepreneurial universities enhance the formal and informal learning experience of students, which develops their entrepreneurial skills and mindset, making them key drivers in the development of regional and national innovation capacity.

Entrepreneurship education can encourage students to gain a better understanding of entrepreneurship, which gives them higher self-efficacy and opportunity recognition capability (Zhao et al., 2005; Karlsson and Moberg, 2013). Certain research identifies a non-significant correlation between entrepreneurial education (EE) and entrepreneurial intention (EI). Oliver Thomas (2003), the author identifies methodological shortcomings in most EE research, including no program evaluation and overuse of self-reported measures. He contends that the positive contribution of EE to EI tends to be exaggerated because of these shortcomings. Individuals with high levels of proactivity can be least influenced by EE programmes, indicating a possible incompatibility between learner types and instruction (Obschonka et al., 2020). Universities have a crucial responsibility of offering Entrepreneurship education to foster entrepreneurial growth (Ncanywa & Dyantyi,2022). Nonetheless, Fayolle (2013) highlights that the majority of programs have no sound theoretical base, thereby making it difficult to assess their real value. Nabi et al. (2017) further contend that the diversity in program design and implementation causes unequal outcomes. This leaves one wondering whether entrepreneurship can truly be taught or whether it is largely influenced by individual character and environmental factors. These challenges have generated demands for stronger evaluations and evidence-based practices in the field. One of the promising solutions lies in the utilization of the power of technological innovations, particularly Artificial Intelligence (AI). This revolutionary technology has become a dominant force, having a profound impact on many aspects of life and redrawing the map of the business world. From streamlining operations to improving user experiences, AI is transforming our interfaces with systems and with one another and setting the stage for a more productive and interconnected future. AI systems could assist in overcoming uncertainty problems and hence open up new avenues of entrepreneurial action and for entrepreneurs of the future. (Townsend and Hunt, 2019). (Acs et al., 2022; Wurth et al., 2023) AI has a central role to play in (digital) entrepreneurial ecosystems in providing means of information exchange, generating and disseminating new products, and driving innovation.

This underlines the useful contribution that AI can make to entrepreneurship education in the contemporary world.This study delves into the integration of Artificial Intelligence (AI) within the realm of Entrepreneurship Education (EE), specifically examining its impact on the entrepreneurial intentions of women students at universities in Manipur. Despite the growing significance of AI in various educational contexts, there remains a paucity of

empirical research focusing on its role in shaping entrepreneurial aspirations. This investigation seeks to fill that gap by exploring how AI can enhance entrepreneurial education and influence the business ambitions of female students in Universities of Manipur, a region where such studies are notably limited.

Review of Literature

Entrepreneurial intention

Entrepreneurial intention (EI) refers to a person's conscious state of mind that directs attention, experience, and behavior toward planned entrepreneurial behavior (Bird, 1988). It is widely regarded as the most important predictor of entrepreneurial behavior and a precursor to the actual act of venture creation. Thompson (2009) further refined the definition, describing EI as "a self-acknowledged conviction by a person that they intend to set up a new business venture and consciously plan to do so at some point in the future."
Understanding EI is critical because it serves as a proximal predictor of entrepreneurial behavior. Since actual venture creation is rare and difficult to capture in short-term studies, EI acts as a meaningful and measurable construct for early-stage entrepreneurship research (Fayolle & Liñán, 2014). Liñán & Chen (2009); Lee & Wong (2004) The decision to pursue an entrepreneurial career is the first step in the protracted process of becoming an entrepreneur, which can be viewed as a time-consuming process. Ajzen's theory of planned behavior (TPB) and Shapero A.'s entrepreneurial model (1982) are two of the main ideas that have been used to investigate the propensity for entrepreneurship, particularly among college students. TPB, proposed by Ajzen (1991), views intention as a result of three psychological components—personal attitude toward entrepreneurship, perceived social expectations (subjective norms), and the belief in one's own ability to carry out entrepreneurial tasks (perceived behavioral control). On the other hand, Shapero's model (1982) emphasizes how significant life events can act as catalysts, prompting individuals to consider entrepreneurship when they perceive it as both desirable and achievable. While TPB focuses on planned, rational decision-making, SEE introduces the idea of situational triggers that push individuals toward entrepreneurial action. Together, these frameworks offer valuable insights into the psychological and contextual factors shaping entrepreneurial intentions.

Factors affecting women entrepreneurial intention

Attitude is a core construct in the Theory of Planned Behavior (Ajzen, 1991) and significantly influences entrepreneurial intention. It represents an individual's positive or negative evaluation of entrepreneurship as a career choice. Studies consistently show that a favorable entrepreneurial attitude increases the likelihood of intending to start a business (Krueger, Reilly, & Carsrud, 2000; Liñán & Chen, 2009). Shahriar et al. (2024) found that positive attitudes among university students in Bangladesh strongly predict entrepreneurial intention, highlighting the importance of fostering such attitudes through education and support programs. Additionally, gender differences exist, as women's entrepreneurial intentions are often linked to attitudes related to balancing organizational and personal life demands (Maes, Leroy, & Sels, 2024). Access to finance plays a crucial role in shaping entrepreneurial intentions among university students in developing economies. Shahriar et al.

(2024) found that having easier access to financial resources significantly increases students' motivation and confidence to start their own businesses. Without sufficient funding options, even students with strong entrepreneurial traits may hesitate to pursue ventures, highlighting the importance of financial support alongside education programs. Bongomin et al. (2017) found that limited access to financial resources often restricts business expansion and innovation. They also highlighted that financial literacy plays a crucial role in enabling entrepreneurs to better utilize available funding. Without sufficient financial support, many startups struggle to survive, making access to finance a critical barrier for entrepreneurs.

Chowdhury (2017) clearly demonstrated that access to funding is a key driver of entrepreneurial mindsets and intentions. This underscores the importance of funding in empowering and motivating entrepreneurs to seize opportunities and innovate. According to Chowdhury (2017), the availability of funding has a significant impact on the development of entrepreneurial attitudes and goals. Aspiring business owners can develop their concepts and move their endeavors forward with more confidence when they have access to financial resources. In a similar vein, Islam (2021) emphasized that the availability of funding options greatly increases entrepreneurial intention, highlighting the importance of financial support in encouraging and facilitating entrepreneurial endeavors. When taken as a whole, these studies demonstrate how crucial easily available capital is to creating a thriving entrepreneurial climate. Laguía et al., (2022). Even though entrepreneurship has the potential to help women grow economically and socially, women are still disproportionately underrepresented in entrepreneurial endeavors worldwide. Gender stereotyping—socially embedded ideas about the roles, skills, and traits considered suitable for women—is one of the subtle but pervasive barriers females encounter. In addition to influencing how others perceive female entrepreneurs, these preconceptions also affect how women evaluate their own abilities and prospects in the business world.

Haus et al., (2013); Camelo Ordaz et al. (2016) have been repeatedly found to reduce women's confidence in their entrepreneurial skills, which is a key factor in determining their desire to launch a firm. Steinmetz et al., (2021) When being an entrepreneur is linked to characteristics that are generally associated with men, women may question their ability to succeed. Social traditions in many societies deter women from starting their own businesses, particularly in fields where males predominate. These social norms serve as subjective standards that deter women from pursuing starting their own businesses as a respectable or legitimate career path.

Governments and politicians frequently promote self-employment as a feasible career option, and entrepreneurship is widely seen as a solution to unemployment, especially during times of economic distress or high unemployment rates. However, there is continuous discussion over the relationship between unemployment and the desire to start your own business. Some view entrepreneurship as a last resort, while others see it as a proactive option for those who are unemployed. According to research by Kolvereid and Isaksen (2006), jobless persons have a higher desire to start their own business than do employed people, particularly if they can also access government programs or training. According to Arenius and Minniti's (2005) analysis, necessity-driven entrepreneurship tends to increase in low-income nations based on data from the Global Entrepreneurship Monitor (GEM). However, Fayolle and Gailly (2015)

argue that not all unemployed people are ready or able to start a business; fear of failure, low confidence in one's skills, and a lack of capital are major barriers.

Li and Wu (2019), Entrepreneurship-focused educational programs aim to increase students' aspirations to start their own business. The ways that entrepreneurship education increases these entrepreneurial ambitions have been demonstrated by research (Nabi et al., 2018). First of all, it enables students to enhance their entrepreneurship-related information, abilities, attitudes, and even personal characteristics through its courses and services (Wu et al., 2022). Second, incorporating real-world experiences such as field research, internships, and extracurricular activities gives students access to creative ideas and worthwhile entrepreneurial encounters. Sun J, Shi J, and Zhang J (2023) claim that by improving students' attitudes, drive, and initiative, entrepreneurship education (EE) has a beneficial effect on entrepreneurial intentions (EI). According to data collected from Chinese students, EE strengthens EI, especially when supported by psychological factors and early exposure to entrepreneurship. These findings highlight the value of thoughtfully designed courses and supportive learning environments in encouraging entrepreneurial behavior. Indian college students studying entrepreneurship are more likely to have heightened entrepreneurial inclinations, according to Pandit et al. (2018).

Townsend et al. (2018), Artificial intelligence (AI) is generally described as intelligent systems that possess the ability to think and learn. The implementation of artificial intelligence technologies is revolutionizing how entrepreneurship is practiced. Kabir (2018), When examining entrepreneurial intentions, AI is a significant factor to take into account, especially given that the adoption of AI technologies is predicted to lead to a substantial wave of innovation, fostering considerable entrepreneurial opportunities and ultimately resulting in positive social and economic outcomes. Davidsson et al. (2018) pointed out that the technological advancements triggered by artificial intelligence can serve as an external impetus for new entrepreneurial ventures. Rahman et al. (2022) demonstrated that AI has a partial mediating effect on the connection between entrepreneurship education and entrepreneurial intention.

Research Aim and Objectives

This research endeavour seeks to systematically address the following questions with the aim of contributing valuable insights to the fields:

- To evaluate the relation between various antecedents or factors and Entrepreneurial intention among female students of Universities of Manipur.
- To study the extent of entrepreneurship education influence on entrepreneurial intentions among female students in Universities of Manipur.
- To study how artificial intelligence enhances entrepreneurship education and fuels the entrepreneurial aspirations of female students in Manipur's Universities.

Hypothesis Development

The following hypotheses have been framed to meet the objectives of the study.

H1: Attitude (AT) significantly influence women’s entrepreneurial intention (EI)

H2: Fear of Unemployment (FU) significantly influences women’s entrepreneurial intention (EI)

H3: Gender Stereotyping (GS) and women's entrepreneurial Intention (EI)

H4: Lack of finance (LOF) negatively influences women's entrepreneurial intention (EI)

H5: Entrepreneurship Education (EE) significantly influences women's entrepreneurial Intention (EI).

H6: Artificial intelligence (AI) moderates the relationship between EE and EI.

Research methodology

This study adopted a quantitative, cross-sectional survey design to examine the influence of entrepreneurship education and artificial intelligence on the entrepreneurial intentions of female university students in Manipur, India. A total of 100 respondents were selected using purposive sampling, targeting female students enrolled in undergraduate and postgraduate programs who had exposure to entrepreneurship-related courses. Data were collected using a structured questionnaire consisting of standardized items measured on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The reliability and validity test, and internal consistency were tested using Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Data analysis was performed using IBM SPSS version 26. Descriptive statistics, multiple regression analysis, and Hayes' PROCESS macro (Model 1) were used to assess direct effects and the moderating role of artificial intelligence. Ethical protocols were followed, with informed consent obtained from all participants and confidentiality maintained throughout the research process

Data Analysis and Interpretation

The reliability and convergent validity of the measurement scales were thoroughly assessed to ensure the robustness of the constructs used in this study. Table 1 presents the results of the reliability and validity of constructs.

Table 1. Results for Reliability and Validity of Construct

Construct	Item Loadings	Cronbach's α	CR	AVE
Entrepreneurial Intentions (EI)	EI1 (.72), EI2 (.84), EI3 (.78), EI4 (.80), EI5 (.75)	0.90	0.87	0.58
Attitude (AT)	AT1 (.70), AT2 (.76), AT3 (.78), AT4 (.74), AT5 (.80)	0.85	0.86	0.55
Lack of Funding (LOF)	LOF1 (.68), LOF2 (.72), LOF3 (.80), LOF4 (.75), LOF5 (.70)	0.82	0.83	0.52
Gender Stereotyping (GS)	GS1 (.60), GS2 (.65), GS3 (.72), GS4 (.74), GS5 (.78)	0.75	0.76	0.48
Future Unemployment (FU)	FU1 (.72), FU2 (.75), FU3 (.80), FU4 (.82)	0.85	0.87	0.60
Entrepreneurship Education (EE)	EE1 (.70), EE2 (.73), EE3 (.84), EE4 (.76), EE5 (.79)	0.80	0.82	0.53
Artificial Intelligence (AI)	AI1 (.68), AI2 (.75), AI3 (.78), AI4 (.82), AI5 (.85), AI6 (.70), AI7 (.72)	0.88	0.89	0.56

Source: Primary Data

It is found that the Cronbach's alpha coefficients ranged from 0.75 to 0.90 across all constructs, indicating good to excellent internal consistency reliability (Nunnally, 1978). Composite reliability (CR) values were all above the recommended threshold of 0.70 (Fornell & Larcker, 1981), further confirming the consistency of the constructs. Convergent validity

was supported by Average Variance Extracted (AVE) values exceeding the minimum acceptable level of 0.50 for most constructs, with only Gender Stereotyping slightly below at 0.48, which is still acceptable given its adequate CR (Fornell & Larcker, 1981). Item loadings for each construct were strong, mostly exceeding 0.60, indicating that the observed variables effectively represent their latent constructs (Hair et al., 2010). These results suggest that the measurement model possesses satisfactory psychometric properties, providing a reliable and valid foundation for subsequent analyses of entrepreneurial intentions and its related factors.

Table 2 presents the Kaiser-Meyer-Olkin (KMO) measure of sample adequacy and Bartlett's Test of Sphericity. The results of the KMO and Bartlett's Test of Sphericity indicate that the dataset is appropriate for factor analysis. The KMO value of 0.778 suggests a good level of sampling adequacy, indicating that the variables share enough common variance to justify the use of factor analysis. Furthermore, Bartlett's Test of Sphericity was statistically significant ($\chi^2(21) = 235.619$, $p < .001$), confirming that the correlation matrix is not an identity matrix and that there are sufficient correlations among the variables. Together, these findings support the suitability of the data for extracting meaningful factors.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.778
Bartlett's Test of Sphericity	Approx. Chi-Square	235.619
	df	21
	Sig.	.000

The regression analysis reveals significant relationships between several predictors and entrepreneurial intention (EI) among women as depicted in Table 3. Attitude (AT) exhibits a positive and statistically significant influence on entrepreneurial intention ($\beta = 0.424$, $p < 0.001$), indicating that more favorable attitudes toward entrepreneurship are associated with stronger intentions to pursue entrepreneurial activities. Similarly, concerns about future unemployment (FU) positively predict entrepreneurial intention ($\beta = 0.502$, $p = 0.003$), suggesting that the fear of joblessness motivates women to consider entrepreneurship as an alternative career path.

Table 3: Hypothesis Testing

Relationships	**Estimate (β)**	**Standard Error (SE)**	**Critical Ratio (t)**	**p-value**	**Hypothesis Verification**
H1: Attitude (AT) → Entrepreneurial Intention (EI)	0.424	0.114	3.713	<0.001**	Supported
H2: Future Unemployment (FU) → EI	0.502	0.164	3.053	0.003**	Supported
H3: Gender Stereotyping (GS) → EI	0.286	0.107	2.685	0.009**	Supported
H4: Lack of Finance (LOF) → EI	-0.480	0.160	-3.000	0.003**	Supported (Negative Influence)
H5: Entrepreneurship Education EE → EI	0.323	0.111	2.913	0.004**	Supported

Notes: $R = 0.611$, $R^2 = 0.373$, Adjusted $R^2 = 0.347$, Std. Error of Estimate = 3.964

Gender stereotyping (GS) also shows a significant positive effect on entrepreneurial intention (β = 0.286, p = 0.009). This finding may imply that despite prevalent stereotypes, women's awareness or experiences related to gender bias potentially fuel their entrepreneurial aspirations, possibly as a means to challenge or overcome such societal constraints.
Notably, lack of finance (LOF) demonstrates a significant negative impact on entrepreneurial intention (β = -0.480, p = 0.003). This confirms the hypothesis that financial constraints serve as a substantial barrier, diminishing women's likelihood or readiness to engage in entrepreneurial activities.
Entrepreneurship Education (EE) has a significant positive effect on women's Entrepreneurial Intention (EI), with an unstandardized coefficient (β) of 0.323 (SE = 0.111). The effect is statistically significant (t = 2.913, p = 0.004), indicating that higher levels of entrepreneurship education are associated with greater entrepreneurial intention among women.
The model explains approximately 37.3% of the variance in entrepreneurial intention (R^2 = 0.373), reflecting a moderate level of explanatory power.
The moderation effect of the construct relating to the relationship between Entrepreneurship Education (EE) and Entrepreneurial Intention (EI) may be had from Table 4.c

Table 4: Moderation Effect Construct

Hypothesis Test	β	**SE**	**t**	**P**	**95% CI for** β	**Verification**
H6: AI moderates EE→EI	0.045	0.015	3.00	.003	[0.015, 0.075]	Supported

Source: Primary Data

Hypothesis 6 (H6) proposed that Artificial Intelligence (AI) moderates the relationship between Entrepreneurship Education (EE) and Entrepreneurial Intention (EI). The interaction term between EE and AI was statistically significant (β = 0.045, SE = 0.015, t = 3.00, p = .003), with a 95% confidence interval that excluded zero ([0.015, 0.075]). This finding provides empirical support for H6.
The positive coefficient of the interaction term suggests that the effect of entrepreneurship education on entrepreneurial intention becomes stronger as artificial intelligence integration increases. In other words, students who experience higher exposure to AI technologies and tools appear to derive greater benefit from entrepreneurship education in shaping their entrepreneurial intentions. This finding is consistent with recent studies highlighting the role of AI in enhancing experiential learning, decision-making skills, and cognitive engagement in educational settings (Dwivedi et al., 2021; Margherita et al., 2022). Moreover, the use of a statistically rigorous moderation analysis approach (Hayes, 2022) strengthens the confidence in the interpretation of this interaction effect.

Main Findings

The study found that female students' entrepreneurial ambitions in Manipur's universities were significantly positively impacted by entrepreneurship instruction, attitude, expectations about future unemployment, and gender stereotypes. It was discovered that a lack of funding had a detrimental effect on these goals, underscoring the significant obstacle that funding presents for female entrepreneurs. Importantly, it has been demonstrated that artificial intelligence (AI) greatly modifies the association between entrepreneurial intention and entrepreneurship education, strengthening the impact of education on students' aspirations to pursue entrepreneurship. This implies that entrepreneurship education programs can be made more effective by incorporating AI technologies, which will encourage female students to have more entrepreneurial aspirations. The significance of the chosen predictors was confirmed by the model's moderate ability to explain the variance in entrepreneurial intention.

Suggestions

- Curriculum Innovation with AI Integration: Higher education institutions should embed AI tools and platforms (e.g., business simulation software, chatbots, predictive analytics) within entrepreneurship programs to foster real-time, experiential, and adaptive learning environments.
- Targeted Financial Support for Women Entrepreneurs: Financial institutions, governments, and university incubators must design gender-specific funding schemes and microfinance programs tailored to women in entrepreneurship, with simplified access, mentorship, and financial literacy components.
- Challenge Gender Norms through Role Models and Peer Learning: Universities should proactively feature female entrepreneurs as guest speakers, mentors, and case studies to dismantle stereotypes and reinforce self-efficacy among women.
- Leverage Fear of Unemployment Constructively: Recognize the motivational impact of employment uncertainty by designing career-readiness modules that position entrepreneurship as a proactive career strategy rather than a fallback plan.
- Regional and Cultural Customization: Education policy must be localized to address the unique socio-cultural dynamics of regions like Manipur. Community-driven entrepreneurship education that resonates with local values and opportunities can enhance engagement and impact.
- Further Research: Future studies should explore longitudinal impacts of AI-enhanced entrepreneurship education, including venture creation outcomes and sustainability. Comparative studies across regions and genders can also provide richer insights into the scalability of such interventions.

Conclusions

This study underscores the critical role of both human and technological factors in shaping the entrepreneurial intentions of female students in higher education, particularly within emerging regions such as Manipur. Entrepreneurship education significantly contributes to fostering entrepreneurial intent, especially when delivered in environments enriched by artificial intelligence technologies. The moderating effect of AI reveals that digital transformation in educational delivery is not merely complementary but essential in amplifying learning outcomes, particularly for entrepreneurial skill development.

Furthermore, non-cognitive and contextual variables—such as attitude, fear of unemployment, and gender norms—play significant roles in determining entrepreneurial motivation. The presence of gender stereotypes, while traditionally seen as a barrier, may paradoxically act as a motivator for women seeking to redefine their societal roles. However, lack of access to finance continues to be a pressing constraint, calling for structural interventions beyond education alone. Collectively, these findings provide empirical insights into how a digitally inclusive and context-sensitive entrepreneurial ecosystem can empower women to actively pursue self-employment and innovation.

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Relationship Marketing as a Strategic tool for Building Customer Loyalty in the Banking Sector

Thongam Bijiyarani Devi[1,*], Sorokhaibam Keshorjit Singh[2]

[1] DVSSD, Manipur University, Imphal West, Manipur -795003, India
[2]MIMS, Manipur University, Imphal West, Manipur -795003, India
**Corresponding author: chanthongam2017@gmail.com*

Abstract

After the economic liberalization of 1991, the Indian banking sector underwent significant changes and became highly competitive due to the access of many multinational companies (MNCs). Therefore, retaining core competencies was the vital strategy for all banks. One of the most effective marketing practices adopted by numerous banking organizations is relationship marketing. Relationship marketing plays a crucial role in securing customer loyalty, which in turn strengthens competitiveness and refine customer satisfaction. This study investigates the various factors contributing to customer loyalty and analyzes the influence of relationship marketing dimensions on customer loyalty. Both exploratory and descriptive research designs were employed and data were collected from 510 banking customers across 6 different banks using stratified random sampling. For data analysis, percentage analysis, factor analysis and multiple regression analysis were employed. The findings recommend that banks in Manipur can significantly strengthen customer loyalty by fostering trust, demonstrating service commitment, effectively managing conflicts, and maintaining clear and transparent communication.

Keywords: Relationship marketing, customer loyalty, public banks, private bank, Manipur.

Introduction

In the current era of globalization and intense competition, marketing practices are rapidly evolving. Customers have become increasingly demanding and well-informed, largely due to the widespread use of the internet and Smartphone. As a result, marketing studies now extend beyond the traditional 4Ps, reflecting significant shifts in markets, demographic profiles, and consumer segments. These changes have led to the emergence of multi-tiered and complex networks, ushering in a new horizon for relationship marketing. Establishing strong relationships with customers encourages repeat purchases and drives increased firm revenue. When emotional connections with customers are robust, firms are more likely to experience positive business outcomes and enhanced customer retention.

The term "Relationship Marketing" was first introduced by Leonard L. Berry in 1983 at the American Marketing Association's Services Marketing Conference. Berry and Parasuraman (1991) later defined relationship marketing as "a process of attracting, developing, and

retaining customer relationships," highlighting core principles such as trust and mutual benefit. Theodore Levitt further emphasized that ongoing relationships between organizations and customers depend on service quality and customer satisfaction, adding that the quality of goods and services is a critical component in relationship marketing.

Literature Review

Relationship marketing has been extensively studied across various sectors, with key themes emerging such as trust, commitment, communication, and conflict-handling as essential elements in building customer loyalty. Dwyer et al. (1987) described five phases of a relationship: awareness, exploration, expansion, commitment, and dissolution, which are characterized by varying degrees of interaction between the selling organization and its customers.

Too et al. (2001) examined the effects of relationship marketing dimensions viz. trust, commitment, communication, conflict management, and competence on customer satisfaction and relationship quality, identifying five foundational principles that distinguish customers based on perceived relationship quality and satisfaction.

Ndubisi and Ndubisi (2014) analyzed the impact of relationship marketing on customer loyalty, focusing on four main variables: trust, commitment, communication, and conflict-handling, finding these factors significantly influence customer loyalty and are interrelated. Prasad and Aryasri (2008) studied the effects of trust, commitment, communication, empathy, and conflict handling on attitudinal outcomes like relationship quality and behavioral outcomes such as customer loyalty, particularly within the evolving food retail sector in India. This work has provided valuable insights for both academic researchers and retail managers.

Gaurav (2008) identified trust, customer focus, and communication as critical factors influencing customer loyalty, also examining the demographic impacts of gender, income, and education in a study of 130 bank customers in Hyderabad. The findings suggested that Indian bank management should concentrate on these variables to enhance customer loyalty. Furthermore, Too et al. (2001) highlighted that acquiring new customers is more costly than retaining existing ones, underscoring how relationship marketing can increase customer loyalty through tested conceptual models in retail settings.

Jumaev and Hanaysha (2012) noted that customer loyalty remains a significant concern in the banking sector due to fierce competition and heightened customer expectations, investigating causal factors in Malaysia's banking industry. Similarly, Narteh et al. (2012) explored the influence of six relationship marketing dimensions including competence, commitment, conflict handling, trust, communication, and relational bonds on customer loyalty in the Ghanaian hotel industry, recommending practical relationship marketing strategies for hotel managers.

Al-hersh (2018) examined the connections between relationship marketing and customer loyalty by employing customer trust and satisfaction as mediators, using structural equation modeling on data from 150 customers to affirm the significant influence of relationship marketing dimensions.

Al-hersh (2018) also studied customer relationship marketing's effect on customer satisfaction in Saudi Arabia and Jordan's banking industries, incorporating variables like trust, commitment, communication, empathy, social bonding, and promise fulfillment, moderated by gender, age, income, and education. The study advocated for banks, including Arab Bank in these countries, to leverage CRM for maintaining market share.
Ali and Bisht (2018) compared customer satisfaction levels in public and private sector banks in India, attributing lower satisfaction in public banks to tangible and behavioral factors.
Marketing and Hasan (2019) investigated the impact of relationship marketing orientation on customer loyalty among Bangladeshi banking customers, considering demographic influences and analyzing how trust, commitment, conflict handling, communication, and bonding affect loyalty, positive word of mouth, and customer retention. Based on these comprehensive studies, the current research focuses on four key constructs of relationship marketing: Trust, Commitment, Communication, and Conflict-handling.

Objectives of the Study

- To examine the various factors contributing to customer loyalty.
- To analyze the influence of relationship marketing dimensions on customer loyalty.

Hypotheses of the study

a. Ho_1: There is no significant influence of relationship marketing dimensions on customer loyalty
b. Ha_1: There is significant influence of relationship marketing dimensions on customer loyalty

Research Methodology

This study engaged both exploratory and descriptive research designs. The exploratory design was utilized to gain deeper insights into the research topic and to clarify key concepts and constructs (Chawla & Sondhi, 2016). Descriptive research design, being more structured and formal, was adopted to provide a comprehensive explanation of the phenomena under investigation (Kothari, 2004). A total of 600 respondents were initially selected from six different banks, comprising three public sector banks—State Bank of India, Punjab National Bank, and Bank of Baroda—and three private sector banks—HDFC, AXIS, and ICICI. After eliminating 50 incomplete and 40 incorrectly filled questionnaires, the final sample size consisted of 510 respondents. To ensure that the sample was representative, stratified random sampling was employed (Cochran, 1977). Primary data collection was conducted using structured questionnaires, while both primary and secondary sources were consulted to inform the study. The reliability of the survey instrument, as presented in Table 1, is evaluated using Cronbach's Alpha, with values exceeding 0.9 for all dimensions (Trust, Commitment, Conflict-handling, and Communication), confirming a high level of internal consistency.

Table 1: Reliability Check

Variables	Cronbach's alpha
Trust	**0.927**
Commitment	**0.952**
Conflict-handling	**0.919**
Communication	**0.924**

Reliability was assessed using Cronbach's Alpha, with values above 0.9 across all dimensions (Trust, Commitment, Conflict-handling and Communication), confirming strong internal consistency.

Percentage analysis was used to present results pertaining to customer demographic variables and to explore the relationship between these demographic factors and customer loyalty within the context of relationship marketing.

Factor analysis was conducted to identify the key dimensions of relationship marketing that contribute to customer loyalty, aligning with the methodology outlined by Comrey & Lee (2013). Multiple regression analysis was applied to examine how various relationships marketing variables influence customer loyalty, enabling a precise understanding of the strength and direction of these relationships.

Data Analysis and Interpretation

Socio-demographic profile

Table 2 shows the profile of the sample respondents, indicating a judicious selection of respondents. 79.4% of the respondents have accounts in public sector banks while only 20.6% have accounts in private sector banks. Male respondents (54.5%) slightly outnumbered females (45.5%) indicating a slight predominance of male participants. (42.2%) of the respondents are found to be graduates and (29.4%) are postgraduates. It has been found that (32.9%) of respondents are salaried whereas (29.6%) are self-employed.

Table 2: Respondent Profile

Parameters	Categories	Frequency	Percent
Bank type	Public	405	**79.4**
	Private	105	**20.6**
Gender	Male	278	**54.5**
	Female	232	**45.5**
Qualification	Matriculate	34	**6.7**
	12 Std	67	**13.1**
	Graduate	215	**42.2**
	Post-Graduate	150	**29.4**
	Doctorate	25	**4.9**
	Professional	19	**3.7**
	Salaried	168	**32.9**

	Self-employed	151	**29.6**
Occupation	Student	127	**25.0**
	Retired	16	**3.1**
	Housewife	48	**9.4**
	Total	N=510 (Respondents)	100%

Source: Primary data

Factor Analysis

To identify the underlying dimensions of relationship marketing contributing to customer loyalty in the banking sector, principal component analysis (PCA) was employed. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, as presented in Table 3, is exceptionally high at 0.970, and Bartlett's Test of Sphericity was significant (χ^2= 13780.85, p < 0.001), confirming suitability for factor analysis.

Table 3: Test of sample adequacy through KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.970
Bartlett's Test of Sphericity	Approx. Chi-Square	13780.854
	df	465
	Sig.	.000

From the factor analysis, four components were extracted, each representing a relationship marketing construct: Trust, Commitment, Communication, and Conflict-handling. These components together described 70.18% of the total variance, indicating a robust factor structure within the data.

Table 4: Communalities with initial 1.000

Communalities	
	Extraction
The bank is trustworthy.	0.683
The bank maintains fund security.	0.597
The bank offers secured net banking facilities.	0.624
The bank has reliable employees.	0.687
The bank keeps the records accurately.	0.658
The bank's promises are reliable.	0.722
The bank performs its obligations to customers	0.731
The bank is constant in delivering premier services.	0.699
The bank has responsible employees.	0.737
The bank had provided promised services consistently on committed time.	0.701
The bank adjusts to meet the customers' requirements.	0.728
The bank offers personalized services to meet customer need.	0.731
The bank is cooperative when its services are revised and in serving customers' need.	0.647
The bank employees are always open-handed.	0.745
The bank employees are kindly and polite.	0.787
The bank employees deliver quick response to complaints.	0.742

The bank sends immediate reply for online queries.	0.646
. The bank tries to avoid potential conflict.	0.584
The bank resolves manifested conflicts before they create problems.	0.721
The bank has the capability to tackle solutions when problems arise.	0.700
The bank solves the complaints within a short period.	0.731
Complaints are dealing in friendly manner.	0.719
Conflict outcome brings benefit to the customer.	0.634
The bank provides actual response to online complaints.	0.631
The bank delivers accurate and timely information.	0.654
The bank imparts information regarding any new banking service.	0.700
The bank employees inform customers exactly when the services will be executed.	0.709
The bank has a toll free customer care helpline which operates 24hrs a day.	0.546
The bank uses text messages, emails to notify customers of new products.	0.638
The bank has a suggestion box placed in a strategic point in the banking hall.	0.532
The bank makes and fulfils promises	0.766
Extraction Method: Principal Component Analysis.	

It was evident from Table 4 above that the variance of 31 variables of factors contributing to customer loyalty ranges from 0.532 to 0.787. This shows that the factors contributing to customer loyalty in the banking sector of Manipur vary from 53% to 78%.

Table 5: Rotated Component Matrix[a]

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
The bank employees are kindly and polite.	**0.796**	0.226	0.274	0.240
The bank employees are always open-handed.	**0.745**	0.220	0.288	0.259
The bank has responsible employees.	**o.743**	0.311	0.233	0.207
The bank offers personalized services to meet customer need.	**0.742**	0.305	0.159	0.258
The bank adjusts to meet the customers' requirements	**0.729**	0.246	0.329	0.203
The bank employees deliver quick response to complaints.	**0.698**	0.237	0.364	0.258
The bank is cooperative when its services are revised and in serving customers' need.	**0.670**	0.375	0.174	0.300
The bank had provided promised services consistently on committed time.	**0.632**	0.263	0.283	0.307
The bank sends immediate reply for online queries.	**0.628**	0.218	0.343	0.296
The bank's promises are reliable.	0.254	**0.768**	0.180	0.195
The bank offers secured net banking facilities.	0.110	**0.738**	0.248	0.126
The bank keeps the records accurately.	0.137	**0.735**	0.289	0.177
The bank performs its obligations to customers	0.379	**0.716**	0.165	0.235
The bank is trustworthy.	0.310	**0.704**	0.192	0.231
The bank has reliable employees.	0.429	**0.661**	0.222	0.189
The bank is constant in delivering premier services.	0.423	**0.655**	0.140	0.243
The bank maintains fund security.	0.142	**0.652**	0.363	0.172
The bank employees inform customers exactly when the services will be executed.	0.185	0.263	**0.764**	0.183

The bank uses text messages, emails to notify customers of new products.	0.332	0.293	**0.730**	0.167
The bank imparts information regarding any new banking services.	0.410	0.302	**0.654**	0.302
The bank makes and fulfils promises	0.336	0.311	**0.633**	0.316
The bank delivers accurate and timely information.	0.265	0.259	**0.631**	0.225
The bank has a suggestion box placed in a strategic point in the banking hall.	0.319	0.323	**0.592**	0.200
The bank has a toll free customer care helpline which operates 24hrs a day.	0.514	0.182	**0.580**	0.296
The bank resolves manifested conflicts before they create problems.	0.260	0.273	0.243	**0.755**
The bank tries to avoid potential conflict.	0.114	0.244	0.046	**0.748**
The bank has the capability to tackle solutions when problems arise.	0.351	0.227	0.295	**0.679**
Conflict outcome brings benefit to the customer.	0.366	0.151	0.266	**0.649**
The bank solves the complaints within a short period.	0.452	0.218	0.315	**0.621**
Complaints are dealing in friendly manner.	0.301	0.218	0.406	**0.605**
The bank provides actual response to online complaints.	0.507	0.163	0.272	**0.597**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

The factorisation of the thirty-one variables has been done through the Rotated Component Matrix as illustrated in Table 5. It implies that the matrix comprises 4 components from which the first factor constitutes 9 variables. In the same way, the second factor consists of 8 variables. Besides, the third factor consists of 7 variables. Likewise, 7 variables formed the fourth factor contributing to customer loyalty.

The rotated component matrix illustrates the factor loadings of the identified components derived through Principal Component Analysis (PCA) with Varimax rotation. The rotation converged in 7 iterations, producing a clear and interpretable factor structure with four distinct components:

Component 1: Commitment

Items in this component (e.g., employee politeness, helpfulness, personalized service, flexibility) loaded strongly (0.628–0.796), demonstrating these attributes collectively illustrate commitment to customers.

Component2: Component 2: Trust

This factor included variables such as reliability of promises, fund security, and record keeping, with loadings between 0.652 and 0.768, emphasizing the bank's role in fostering trust.

Component3: Communication

Relevant items (timely information, notification of new services, suggestion box, customer care helpline) loaded from 0.580 to 0.764, highlighting transparent, prompt communication as vital for loyalty.

Table 6: Total Variance Explained for factors influencing customer loyalty

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.108	55.188	55.188	17.108	55.188	55.188	7.023	22.654	22.654
2	1.971	6.358	61.546	1.971	6.358	61.546	5.516	17.795	40.449
3	1.361	4.390	65.936	1.361	4.390	65.936	4.735	15.274	55.722
4	1.316	4.246	70.183	1.316	4.246	70.183	4.483	14.460	70.183
5	.788	2.542	72.724						
6	.656	2.115	74.840						
7	.578	1.866	76.706						
8	.529	1.707	78.413						
9	.493	1.591	80.003						
10	.479	1.546	81.549						
11	.427	1.376	82.926						
12	.409	1.320	84.246						
13	.406	1.311	85.557						
14	.385	1.243	86.799						
15	.373	1.203	88.002						
16	.348	1.123	89.125						
17	.328	1.059	90.184						
18	.310	.999	91.182						
19	.284	.915	92.098						
20	.271	.874	92.972						
21	.261	.841	93.812						
22	.234	.756	94.568						
23	.228	.735	95.304						
24	.219	.708	96.012						
25	.215	.694	96.705						
26	.203	.655	97.360						
27	.189	.608	97.969						
28	.175	.566	98.534						
29	.165	.531	99.065						
30	.154	.495	99.560						
31	.136	.440	100.000						
Extraction Method: Principal Component Analysis.									

Table 7: Summary of the principal factors with their respective attributes

Sl. No.	Principal Factors	Attributes	Factor Score
1	Commitment	The bank employees are friendly and polite.	.796
		The bank employees are always generous to help.	.745
		The bank has responsible employees.	.743
		The bank offers personalized services to meet customer need.	.742
		The bank makes adjustments to suit customers' needs	.729
		The bank employees give response to complaints.	.698
		The bank is flexible when its services are changed and in serving customers' need.	.670
		The bank had provided promised services consistently on committed time.	.632
		The bank gives immediate reply for online queries.	.628
2	Trust	The bank's promises are reliable.	.768
		The bank provides secured net banking facilities.	.738
		The bank keeps the records accurately.	.735
		The bank fulfils its obligations to customers	.716
		The bank is honest and truthful.	.704
		The bank employees are trustworthy.	.661
		The bank is consistent in providing quality services.	.655
		The bank provides fund security.	.652
3	Communication	The bank employees tell customers exactly when the services will be performed.	.764
		The bank uses text messages, emails to notify customers of new products.	.730
		The bank provides information when there are new banking services.	.654
		The bank makes and fulfils promises	.633
		The bank provides accurate and timely information.	.631
		The bank has a suggestion box placed in a strategic point in the banking hall.	.592
		The bank has a toll free customer care helpline which operates 24hrs a day.	.580
4	Conflict-handling	The bank tries to solve manifested conflicts before they create problems.	.755
		The bank tries to avoid potential conflict.	.748
		The bank has the ability to openly discuss solutions when problems arise.	.679
		Conflict outcome gives benefit to the customer.	.649
		The bank gives result to the complaints within a short period.	.621
		Complaints are handled in friendly manner.	.605
		The bank gives proper response to online complaints.	.597

Source: Extracted from table 5

Component 4: Conflict-handling-

This dimension included conflict avoidance, prompt complaint resolutions, and friendly handling, with loadings from 0.597 to 0.755; these are essential for addressing customer grievances and sustaining loyalty.

The extracted factors collectively explained 70.18% of the variance, with individual contributions of 55.18%, 6.35%, 4.39%, and 4.24% respectively for Commitment, Trust, Communication, and Conflict-handling as presented in Table 6.
This indicates that these four constructs are strongly supported by the data and significantly define how relationship marketing influences customer loyalty.

The factors extracted through the Rotated Component Matrix have been rearranged in above table 7 with their respective attributes for further clarity. It was found that four factors contributed to customer loyalty in the banking sector of Manipur. They are (1) Commitment, (2) Trust, (3) Communication, and (4) Conflict-handling.

Multiple Regression Analysis

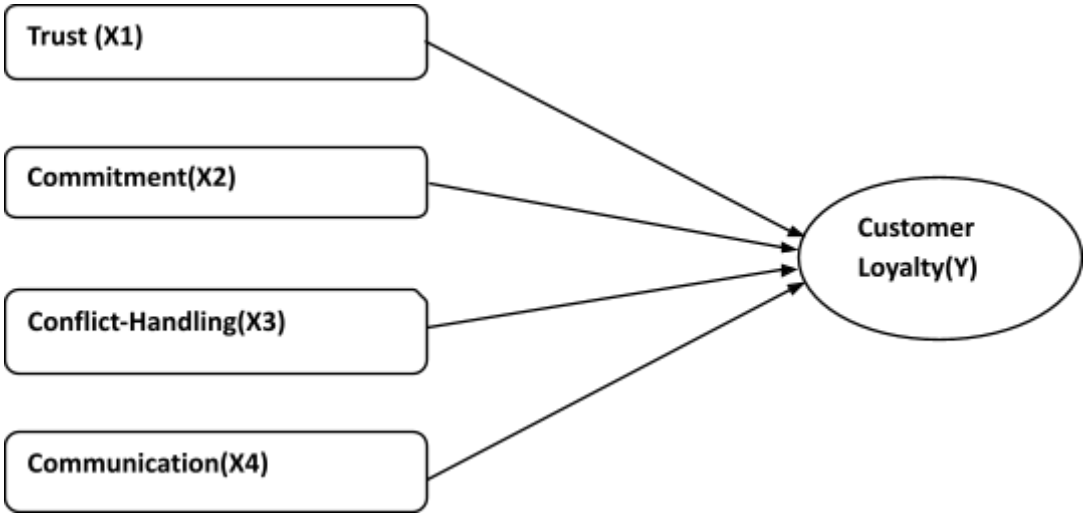

Figure 1: Multiple Regression model of Relationship Marketing and Customer Loyalty

From this multiple regression model (Figure1), Trust, commitment, conflict-handling and communication are taken as independent variables and customer loyalty as dependent variables.

Table 8: Descriptive statistics of customer loyalty and dimensions of relationship marketing

Descriptive Statistics			
	Mean	Std. Deviation	N
Customer Loyalty	3.90	0.840	510
Trust	4.16	0.701	510
Commitment	3.82	0.885	510
Conflict-handling	3.71	0.728	510
Communication	3.9275	0.83668	510

Trust had the highest mean score (M=4.16), highlighting its central role in customer loyalty, while Conflict-handling scored lowest (M=3.71). Commitment exhibited the greatest variability (SD=0.885), suggesting diverse perceptions among respondents.

Table 9: Multicollinearity of factors influencing customer loyalty

Sl. No.	Predictors	Collinearity Statistics	
		Tolerance Value (TV)	Variance Inflation Factor (VIF)
1	Trust	0.516	1.937
2	Commitment	0.375	2.665
3	Conflict-handling	0.459	2.177
4	Communication	0.428	2.338

a. Dependent Variable: Customer Loyalty

As shown in table 9, the values of VIF range between 1.937 and 2.665 which are below 10, it hints at the existence of non-collinearity among the independent variables. Further, the tolerance value is greater than 0.1, which signifies that there is no confirmation of multicollinearity. As a result, it can be considered that there is no significant proof of multicollinearity issues in the independent variables. Therefore, correlation can be initiated.

Table 10: Correlations between customer loyalty and dimensions of relationship marketing

Correlations						
		Customer Loyalty	Trust	Commitment	Conflict-handling	Communication
Pearson Correlation	Customer Loyalty	1.000				
	Trust	0.637	1.000			
	Commitment	0.636	0.630	1.000		
	Conflict-handling	0.647	0.561	0.703	1.000	
	Communication	0.669	0.639	00.696	0.630	1.000

It is visible from the above table 10 that all the correlation values are positive, indicating a positive relationship among the variables. This suggests that as one variable increases, the other tends to increase as well. In other words, the variables move in the same direction, reinforcing their interdependence in circumstances of relationship marketing background and customer loyalty.

Table 11: Model Summary of Multiple Regression Analysis

Model Summary[b]										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.760[a]	.578	.574	.548	.578	172.625	4	505	.000	1.048
a. Predictors: (Constant):Trust, Commitment, Conflict-handling, Communication										
b. Dependent Variable: Customer Loyalty										

From Table 11, the multiple correlation coefficient I illustrates the relationship strength between the dependent variables (trust, commitment, conflict handling, and communication) and the independent variable (customer loyalty). The value of R varies from -1 to 1. In this analysis, R =0.760, indicating a strong positive relationship between relationship marketing constructs and customer loyalty.

In this multiple regression model, the R^2 denotes coefficient of determination which shows the degree of difference in the dependent variable justified by the regression model. A higher R^2value suggests a better fit of the regression model. Generally, R^2 value varies from 0 and 1, if the value of $R^2 = 1$ implies a perfect fit. A good regression model should have **R^2> or = 0.3**. In this analysis, $R^2 = 0.578$, meaning that 57.8% of the variation is explained by trust, commitment, conflict handling, and communication in customer loyalty. The adjusted R^2 =0.574, further validating the model's suitability.

Moreover, the Durbin-Watson value is 1.048, indicating that no autocorrelation exists in the data sample, which strengthens the reliability of the regression results.

Table 12: ANOVA and F Statistics of customer loyalty with relationship marketing dimensions

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	207.409	4	51.852	172.625	.000[b]
	Residual	151.689	505	.300		
	Total	359.098	509			
a. Dependent Variable: Customer Loyalty						
b. Predictors: (Constant): Trust, Commitment, Conflict-handling, Communication						

Table 12 shows the multiple regression model is significant (F = 172.625, p<0.0) at 5% level of significance. The ANOVA and F- statistics indicate that all the independent variables considered in the study are important in defining customer loyalty.

Furthermore, the significant F- value from the ANOVA test supports the use of multiple regression analysis to examine the influence of relationship marketing dimensions on customer loyalty.

Table 13: Coefficients of customer loyalty and relationship marketing dimensions

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	0.083	0.156		0.531	0.596	-0.224	0.389
	Trust	0.300	0.048	0.250	6.220	0.000	0.205	0.395
	Commitment	0.101	0.045	0.107	2.260	0.024	0.013	0.189
	Conflict-handling	0.302	0.049	0.262	6.136	0.000	0.205	0.399
	Communication	0.271	0.044	0.270	6.104	0.000	0.184	0.358
a. Dependent Variable: Customer_Loyalty								

Communication (β=0.270) had the strongest impact on customer loyalty, which is closely followed by Conflict-handling (β=0.262) and Trust (β=0.250). Commitment, while significant, exerted the weakest effect (β=0.107).

Results and Discussion

The findings indicate that trust, communication, commitment, and conflict-handling all play vital roles in shaping customer loyalty. Among these, communication emerged as the most influential factor, underscoring the importance of clear, timely, and transparent interactions between banks and customers.

Trust, a fundamental pillar of banking relationships, also ranked highly, as customers value reliability, accuracy, and security in financial transactions. Conflict-handling proved significant, suggesting that effective resolution of disputes enhances customer confidence and long-term engagement. Commitment, although least impactful, remains essential for reinforcing customer perceptions of reliability and accountability.

Conclusion

This study confirms that relationship marketing dimensions significantly affect customer loyalty in Manipur's banking sector. Effective communication, trust-building, commitment to service quality, and competent conflict-handling collectively strengthen customer loyalty. By focusing on these areas, banks can improve retention, reduce churn, and secure long-term competitive advantages. Implementing strategies that enhance these relationship marketing dimensions will help banks achieve higher customer retention and sustained competitive

advantage. Future research should consider additional variables and broader samples to build on these findings.

Directions For Future Research

Future studies should incorporate additional constructs such as competence, empathy, innovation, and customer satisfaction to develop a more holistic understanding of relationship marketing. Expanding the study to include more banks and regions could improve the generalizability of findings. Exploring moderating variables such as customer satisfaction and demographic factors could yield deeper insights.

Employing longitudinal research designs and advanced statistical methods could offer deeper insights into causal relationships and long-term effects. Comparative studies between public and private sector banks may also yield valuable perspectives on sectoral differences in relationship marketing effectiveness.

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Education in Transition: Navigating the Interplay of Technology, Society, and Governance

Praveer Saxena*

Manipur Institute of Management Studies,
Manipur University, Imphal, Manipur-795003, India
**Corresponding author:praveersaxena@gmail.com*

Abstract

The education sector today stands at the crossroads of profound transformation, shaped by rapid technological innovation, shifting societal expectations, and evolving governance models. Emerging technologies such as artificial intelligence, online learning platforms, and digital repositories are revolutionizing access to knowledge and enabling personalized, flexible, and inclusive learning environments. At the same time, they pose challenges of digital equity, ethical use, and the preservation of humanistic values in pedagogy. Parallel to these technological shifts, globalization, urbanization, and demographic transitions are redefining the skills required for employability and citizenship in the twenty-first century. Critical thinking, creativity, collaboration, and sustainability have become essential competencies, calling for innovative curricular designs and assessment reforms. Governance structures are also transitioning toward decentralization and accountability, fostering participatory decision-making and institutional autonomy. Together, these transformations demand a holistic response that balances innovation with inclusion. Education in transition thus represents both a challenge and an opportunity—to re-envision learning systems that are equitable, adaptive, and future-ready. This transformative vision resonates deeply with the National Education Policy (NEP) 2020, which positions education as the foundation of an equitable, vibrant, and knowledge-driven society. The policy emphasizes the integration of technology (Sections 23.1–23.5) through digital platforms, artificial intelligence, and e-learning resources to enhance access, inclusion, and quality—aligning with the idea of technology-enabled personalized learning. Similarly, the focus on holistic and multidisciplinary education (Sections 4–11) reflects the growing need for creativity, critical thinking, and collaboration, promoting a competency-based, learner-centric approach that bridges disciplinary boundaries. The concern for equity and inclusion (Section 6) mirrors the discussion on digital divides and equitable opportunities, emphasizing NEP's commitment to bridging socio-economic and gender gaps through inclusive education frameworks. Furthermore, the evolution of governance and institutional reform (Sections 18–19) finds resonance in the policy's advocacy for decentralization, autonomy, and accountability under a light-but-tight regulatory framework to enhance institutional efficiency. The evolving role of educators as facilitators of experiential and digital learning (Sections 5.15–5.20) is also central to NEP 2020's vision of continuous professional development and capacity building.

Keywords: Educational Transformation, Technology Integration, Governance and Autonomy, Equity and Inclusion, National Education Policy (NEP) 2020.

Introduction

The education sector in the twenty-first century stands at the threshold of profound transformation, shaped by the convergence of rapid technological innovation, evolving societal expectations, and shifting governance paradigms. The integration of emerging technologies such as artificial intelligence (AI), machine learning, and digital learning platforms has revolutionized the ways in which knowledge is produced, accessed, and disseminated (Selwyn, 2016; Holmes et al., 2021). These innovations have expanded opportunities for personalization, flexibility, and inclusivity, offering the potential to democratize education and create learner-centric environments at a global scale (Anderson & Dron, 2014). At the same time, globalization, demographic transitions, and knowledge-based economic development are reshaping the skills required for employability, civic participation, and lifelong learning (Schwab, 2016; UNESCO, 2021). Consequently, education systems across the world are being compelled to rethink their structures, pedagogies, and governance mechanisms to ensure both relevance and equity in a rapidly evolving global context (OECD, 2019).

This ongoing transformation represents a dual reality—one of immense opportunity and significant challenge. On one hand, technology-enabled learning promises to enhance learner autonomy, foster collaboration and experiential learning, and extend access to quality education beyond physical and institutional boundaries (Siemens, 2013; Bates, 2019). On the other hand, the digital revolution has magnified persistent inequalities in access, infrastructure, and socio-economic capital, raising critical concerns about digital equity, ethical data practices, and technological dependence (Van Dijk, 2020; Warschauer, 2011). Moreover, while governance reforms promoting decentralization and institutional autonomy have strengthened innovation and accountability, they also necessitate robust mechanisms to maintain transparency, inclusivity, and quality assurance (Trow, 2006; Marginson, 2016). These dynamics together situate education at a critical crossroads—between continuity and disruption, tradition and transformation, and global competitiveness and local relevance.

In this shifting landscape, the central challenge for policymakers, educators, and institutions is to balance innovation with inclusion—to harness the power of technology and governance reform while upholding the humanistic values that lie at the heart of education. The National Education Policy (NEP) 2020 of India embodies such a holistic and future-oriented vision. It conceptualizes education as both a foundation of national development and a means of individual empowerment, emphasizing technological integration for inclusive growth, the cultivation of twenty-first-century competencies, and the establishment of transparent, accountable, and autonomous governance frameworks (Government of India, 2020).

Accordingly, this study seeks to examine how the intersecting forces of technology, societal transformation, and governance reform are reshaping education, and how the spirit of NEP 2020 reflects this evolving paradigm. The central problem addressed by this research is how education systems can integrate technological innovation while upholding equity, inclusion, and humanistic values in an increasingly complex, digitalized, and interconnected world. The significance of the study lies in its potential to offer a multidimensional understanding of how

educational systems can navigate this transition responsibly and sustainably. By analyzing the intersections of technology, society, and governance, the study contributes to the broader discourse on reimagining education for a future that is equitable, adaptive, and resilient. The findings are expected to provide valuable insights for policymakers, in designing responsive and inclusive educational frameworks; for educators, in adopting innovative yet human-centered pedagogies; and for institutions, in implementing governance models that foster autonomy while maintaining accountability. Furthermore, the study aligns with the transformative vision of NEP 2020, reaffirming India's commitment to an education system that is rooted in Indian ethos yet globally competent—a system that harmonizes technological advancement with the timeless human values of empathy, equity, and social responsibility.

Objectives of the Study

The primary objective of this study is to examine the interrelationship among technology, societal change, and governance in shaping the transformation of educational systems, and to analyze how these transformative processes align with the vision and provisions of the National Education Policy (NEP) 2020, particularly in promoting access, equity, quality, and institutional reform within India's evolving educational landscape.

Research Questions

- What are the major technological and societal forces driving educational change in the twenty-first century?
- How are governance reforms influencing institutional autonomy, accountability, and participatory decision-making within education systems?
- In what ways does the National Education Policy (NEP) 2020 embody and operationalize the vision of education in transition, balancing innovation with inclusion?

Theoretical and Conceptual Framework

The theoretical foundation of this study is anchored in the transformative education paradigm, which envisions learning as a holistic process aimed at nurturing autonomous, reflective, and socially responsible individuals. Drawing from the humanistic and constructivist traditions, transformative education rejects the notion of learning as mere knowledge transmission and instead emphasizes meaning-making through experience, dialogue, and reflection. John Dewey (1938) conceptualized education as a process of continuous reconstruction of experience, where learners engage actively with their environment to derive meaning and develop critical understanding. Similarly, Jean Piaget (1973) viewed knowledge as a product of cognitive interaction between the learner and the world, emphasizing discovery and experimentation as central to learning. From a humanistic standpoint, education is not confined to intellectual growth but also involves the cultivation of empathy, creativity, and moral responsibility—qualities vital for human flourishing in a rapidly transforming global context (Rogers, 1983; Noddings, 2005). In parallel, constructivist theorists such as Lev Vygotsky (1978) and Jerome Bruner (1996) highlight the socio-cultural nature of learning, arguing that knowledge construction is mediated by

collaboration, language, and cultural context, thereby positioning the learner as an active co-creator of understanding. Jack Mezirow's (1991) Transformative Learning Theory provides a critical perspective on adult and lifelong learning by emphasizing the role of reflective discourse in transforming frames of reference. Mezirow argues that meaningful learning involves questioning one's assumptions, engaging with alternative perspectives, and adapting to new realities—a process essential in navigating socio-technological transformations. This approach aligns with the goals of 21st-century education, which calls for the cultivation of higher-order thinking skills, creativity, global citizenship, and adaptive learning capacities (UNESCO, 2021; Fullan & Langworthy, 2014). Within this paradigm, education becomes a dynamic, value-driven, and future-oriented enterprise capable of addressing complex societal challenges. Therefore, the transformative education framework provides a robust epistemological lens to understand how the dimensions of technology, society, and governance converge to reimagine education in an interconnected, knowledge-driven world. From this standpoint, educational transformation can be conceptualized as a triadic model encompassing the interdependent dimensions of technology, society, and governance. These three spheres are not isolated entities but operate as mutually reinforcing systems shaping the evolution of education. Technology functions as a catalyst for innovation and personalization, enabling adaptive learning environments through artificial intelligence, open educational resources, and digital learning ecosystems (Siemens, 2013; Bates, 2019). These technological affordances promote flexibility and learner-centered education, breaking spatial and temporal barriers to access. However, scholars caution that without ethical and equitable implementation, technology risks reproducing existing socio-economic inequalities (Selwyn, 2016; Van Dijk, 2020). Thus, the educational value of technology lies not merely in its capacity for efficiency, but in how it enhances inclusivity and human potential. The societal dimension represents the cultural and moral context within which education operates. Globalization, urbanization, and demographic change have reshaped the demands placed upon education systems, shifting the focus toward competencies such as critical thinking, creativity, collaboration, sustainability, and intercultural understanding (Schwab, 2016; OECD, 2019). This social transition underscores the need for value-based and inclusive education, one that integrates ethical sensibilities, respect for diversity, and environmental consciousness (Noddings, 2005; UNESCO, 2021). Education thus serves as both a mirror and a mediator of societal transformation, nurturing citizens capable of contributing to sustainable and equitable development. Finally, the governance dimension refers to the institutional structures and policy mechanisms that sustain and regulate educational transformation. Contemporary educational governance has evolved from centralized bureaucracies toward decentralized, participatory, and accountable models, empowering institutions to exercise autonomy while remaining responsible for quality and equity (Marginson, 2016; Trow, 2006). This evolution reflects a broader paradigm shift toward "light-but-tight" regulatory frameworks, which ensure flexibility and innovation without compromising oversight. Effective governance, therefore, is not merely administrative—it is a moral and systemic foundation that balances autonomy, accountability, and inclusivity in education reform.

The NEP 2020 reflects the essence of the transformative education paradigm by integrating technology, society, and governance into a coherent framework of reform. Sections 4–11

advocate holistic and multidisciplinary education, encouraging creativity, critical thinking, and collaboration in alignment with humanistic and constructivist philosophies. Section 6 addresses equity and inclusion, emphasizing that technological and pedagogical innovations must bridge rather than widen social and gender divides. Sections 18–19 focus on governance and institutional reform, endorsing decentralization, autonomy, and accountability through a transparent "light-but-tight" regulatory model. Finally, Sections 23.1–23.5 highlight technology integration, including artificial intelligence, e-learning platforms, and digital repositories, as enablers of access, quality, and inclusion. Collectively, these provisions operationalize the triadic framework, linking technological innovation with social responsibility and institutional reform. Thus, NEP 2020 not only envisions education as an engine of national development but also as a transformative force that is equitable, adaptive, and deeply rooted in India's cultural ethos while responsive to global realities.

Technological Transformation in Education

The twenty-first century has witnessed an unprecedented integration of technology into educational systems, fundamentally reshaping how knowledge is created, accessed, and disseminated. Emerging technologies such as Artificial Intelligence (AI), e-learning platforms, digital repositories, and open educational resources (OERs) are redefining both pedagogy and learner experience (Bates, 2019; Holmes et al., 2021). These innovations have shifted education from teacher-centered models toward learner-centric ecosystems, emphasizing personalization, flexibility, and lifelong learning. Artificial intelligence, in particular, has enabled the development of adaptive learning systems that respond to individual learners' progress, learning styles, and cognitive needs, making education more data-informed and personalized (Luckin et al., 2016; Holmes et al., 2021). Similarly, digital platforms such as Massive Open Online Courses (MOOCs), Learning Management Systems (LMSs), and mobile learning applications have expanded access to quality education beyond geographical and socio-economic boundaries, democratizing learning opportunities across diverse populations (Anderson & Dron, 2014; Siemens, 2013). The integration of technology in education offers numerous benefits, transforming both teaching and learning processes. It enhances personalization, enabling educators to tailor instruction to individual learners through data analytics and AI-driven feedback mechanisms (Siemens, 2013; Williamson & Eynon, 2020). Technology also fosters flexibility, allowing asynchronous learning and self-paced progress, which is particularly beneficial in accommodating diverse learners, including working professionals and those in remote or underserved areas (Bates, 2019). Furthermore, it promotes inclusivity by creating opportunities for learners with disabilities through assistive technologies and accessible learning designs (UNESCO, 2021). The use of OERs and digital repositories facilitates expanded access to knowledge, reducing costs and supporting collaborative content development (Weller, 2014). In this sense, technology serves as an enabler of equity and innovation, aligning closely with the objectives of the National Education Policy (NEP) 2020, which envisions technology as a tool to enhance access, inclusion, and quality across all levels of education (Government of India, 2020). Despite these advantages, the rapid digitization of education also presents a range of challenges that demand critical reflection and policy attention. The most pressing among these is the issue of digital equity, as disparities in internet connectivity, device ownership, and digital literacy

perpetuate socio-economic inequalities (Van Dijk, 2020; Warschauer, 2011). In developing nations like India, such divides can marginalize rural learners and under-resourced institutions, undermining the inclusive aspirations of technology-driven reforms. Moreover, concerns regarding the ethical use of data and privacy have intensified with the proliferation of AI and learning analytics in education (Williamson & Eynon, 2020). Questions about algorithmic bias, surveillance, and data governance underscore the need for robust ethical frameworks and transparent digital policies (Selwyn, 2016). Another challenge lies in the preservation of humanistic values—as education becomes increasingly technologized, it risks losing its relational, emotional, and moral dimensions (Biesta, 2015). Hence, technological transformation must be guided by pedagogical and ethical principles that ensure technology serves humanity, not the reverse.

In the Indian context, several digital initiatives exemplify how technology can be harnessed to democratize and improve educational delivery. Government-led platforms such as DIKSHA (Digital Infrastructure for Knowledge Sharing), SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds), and NPTEL (National Programme on Technology Enhanced Learning) represent concrete efforts toward digital empowerment and lifelong learning. These initiatives, aligned with Sections 23.1–23.5 of NEP 2020, aim to leverage AI, digital content, and online platforms to make education more accessible, efficient, and learner-centric. DIKSHA serves as a national digital infrastructure for teachers and students, providing multilingual content and e-resources accessible via mobile devices and offline modes (Mehta & Kalra, 2021). SWAYAM offers free online courses designed by leading universities and institutions, fostering open access to higher education and skill development (Babu & Sridevi, 2020). Similarly, NPTEL, a joint initiative of the IITs and IISc, provides high-quality technical courses and certifications that promote employability and academic excellence (Chakraborty & Singh, 2022). Together, these platforms reflect India's commitment to integrating technology in education as envisioned by NEP 2020—creating a system that is innovative, inclusive, and globally relevant.

Societal Transitions and Educational Implications

The rapid processes of globalization, urbanization, and demographic transition have profoundly influenced the purposes and practices of education worldwide. In the twenty-first century, education is increasingly called upon to prepare learners not merely for employment but for responsible and sustainable citizenship in an interconnected world (UNESCO, 2021). Globalization has accelerated the exchange of knowledge, culture, and innovation, creating both opportunities for collaboration and challenges of cultural homogenization (Spring, 2015). Meanwhile, urbanization and demographic change have altered labor markets and social structures, demanding that education systems cultivate adaptability, lifelong learning, and digital literacy among diverse populations (Schwab, 2016; OECD, 2019). In this context, employability is no longer defined by technical expertise alone but by the ability to integrate cognitive, social, and emotional competencies necessary for navigating complexity and uncertainty (WEF, 2020). Consequently, education must balance economic relevance with moral and civic responsibility, promoting sustainability and global awareness as integral dimensions of twenty-first-century learning (Sterling, 2010; UNESCO, 2017). These global shifts have led to a changing skill landscape that prioritizes creativity, critical thinking,

collaboration, and sustainability as foundational competencies for modern learners. The World Economic Forum (2020) identifies these as "future skills" essential for success in rapidly evolving industries shaped by automation, artificial intelligence, and climate change. Scholars such as Trilling and Fadel (2009) and Fullan and Langworthy (2014) emphasize that educational systems must move beyond rote learning toward fostering deep learning—a process that enables learners to construct knowledge, solve problems collaboratively, and apply understanding to real-world contexts. The OECD Learning Compass 2030 (2019) similarly calls for transformative competencies that empower learners to shape better futures for themselves and others. Within this framework, education becomes not only a means of economic participation but a pathway for human and planetary well-being, emphasizing sustainability, ethical reasoning, and social innovation. Responding to these imperatives, the National Education Policy (NEP) 2020 envisions a paradigm shift toward competency-based, interdisciplinary, and experiential education, as articulated in Sections 4–11. The policy promotes multidisciplinary curricula, integrating the arts, sciences, and vocational education to foster holistic learning and creativity. It emphasizes critical thinking, communication, and problem-solving as central outcomes of schooling and higher education, replacing traditional rote-based assessment with formative and performance-based evaluation (Government of India, 2020). Furthermore, NEP 2020 highlights the significance of experiential pedagogy, including project-based and inquiry-driven approaches that connect learning to local contexts, thereby aligning with constructivist and transformative educational theories (Dewey, 1938; Bruner, 1996). This shift reflects the global movement toward education for sustainable development (ESD) and global citizenship education (GCED), which seek to empower learners as active participants in addressing global challenges (UNESCO, 2017).

Equally central to this transformation is the principle of equity and inclusion, emphasized in Section 6 of NEP 2020. Despite advances in technology and policy reform, significant socio-economic, gender, and regional disparities persist in access to quality education (Tilak, 2020). Inclusive education frameworks aim to ensure that all learners—irrespective of caste, gender, disability, or economic status—can participate fully in educational opportunities (UNESCO, 2020). The NEP underscores targeted interventions for disadvantaged groups (SEDGs) through financial aid, gender inclusion funds, and localized strategies to bridge participation gaps (Government of India, 2020). Scholars such as Nussbaum (2011) and Sen (1999) argue that educational justice is a cornerstone of human development, as equitable learning opportunities expand individual capabilities and strengthen democratic citizenship. Therefore, the pursuit of inclusion must be understood not only as a social obligation but as a moral and developmental necessity for a just and sustainable society.

Governance Transformation and Institutional Reform

Governance in education has emerged as a central pillar of reform in response to the growing complexity, diversity, and accountability demands of modern educational systems. Traditionally, educational governance in many countries, including India, operated under centralized and bureaucratic models that prioritized administrative control over institutional autonomy (Trow, 2006; Marginson, 2016). However, the twenty-first century has witnessed a paradigm shift toward decentralization and participatory governance, reflecting broader democratic trends in policy and management (McGinn & Welsh, 1999). Decentralization in

education entails the transfer of decision-making authority from central governments to local institutions, communities, and educators, thereby enabling context-sensitive and responsive governance (Bray, 2003). This shift aligns with the principles of subsidiarity and shared leadership, ensuring that those closest to the learners and teaching processes have a meaningful voice in shaping policies and practices (Hallinger & Heck, 2010). Participatory governance, therefore, not only enhances efficiency and innovation but also deepens democratic engagement and institutional accountability. The move toward autonomy is closely intertwined with decentralization and has been a defining feature of educational reforms globally. Institutional autonomy empowers universities and schools to design curricula, manage resources, and develop strategic plans suited to their local needs and strengths (Enders, 2015). Autonomy, however, does not imply the absence of regulation; rather, it requires a balanced framework that supports freedom with responsibility. The challenge lies in establishing governance systems that grant flexibility to institutions while maintaining coherence with national educational objectives and quality standards. As Clark (1998) notes, effective higher education systems are characterized by a dynamic balance between state steering, institutional autonomy, and stakeholder engagement, forming what he calls the "triangle of coordination." This balance is essential for fostering innovation without compromising accountability or public trust. The notion of accountability and quality assurance has gained prominence as a complement to autonomy, particularly in massified and diversified higher education systems (Altbach, Reisberg, & Rumbley, 2009). Contemporary policy discourses emphasize "light-but-tight" regulatory frameworks, which combine minimal administrative interference with strong mechanisms for performance evaluation and public accountability (Government of India, 2020; Marginson, 2016). Such frameworks aim to reduce bureaucratic rigidity while ensuring that institutions remain aligned with national goals of access, equity, and excellence. Instruments such as accreditation, performance audits, and outcome-based assessment serve as safeguards against institutional complacency and help maintain standards across diverse educational landscapes (Harvey & Williams, 2010). Moreover, transparent governance structures—including participatory boards, open data systems, and stakeholder consultations—are critical in enhancing institutional credibility and responsiveness to societal needs. In practice, effective institutional governance relies on visionary academic and administrative leadership capable of fostering innovation and collaboration. Educational leaders today must navigate competing demands—balancing academic freedom with accountability, tradition with transformation, and local relevance with global competitiveness (Bush, 2020). Leadership that encourages distributed decision-making and cultivates professional trust has been shown to enhance institutional performance and adaptability (Leithwood et al., 2020). Furthermore, fostering a culture of shared governance—where faculty, students, and administrators collectively participate in decision-making—promotes transparency and inclusivity, vital for sustaining reform momentum (Tierney, 2008). The interplay of leadership, autonomy, and accountability thus forms the operational heart of institutional transformation.

The National Education Policy (NEP) 2020 provides a comprehensive framework for governance reform through Sections 18–19, which advocate for the transformation of higher education governance to ensure flexibility, transparency, and institutional autonomy. The policy envisions the establishment of Higher Education Councils and National Accreditation

Councils that will function with minimal administrative burden while ensuring rigorous standards of quality and accountability. It also proposes the consolidation of higher education institutions into large multidisciplinary universities and clusters, designed to reduce fragmentation and foster synergy across disciplines (Government of India, 2020). Moreover, the NEP emphasizes independent and empowered Boards of Governors (BoGs) to oversee academic and financial decisions, marking a decisive shift toward self-regulation and participatory decision-making. This structural realignment seeks to create an ecosystem where institutions are free to innovate while remaining accountable to public expectations and ethical standards.

Educators and Professional Development in the Digital Era

The transformation of education in the twenty-first century has redefined the role of teachers from mere transmitters of knowledge to facilitators, mentors, and co-learners in dynamic, technology-mediated ecosystems. This shift reflects a broader epistemological change in educational philosophy—from behaviorist models of instruction to constructivist and learner-centered paradigms that prioritize critical inquiry, collaboration, and creativity (Vygotsky, 1978; Bruner, 1996). Teachers are no longer positioned as the sole authorities of knowledge but as designers of learning experiences who scaffold understanding, foster curiosity, and guide students in navigating complex information landscapes (Laurillard, 2012). In digital learning environments, educators must integrate technology not as an add-on but as a pedagogical tool that enhances engagement, interaction, and reflective thinking (Mishra & Koehler, 2006). As UNESCO (2021) notes, the effectiveness of digital education ultimately depends on teachers' ability to blend technological competence with pedagogical and emotional intelligence. Thus, the teacher's role in the digital era extends beyond instruction to encompass mentorship, motivation, and moral guidance in cultivating responsible digital citizens.

The growing emphasis on capacity building and lifelong learning highlights the necessity of continuous professional development (CPD) as an integral component of educational reform. In a rapidly evolving knowledge society, educators must engage in ongoing learning to remain adaptable, innovative, and technologically literate (OECD, 2019; Darling-Hammond et al., 2017). The National Education Policy (NEP) 2020, particularly in Sections 5.15–5.20, underscores the importance of teacher empowerment through structured, sustained, and competency-based professional development programs. It advocates for the establishment of the National Mission for Mentoring (NMM) and the National Professional Standards for Teachers (NPST), which aim to create a continuum of teacher learning through mentorship, peer collaboration, and reflective practice (Government of India, 2020). Additionally, NEP 2020 emphasizes digital literacy and technological integration as essential aspects of teacher education, recognizing that pedagogical innovation requires both content mastery and technological fluency (Koehler et al., 2013). Effective capacity building, therefore, involves not only technical training but also the cultivation of adaptive expertise, allowing teachers to critically evaluate and apply technology in ways that support diverse learners.

Equally crucial to this transformation is the reaffirmation of pedagogical ethics and human values in education. As classrooms become increasingly digital, there is a risk of

depersonalization and over-reliance on technology, which may erode the relational and moral dimensions of teaching (Biesta, 2015). Teachers thus serve as ethical anchors, ensuring that technological tools are used in ways that promote empathy, inclusion, and social responsibility (Noddings, 2005). Digital education must not only enhance efficiency and access but also uphold the principles of care, respect, and equity that form the foundation of humanistic education (Rogers, 1983; Freire, 1970). The cultivation of digital ethics—including data privacy, academic integrity, and respect for diversity—has become a core responsibility of educators in shaping conscientious learners (Selwyn, 2016). In this sense, the professional identity of the teacher transcends technical proficiency; it embodies the moral and cultural stewardship required to sustain human connection in an increasingly mediated world.

Discussion

The complex interplay among technology, society, and governance represents a defining characteristic of educational transformation in the twenty-first century. These dimensions are not isolated domains but interconnected systems that collectively shape the direction, depth, and inclusivity of change. Technology serves as a catalyst for pedagogical innovation, enabling flexibility, personalization, and access at an unprecedented scale (Siemens, 2013; Holmes et al., 2021). Society, in turn, determines the ethical and cultural orientation of this transformation—defining the values, equity frameworks, and skill priorities that guide educational design (UNESCO, 2021; Schwab, 2016). Meanwhile, governance functions as the regulatory and enabling structure that ensures systemic coherence, accountability, and sustainability (Marginson, 2016; Clark, 1998). The synergy among these three domains—technological innovation, societal responsiveness, and adaptive governance—creates the conditions for systemic educational reform that transcends institutional boundaries. When harmonized effectively, this triadic relationship fosters an ecosystem where learning is both globally connected and locally contextualized, balancing progress with inclusion. At the heart of this interplay lies the challenge of balancing innovation with inclusion—a theme central to both global educational discourses and India's NEP 2020 vision. While technological advances such as artificial intelligence, big data, and online learning have revolutionized access to knowledge, they have also risked deepening socio-economic and digital divides (Van Dijk, 2020; Warschauer, 2011). The task before policymakers and educators is to ensure that innovation remains human-centered, guided by principles of equity, ethics, and empathy (Biesta, 2015; Noddings, 2005). Inclusive innovation requires multi-level strategies—expanding digital infrastructure in underserved regions, developing culturally relevant content in local languages, and equipping teachers with the skills to integrate technology pedagogically rather than instrumentally (UNESCO, 2020; Mishra & Koehler, 2006). Furthermore, equity must be embedded not only in access but also in participation and outcomes, ensuring that every learner—regardless of gender, geography, or socio-economic background—can benefit meaningfully from educational transformation (Sen, 1999; Nussbaum, 2011). Such a humanistic approach to innovation aligns with the NEP 2020's ethical commitment to creating an education system that is inclusive, value-driven, and reflective of India's civilizational ethos while responsive to global change. In a comparative perspective, the reform trajectory envisioned by NEP 2020

resonates with broader global trends in educational transformation. The OECD's Learning Compass 2030 and UNESCO's Futures of Education Report (2021) emphasize lifelong learning, sustainability, and digital literacy as foundational competencies for global citizenship—principles mirrored in NEP 2020's focus on holistic and multidisciplinary education (Sections 4–11) and technology integration (Sections 23.1–23.5). Similarly, policies such as Finland's National Core Curriculum (2016) and Singapore's Smart Nation Education Initiative demonstrate the integration of technology with humanistic learning, prioritizing creativity, collaboration, and social responsibility (Sahlberg, 2018; Tan, 2019). India's NEP 2020, however, distinguishes itself by rooting these global imperatives in its indigenous philosophical foundations, emphasizing education as a means of self-realization (Atmanirbhar Bharat) and social harmony (Sarvodaya). This synthesis of the global and the local—what Appadurai (2013) calls "vernacular globalization"—positions NEP 2020 as a uniquely contextual yet forward-looking framework for educational reform.

Thus, the discussion underscores that sustainable educational transformation requires an integrative, multi-scalar approach—one that connects digital innovation with social equity and institutional reform. The Technology–Society–Governance triad provides a conceptual blueprint for achieving this synthesis. Technology must be leveraged not as an end in itself but as a means to advance human potential; society must embrace inclusivity and ethical responsibility as guiding values; and governance must ensure that flexibility coexists with accountability. The NEP 2020, in its holistic vision, encapsulates these principles—offering a model of educational reform that is adaptive, inclusive, and ethically grounded, capable of preparing learners and institutions for the complexities of a rapidly transforming world.

Conclusion

Education in the twenty-first century has evolved into a dynamic and adaptive ecosystem that continuously responds to the intersecting forces of technological innovation, societal transformation, and governance reform. The synthesis of the study reveal that the technological revolution—driven by artificial intelligence, digital learning platforms, and open educational resources—has redefined how knowledge is produced, accessed, and disseminated, thereby expanding the possibilities of personalized, flexible, and inclusive learning (Bates, 2019; Holmes et al., 2021). At the same time, societal transitions influenced by globalization, demographic shifts, and sustainability concerns have broadened the aims of education beyond employability to encompass ethical awareness, global citizenship, and ecological responsibility (UNESCO, 2021; Schwab, 2016). Complementing these transformations, governance reforms that emphasize decentralization and institutional autonomy have underscored the importance of participatory, transparent, and accountable decision-making processes (Clark, 1998; Marginson, 2016). Collectively, these interrelated forces reinforce the conception of education as an interconnected, human-centered, and transformative system, in which innovation and inclusion function as mutually reinforcing imperatives rather than competing objectives. The National Education Policy (NEP) 2020 embodies this holistic vision by positioning education as both the foundation of national development and an instrument of social justice, reaffirming India's commitment to building an equitable, sustainable, and knowledge-driven society. Building upon the analysis of the Technology–Society–Governance triad and its alignment with NEP 2020, several policy and

practice imperatives emerge to strengthen India's educational transformation. First, digital equity must remain a national priority. Bridging the digital divide requires sustained investment in infrastructure, affordable internet access, and digital literacy initiatives that empower marginalized communities (Van Dijk, 2020; Warschauer, 2011). Public–private partnerships can enhance resource mobilization while ensuring data privacy and ethical governance. Second, the curriculum must evolve toward interdisciplinary and competency-based design, integrating science, humanities, and vocational disciplines to promote creativity, critical thinking, and sustainability-oriented problem solving (Trilling & Fadel, 2009; Government of India, 2020). Higher education and teacher education institutions should foster cross-disciplinary collaborations that prepare learners for complex real-world challenges. Third, teacher empowerment through continuous professional development remains central to the success of educational reform. Strengthening the National Mission for Mentoring (NMM) and National Professional Standards for Teachers (NPST), as proposed in NEP 2020 (Sections 5.15–5.20), will ensure that teachers remain technologically adept, pedagogically innovative, and ethically grounded (Darling-Hammond et al., 2017; Mishra & Koehler, 2006). Building professional learning communities and digital CPD platforms can further sustain lifelong learning and reflective practice among educators. Finally, governance models must embrace a "light-but-tight" regulatory framework that balances autonomy with accountability (Marginson, 2016; Government of India, 2020). Strengthening decentralized decision-making, empowering independent Boards of Governors, and institutionalizing transparent quality assurance mechanisms can foster innovation while maintaining academic integrity and social trust. If effectively implemented, these strategies can translate the transformative aspirations of NEP 2020 into tangible educational outcomes, ensuring that India's education system remains technologically advanced, socially inclusive, and ethically grounded. Looking ahead, this study underscores the need for empirical research to evaluate the impact and implementation of NEP 2020 in practice. Systematic investigations are required to examine how policy provisions related to technology integration, curricular flexibility, and governance reform are being realized across different states, regions, and institutions. Such studies can illuminate both contextual challenges and institutional innovations, informing evidence-based policymaking and adaptive governance. Moreover, longitudinal and comparative research should assess the impact of technology-enabled learning on equity and inclusion, particularly in rural and underserved regions where infrastructural and digital divides persist (UNESCO, 2020; Van Dijk, 2020). Examining how digital tools influence learner engagement, teacher agency, and educational outcomes will provide crucial insights into the social and pedagogical consequences of digitalization. Future research should adopt mixed-methods approaches, combining quantitative policy analysis with qualitative insights from educators, students, and administrators. Such an integrative methodology would provide a holistic understanding of how education systems can balance innovation, equity, and governance in a rapidly evolving global landscape.

In conclusion, education stands at a pivotal moment of redefinition—poised between transformation and tradition, innovation and inclusion. By aligning technology with human values, fostering interdisciplinary learning, empowering educators, and strengthening participatory governance, India's education system can realize the vision articulated in NEP

2020: an education that is equitable, adaptive, and future-ready, deeply rooted in its cultural ethos yet responsive to global change.

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Food Utilization Patterns under Mountain and Plain Specificities: A Comparative Study

Deepak Bhagat[1,]*, Shweta Priyamvada[2], Pavnesh Kumar[3], Golli Mohan[4]

[1]Department of Agribusiness Management & Food Technology,
North-Eastern Hill University, Tura Campus, Meghalaya-794002, India
[2]Department of Rural Development, University of Science & Technology,
Ri Bhoi, Meghalaya-793101, India
[3]School of Management Studies, IGNOU, New Delhi-110068, India
[4]ICSSR, Major Research Project, North-Eastern Hill University,
Tura Campus, Meghalaya-794002, India
**Corresponding Author: dip19bhagat@gmail.com*

Abstract

The present study attempted to make a comparative investigation of the conditions underlying food and nutrition security in plain and mountain environments of rural India on the utilization dimension of food security. For this, two states from North-East India (Assam and Meghalaya) and two States from East India (Bihar and Jharkhand), who are having lowest SDG Index Score (NITI Aayog 2021) were taken. Thus from each specificity 30 villages were selected and then from each village 30 households were selected making a total of 900 sample households selected for the study from each specificity. From the study it was observed that income distribution differs significantly between the two regions. The majority of households in the mountain region fall into the low-income category (≤5000.00), while the plain region has a higher representation in the middle- and upper-income categories. In the mountain region, 21% of mothers are underweight, while the majority, 79.3%, fall within the normal BMI range, and 38.2% are classified as obese. In contrast, the plain region shows a much higher proportion of underweight mothers at 79%, with only 20.7% in the normal range and 61.8% categorized as obese. The data reveal that in mountain regions, chronic malnutrition represented by stunting is relatively stable but with steady figures across ages. Wasting, indicating recent or acute nutritional deficiency is somewhat variable but remains a concern, especially in the 36- 47 months age group. Conversely, children in the plain regions show lower but more fluctuating levels of these indicators, with some age groups experiencing higher malnutrition rates. While maternal nutrition requires greater attention in the plains, targeted child focused interventions are urgently needed in the mountains. Addressing these disparities is essential for strengthening the overall food and nutrition security of rural households across both environments.

Keywords: Food security, Utilization, Nutrition, Mountains and Plains, Anthropometric measurements, Body Mass Index (BMI)

Introduction

Food security is multi-dimensional, consisting of physical availability, physical and economic access, food utilisation, and stability of food supply and access over time as essential components (FAO, 2008). “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 1996). Fighting hunger in a changing world demands that we stay vigilant in our efforts to collect, analyze and disseminate information that is so very critical for designing and implementing hunger solutions which can save lives in emergencies, as well as putting the hungry poor on the path to food security (WFP, 2009). However, the present information on the subject fails to clearly differentiate the vulnerability to food insecurity under plain and mountain/hill specificities, thus providing little information to policy makers to prepare separate strategies under plain and mountain/hill specificities (Bhagat, 2021). This necessitates several comparative studies under plain and mountain specificities on complex food systems to facilitate the portrayal of existing trends and challenges and make available comprehensive information to policymakers (Bhagat, 2021; Dame, 2018). The present study attempted to make a comparative investigation of the conditions underlying food and nutrition security in plain and mountain environments of rural India on the utilization dimension of food security. For this, two states from North-East India (Assam and Meghalaya) and two States from East India (Bihar and Jharkhand), who are having lowest SDG Index Score (NITI Aayog 2021) were taken.

Research Methodology

Based on “Comprehensive Food Security and Vulnerability Analysis (CFSVA) guidelines” designed by World Food Programme of United Nations (WFP, 2009a), a stratified two-stage cluster sampling was used in the present study. In the first step the household aggregation that will be used as “clusters” is defined. Since aggregations should be pre-existing and recognized, the administrative aggregations such as villages as clusters were recommended in CFSVA Guidelines (2009). Based on this, for the present study the villages of Assam (Karbi Anglong Plateau), Meghalaya (Meghalaya Plateau), Bihar and Jharkhand were identified as clusters. List of villages and population statistics of the villages were drawn from Census, 2011 (District Census Handbook, Village and Town Wise, Primary Census Abstract, Census, 2011 Series- 19, Part- XII-B). Since the focus of the study was to investigate vulnerability of indigenous people food insecurity, the blocks with highest tribal population (based on basis of “Socio Economic and Caste Census (SECC), 2011(Rural)”, Ministry of Rural Development Government of India) were short-listed for the purpose of inclusion in the sample. CFSVA Guidelines (2009) recommends a 30-by-30 cluster sampling where 30 households are selected in each of 30 villages (CFSVA Guidelines, 2009). Thus, in the first stage first 30 villages i.e. 30 clusters are selected separately under plain and mountain specificities. And then in the second stage from each village 30 households are selected. To do this the villages having less than 30 households were dropped from the initial list of villages. The new list comprises only those villages which were having 30 or more than 30 households. The sampling frame of all the households in the selected clusters i.e. villages were constructed with the help of electoral roll and with consultation with the village headman. After that

following the procedure of systematic random sampling the households were selected for inclusion. Thus, in brief it can be said that in the first stage first 30 villages i.e. 30 clusters are selected. And then in the second stage from each village 30 households are selected. Thus from each specificity 30 villages were selected and then from each village 30 households were selected making a total of 900 sample households selected for the study from each specificity. The total sample thus constituted 1800 rural households. The present study was initiated on 1st of April, 2023. Pilot survey was carried out from July, 2023 to August, 2023 and actual data collection was started from 2nd Week of November, 2023 and completed in the last week of February, 2025.

Results and Discussion

Food utilization, typically reflected in an individual's nutritional status, is determined by the quantity and quality of dietary intake, along with health status and its determinants. Based on Lele et al. (2016), Burchi et al (2011), Riely et al. (1999), WFP (2009a) and WFP (2009b), the individual and household food utilization of indigenous hill people of Meghalaya were explored with following indicators.

(i) Access to water and sanitation

(ii) Anthropometric measurements of children under 5 (wasting, stunting underweight); mid-upper arm circumference (MUAC) of children under 5;

(iii) Maternal body mass index (BMI)

The findings of the study on the above dimensions are presented below

Socio-Economic Conditions of the Rural Households under Mountain and Plain Specificities

From the study it was observed that the majority of families in both regions have four or five members (42.2% of families under mountain specificities and 32.4 % under plain specificities). The mean age in the mountain region was found to be 32.69 years, whereas in the plain region, it is significantly higher at 42.87 years with statistically significant difference. The younger household heads in the mountain region may reflect migration or newer family formations. It was observed that the age dependency ratio is higher under mountain regions than in plain regions. The study reveals the majority of respondents in both the mountain and plain regions reported not having access to credit, with 86.0% and 78.9%, respectively. Regarding land holding patterns, the study shows that the majority of landholders in the mountain region own marginal land (92.9%), whereas the plain region has a more diverse landholding pattern, including small, semi-medium, and medium-sized lands. The Kruskal-Wallis test ($H(2) = 254.828$, $p = 0.000$) confirms significant regional differences in land use. These differences shape the agricultural potential and socio-economic conditions, with plains favoring market-oriented farming and mountains relying on diverse livelihoods amidst challenging farming conditions.

Food Utilization Patterns under Mountain and Plain Specificities

Household Wealth Index

The distribution of households across wealth quintiles reveals a stark difference between the mountain and plain regions (Table 1). In the mountain region, a large proportion of households (91.84%) fall within the poorest quintile (Q1). The mean WI in plain is significantly higher at 1.263, revealing a better economic standing. The wealth index values increase progressively from Q1 to Q5 in both regions, but households in the plain region attain higher maximum values (up to 4.461) compared to the mountain region (2.980). The Kruskal-Wallis test results (H = 138.237, p = 0.000) reveal a statistically significant difference in wealth distributions between the two regions. The mean rank is higher in the plain region in contrast to the mountain region, suggesting that overall households in the plains are significantly wealthier than those in the mountains.

Table 1: Wealth Index

Quintile	Mountain	Plain
Q1 (Poorest	300 (PC: 91.84; WI: -1.251)	184 (PC: 44.84; WI: -1.635)
Q2 (Poor)	94 (PC: 302.97; WI: -0.908)	196 (PC: 224.76; WI: -0.867)
Q3 (Middle)	152 (PC: 441.25; WI: -0.021)	227 (PC: 456.02; WI: -0.184)
Q4(Rich)	221 (PC: 635.81; WI: 0.800)	163 (PC: 667.98; WI: 0.769)
Q5 (Richest)	133 (PC: 824.74; WI: 2.160)	130 (PC: 824.41; WI: 2.980)
Mean (WI)	-0.726	1.263
Median (WI)	-1.034	-0.312
Standard Deviation	1.003	1.512
Variance	1.006	2.285
Minimum	-2.913	-2.032
Maximum	2.980	4.641
Range	5.893	6.673
Skewness	0.444	1.071
Kurtosis	-0.163	0.397
Kruskal-Wallis Test		
Mean Rank	756.67	1044.33
H statistic	H (2) =138.237, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

Water and Sanitation

Drinking water sources vary significantly between the regions. The mountain region predominantly relies on rivers, streams, and mountain sources, whereas piped water is more common in the plain region. The Kruskal-Wallis test (H (2) = 428.718, p = 0.000) from Table 2 indicates a significant disparity in water access between regions. The average time required to collect water is slightly longer in the mountain region (13.33 min) compared to the plain region (12.24 min) (Table 3). Although the difference is statistically significant (H (2) = 12.597, p = 0.000), both regions experience challenges in water collection. Additionally, there is no statistically significant difference in the distance travelled for good quality drinking water (H (2) = 3.115, p = 0.07) (Table 4). Water collection responsibilities vary by region, with girls and women playing a more significant role in the plain region compared to the mountain region, where responsibility is more evenly distributed. The Kruskal-Wallis test (H

(2) = 127.955, p = 0.07) suggests no statistically significant difference in gender roles for water collection (Table 5). The mountain region has a higher percentage of households with flush toilets (84.0%) compared to the plain region (57.6%). The Kruskal-Wallis test (H (2) = 178.357, p = 0.07) suggests no significant difference in sanitation facilities (Table 6).

Table 2: Main Sources of Drinking Water

Source of Drinking Water for Household	Mountain Region	Plain Region
Piped water	0 (0.0%)	317 (35.2%)
Well/borehole protected	118 (13.1%)	223 (24.8%)
Well/borehole unprotected	172 (19.1%)	110 (12.2%)
River, stream, or dam	301 (33.4%)	132 (14.7%)
Mountain source	309 (34.3%)	118 (13.1%)
Total	900 (100.0%)	900 (100.0%)
Mean	3.89	2.4567
Median	4	2
Standard Deviation	1.0237	1.42647
Variance	1.048	2.035
Minimum	2	1
Maximum	5	5
Range	3	4
Skewness	-0.514	0.554
Kruskal-Wallis Test		
Mean Rank	1148.6	652.4
H statistic	H (2) =428.718, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

Table 3: Duration to Collect Drinking Water

Time Required to Collect water	Mountain Region	Plain Region
Very Short (≤5 mins)	219 (24.3%)	239 (26.6%)
Short (6–10 mins)	262 (29.1%)	344 (38.2%)
Moderate (11–20 mins)	307 (34.1%)	226 (25.1%)
Long (21–30 mins)	106 (11.8%)	83 (9.2%)
Very Long (>30 mins)	6 (0.7%)	8 (0.9%)
Total	900 (100.0%)	900 (100.0%)
Mean	13.33 min	12.24 min
Median	10.00 min	10.00 min
Standard Deviation	7.28	7.08
Variance	52.99	50.1
Minimum	5	1
Maximum	45	45
Range	40	44
Skewness	0.874	1.315
Kurtosis	0.726	2.17
Kruskal-Wallis Test		
Mean Rank	942.62	858.38
H statistic	H (2) =12.597, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

Table 4: Distance to Access Quality Drinking Water

Distance	Mountain Region	Plain Region
Very Short (≤10 km)	199 (22.1%)	178 (19.8%)
Short (11–30 km)	322 (35.8%)	243 (27.0%)
Moderate (31–60 km)	124 (13.8%)	184 (20.4%)
Long (61–100 km)	116 (12.9%)	235 (26.1%)
Very Long (>100 km)	139 (15.4%)	60 (6.7%)
Total	900 (100.0%)	900 (100.0%)
Mean	54.98	52.85
Median	30	40
Standard Deviation	52.56	42.43
Variance	2762.39	1800.33
Minimum	8	8
Maximum	300	300
Range	292	292
Skewness	1.499	1.536
Kurtosis	1.779	3.557
Kruskal-Wallis Test		
Mean Rank	879.1	921.9
H statistic	H (2) =3.115, p = 0.07. Since the p-value is less than 0.00, the result is not statistically significant	

Table 5: Gender Distribution in Drinking Water Collection

Collection of Water	Mountain Region	Plain Region
Girls	136 (15.1%)	293 (32.6%)
Boys	100 (11.1%)	27 (3.0%)
Women	66 (7.3%)	278 (30.9%)
Men	109 (12.1%)	38 (4.2%)
Every One	489 (54.3%)	264 (29.3%)
Total	900 (100.0%)	900 (100.0%)
Mean	3.7944	2.9478
Median	5	3
Standard Deviation	1.54321	1.59621
Variance	2.382	2.548
Minimum	1	1
Maximum	5	5
Range	4	4
Skewness	-0.825	0.038
Kurtosis	-0.959	-1.463
Kruskal-Wallis Test		
Mean Rank	1032.36	768.64
H statistic	H (2) =127.955, p = 0.07. Since the p-value is less than 0.00, the result is not statistically significant	

Table 6: Access to Sanitation Facilities among Households

Sanitation	Mountain Region	Plain Region
Flush latrine/toilet with water	756 (84.0%)	518 (57.6%)
Traditional pit latrine (no water)	85 (9.4%)	89 (9.9%)
(Partly) open pit (no roof or no wall)	13 (1.4%)	110 (12.2%)
Communal latrine	27 (3.0%)	0 (0.0%)
None/bush (go into forest)	19 (2.1%)	183 (20.3%)
Total	900 (100.0%)	900 (100.0%)
Mean	1.2978	2.1567
Median	1	1
Standard Deviation	0.8198	1.58304
Variance	0.672	2.506
Minimum	1	1
Maximum	5	5
Range	4	4
Skewness	3.178	0.975
Kurtosis	9.745	-0.702
Kruskal-Wallis Test		
Mean Rank	769.33	1031.67
H statistic	H (2) =178.357,p = 0.07. Since the p-value is less than 0.00, the result is not statistically significant	

Income and Expenditure

Income distribution differs significantly between the two regions. The majority of households in the mountain region fall into the low-income category (≤5000.00), while the plain region has a higher representation in the middle- and upper-income categories. The Kruskal-Wallis test (H (2) = 178.357, p = 0.000) indicates a significant disparity in income levels (Table 7). Expenditure patterns show that households in the plain region have higher expenditures than those in the mountain region. The Kruskal-Wallis test (H(2) = 10.608, p = 0.001) confirms a significant difference in spending behaviour between the two regions (Table 8). The results suggest notable demographic and socio-economic differences between households in the mountain and plain regions. The mountain state tends to have younger household heads, larger families and a higher dependency ratio, which may indicate differences in economic opportunities and migration trends. The plain state, with its older household heads and higher levels of secondary education, may reflect a more stable and established population. These findings provide essential insights into regional differences that can inform policy-making, particularly in areas of education, family planning, and economic development. The analysis highlights significant regional differences in financial access, land use, water supply, sanitation and income levels. The findings emphasize the need for targeted policies to address disparities in resource access and economic opportunities across different regions.

Table 7: Household Income Distribution

Income	Mountain Region	Plain Region
Low (≤5K)	600 (66.7%)	300 (33.3%)
Lower-Mid (5K–10K)	280 (31.1%)	250 (27.8%)
Middle (10K–20K)	20 (2.2%)	200 (22.2%)
Upper-Mid (20K–50K)	0 (0.0%)	100 (11.1%)
High (>50K)	0 (0.0%)	50 (5.6%)
Total	900 (100.0%)	900 (100.0%)
Mean	5,559.20	11,624.86
Median	5,562.50	6,423.00
Standard Deviation	943.49	11,790.74
Variance	8,90,165.82	13,90,21,485.61
Minimum	2,942.00	958
Maximum	9,796.00	99,733.00
Range	6,854.00	98,775.00
Skewness	0.374	3.254
Kurtosis	0.621	14.612
Kruskal-Wallis Test		
Mean Rank	769.33	1031.67
H statistic	H (2) =178.357, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

Table 8: Household Expenditure Patterns

Expenditure Category	Mountain Region	Plain Region
Low (≤5K)	848 (94.22%)	531 (59%)
Middle (5K–20K)	52 (5.78%)	333 (37%)
High (>20K)	0 (0.0%)	36 (4%)
Total	900 (100%)	900 (100%)
Mean	4182.46	4289.88
Median	4123.5	4218
Standard Deviation	829.18	867.01
Variance	6,87,531.78	7,51,700.17
Minimum	1756	1722
Maximum	8465	8685
Range	6709	6963
Skewness	0.7	0.84
Kurtosis	1.447	1.874
Kruskal-Wallis Test		
Mean Rank	860.6	940.4
H statistic	H (2) =10.608,p = 0.001. Since the p-value is less than 0.05, the result is statistically significant	

Anthropometric Indicators of Malnutrition

Age Distribution of Children Under 5 Years

The analysis of Tables 9 and 10 reveals negligible differences in the demographic profiles of children below five years across mountain and plain regions.

Table 9: Age Distribution of Children Under 5 Years

Statistic	Mountain Region	Plain Region
0–11 months	42 (18.34%)	41 (16.87%)
12–23 months	48 (20.96%)	52 (21.40%)
24–35 months	43 (18.78%)	47 (19.34%)
36–47 months	48 (20.96%)	61 (25.10%)
48–59 months	48 (20.96%)	42 (17.28%)
Total	229 (100.0%)	243 (100.0%)
Mean	3.0524	3.0453
Median	3	3
Standard Deviation	1.41324	1.35528
Variance	1.997	1.837
Minimum	1	1
Maximum	5	5
Range	4	4
Skewness	-0.037	-0.073
Kurtosis	-1.309	-1.225
Kruskal-Wallis Test		
Mean Rank	236.95	236.08
H statistic	H (2) =.005, p = .943. Since the p-value is not less than 0.05, the result is not statistically significant	

Age distributions in both geographical settings are closely aligned. Moreover, the application of the Kruskal- Wallis test confirms that no statistically significant disparity exists with respect to age distribution between the two regions ($p = 0.943$). Likewise, gender distributions exhibit only marginal variation, with both regions reflecting a slight predominance of female children.

Table 10: Gender Distribution of Children Under 5 Years

Gender	Mountain Region	Plain Region
Female	120 (52.40%)	128 (52.67%)
Male	109 (47.60%)	115 (47.33%)
Total	229 (100.0%)	243 (100.0%)

Table 11 presents the age group distribution of mothers with children below five years. In the mountain area, a majority of mothers (58.5%) fall within the 20- 24 years age group, followed by 23.1% in the 25- 29 years bracket. In contrast, the plain region shows a more even distribution across age groups, with 42.4% in the 25- 29 years, 28.4% in 20- 24 years, and 18.9% in 30- 34 years. The mean age of mothers in the mountain region is 22.84 years compared to 27.07 years in the plain region. Statistical measures reflect notable differences in the two regions. A Kruskal-Wallis test comparing the two groups' age distributions resulted in a significant difference ($H = 103.663$, $p < 0.001$), confirming that the age profiles of mothers in mountain and plain regions differ statistically.

Table 11: Age Group Distribution of Mothers with Children Under 5 Years

Age Group of Mothers below 5-year child	Mountain	Plain
Mother age ≤19	36 (15.7%)	4 (1.6%)
Mother age (20–24)	134 (58.5%)	69 (28.4%)
Mother age (25–29)	53 (23.1%)	103 (42.4%)
Mother age (30–34)	6 (2.6%)	46 (18.9%)
Mother age (≥35)	0 (0.0%)	21 (8.6%)
Total	229	243
Mean	22.843	27.072
Median	23	26.4
Standard Deviation	3.105	4.651
Variance	9.642	21.632
Minimum	18	18.1
Maximum	33	42.5
Range	15	24.4
Skewness	0.512	0.784
Kurtosis	-0.054	0.616
Kruskal-Wallis Test		
Mean Rank	170.73	298.48
H statistic	H (2) =103.663, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

3.2.4.2. BMI Status of Mothers with Children Under 5 Years

The Table 12 presents the distribution of Body Mass Index (BMI) categories among mothers in the mountain and plain regions. In the mountain region, 21% of mothers are underweight, while the majority, 79.3%, fall within the normal BMI range, and 38.2% are classified as obese. In contrast, the plain region shows a much higher proportion of underweight mothers at 79%, with only 20.7% in the normal range and 61.8% categorized as obese. The standard deviation and variance values show that there is more variation in BMI categories among mothers in the plain region compared to those in the mountain region. A Kruskal-Wallis test reveals a statistically significant difference ($H = 14.105$, $p < 0.001$) in the BMI distributions between the mountain and plain regions, affirming that maternal nutritional status varies substantially between these geographic areas. In summary, mothers in the mountain region exhibit a healthier distribution of BMI, with most falling in the normal category and fewer underweight cases. In contrast, the plain region has a higher prevalence of underweight mothers alongside a notable proportion of obesity, indicating a bimodal nutritional challenge requiring targeted health and nutrition interventions in both regions.

The Tables 13 and 14 provide a detailed overview of the nutritional status of children aged 6 to 59 months in mountain and plain regions, focusing on various indicators such as stunting, wasting, underweight, and MUAC (Mid-Upper Arm Circumference). In the mountain regions, the prevalence of stunting across all age groups ranges from approximately 0.00% to 28.42% indicating a persistent issue of chronic malnutrition. Wasting which reflects acute malnutrition ranges from about 7.69% to 36.84%, with the highest incidence observed in the 36-47 months age group. Underweight children show a similar pattern, with percentages between 12.50% and 31.58%. MUAC measurements, an additional indicator of nutritional status, indicate a notable proportion of children at risk of malnutrition, particularly in the

older age groups ranging to 31.58%.In contrast, the plain regions show a significantly different pattern. The prevalence of stunting is lower in the younger age groups but increases with age, reaching up to 30.00% in the 24- 35 months group.

Table 12: BMI Distribution among Mothers

BMI Category	Mountain Region	Plain Region
Underweight	33 (21.0%)	124 (79.0%)
Normal	146 (79.3%)	38 (20.7%)
Obese	50 (38.2%)	81 (61.8%)
Total	229 (100%)	243 (100%)
Mean (Category)	2.0742	1.823
Median	2	1
Standard Deviation	0.5988	0.9031
Variance	0.358	0.816
Minimum	1	1
Maximum	3	3
Range	2	2
Skewness	-0.027	0.357
Kurtosis	-0.213	-1.685
Kruskal-Wallis Test		
Mean Rank	259.32	215.00
H statistic	H (2) =14.105, p = 0.000. Since the p-value is less than 0.05, the result is statistically significant	

Food and Nutrition (In) Security among Children Aged 6-59 Months

Wasting is also present but at lower levels compared to the mountain region, with the highest prevalence around 14.29% to 16.67%. Underweight children in the plain region have a similar pattern, with some age groups reaching around 17.86% to 20.00%. MUAC data shows that a smaller proportion of children are at risk, but the overall pattern suggests these children are vulnerable to malnutrition with MUAC ranging to 14.29%.The data reveal that in mountain regions, chronic malnutrition represented by stunting is relatively stable but with steady figures across ages. Wasting, indicating recent or acute nutritional deficiency is somewhat variable but remains a concern, especially in the 36- 47 months age group. Conversely, children in the plain regions show lower but more fluctuating levels of these indicators, with some age groups experiencing higher malnutrition rates. In conclusion, both regions face significant nutritional challenges among children, but the patterns differ. Mountain children tend to suffer more from chronic malnutrition, while acute issues are also evident, especially in specific age groups. The plain regions show generally lower prevalence but still require targeted nutritional interventions. A comprehensive strategy addressing both chronic and acute malnutrition is essential for improving childhood health outcomes across these regions.

Table 13: Prevalence of Food and Nutrition (In) Security among Children Aged 6-59 months in Mountain Regions

Age in Months	Number of Children (with %)	Height-for-Age (Stunted)	Weight-for-Height (Wasted)	Weight-for-Height (Severely Wasted)	Weight-for-Age (Underweight)	MUAC (< -2SD)
Female children						
0–11	0 (0.0%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
12–23	26 (12.09%)	26 (27.37)	6 (7.69)	2 (7.69)	2 (7.69)	2 (7.69)
24–35	25 (11.63%)	25 (26.32)	4 (10.00)	1 (4.00)	7 (28.00)	7 (28.00)
36–47	27 (12.56%)	27 (28.42)	6 (16.00)	1 (2.22)	7 (25.93)	7 (25.93)
48–59	17 (7.91%)	17 (17.89)	6 (22.22)	0 (0.00)	7 (29.41)	7 (29.41)
Total	120 (55.81%)	95 (52.49)	27 (28.42)	3 (3.16)	21 (22.11)	21 (22.11)
Male children						
0–11	2 (1.03%)	2 (2.33)	1 (50.00)	0 (0.00)	0 (0.00)	0 (0.00)
12–23	19 (9.74%)	19 (22.09)	5 (26.32)	2 (10.53)	3 (15.79)	3 (15.79)
24–35	23 (11.79%)	23 (26.74)	5 (21.74)	3 (13.04)	4 (17.39)	4 (17.39)
36–47	23 (11.79%)	23 (26.74)	8 (34.78)	8 (21.74)	5 (21.74)	5 (21.74)
48–59	19 (9.74%)	19 (22.09)	7 (36.84)	6 (26.32)	6 (31.58)	6 (31.58)
Total	109 (55.9%)	86 (47.51)	26 (30.23)	15 (17.44)	18 (20.93)	18 (20.93)

Table 14: Prevalence of Food and Nutrition (In) Security among Children Aged 6-59 months in Plain Regions

Age in Months	Number of Children (with %)	Height-for-Age (Stunted)	Weight-for-Height (Wasted)	Weight-for-Height (Severely Wasted)	Weight-for-Age (Underweight)	MUAC (< -2SD)
Female Children						
0–11	7 (3.02%)	0 (0.00)	0 (0.00)	0 (0.00)	1 (14.29)	0 (0.00)
12–23	24 (10.34%)	5 (20.83)	2 (8.33)	1 (4.17)	3 (12.50)	2 (8.33)
24–35	28 (12.07%)	8 (28.57)	4 (14.29)	1 (3.57)	5 (17.86)	3 (10.71)
36–47	25 (10.78%)	6 (24.00)	3 (12.00)	1 (4.00)	4 (16.00)	3 (12.00)
48–59	20 (8.62%)	4 (20.00)	2 (10.00)	0 (0.00)	3 (15.00)	2 (10.00)
Total	128 (55.17%)	23 (22.12)	11 (10.58)	3(2.88)	16(15.38)	10(9.62)
Male Children						
0–11	8 (3.56%)	1 (12.50)	0 (0.00)	0 (0.00)	1 (12.50)	0 (0.00)
12–23	25 (11.11%)	6 (24.00)	3 (12.00)	1 (4.00)	4 (16.00)	3 (12.00)
24–35	30 (13.33%)	9 (30.00)	5 (16.67)	2 (6.67)	6 (20.00)	4 (13.33)
36–47	26 (11.56%)	7 (26.92)	4 (15.38)	1 (3.85)	5 (19.23)	4 (15.38)
48–59	21 (9.33%)	5 (23.81)	2 (9.52)	1 (4.76)	3 (14.29)	3 (14.29)
Total	115 (51.11%)	28 (25.45)	14 (12.73)	5(4.55)	19(17.27)	14 (12.73)

Conclusion & Policy implication

The comparative analysis of food and nutrition in security across mountain and plain specificities reveal distinct patterns in maternal and child nutritional outcomes. Mothers in the hill region demonstrate better BMI status than those in plains. This difference may be attributed to more equitable intra household food distribution and smaller family sizes in mountain communities which allows women greater access to avail food resources. In contrast, households in the plains tend to have larger family structures and stronger male dominated food allocation norms which can limit women's dietary intake leading to poorer maternal BMI outcomes. However despite better maternal nutrition in the hills, child nutritional indicators are more favourable in the plains. Children in plain regions benefit from greater access to and probably more efficient delivery of government supported nutrition interventions, such as mid-day meal schemes, Integrated Child Development Services (ICDS), and Anganwadi centres. Poor households often rely on these programmes to ensure that children receive at least one nutritious meal daily. In the hill region children face reduced access to such services due to challenging terrains, restricted mobility, limited service coverage and lower participation in formal schooling. As a result malnutrition among children remains more prevalent in mountain communities. Both regions face significant challenges but the nature of vulnerabilities differs. While maternal nutrition requires greater attention in the plains, targeted child focused interventions are urgently needed in the mountains. Addressing these disparities is essential for strengthening the overall food and nutrition security of rural households across both environments.

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Conflict of Interest

The authors declare no conflict of interest.

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A Study on the Impact of Rainfall and Temperature on Rice Yield in Manipur During 1991-2024

Konthoujam Sunindro Singh*

Department of Economics,
Manipur University, Canchipur, Imphal, Manipur-795003, India
**Corresponding author: konthoujam5554@gmail.com*

Abstract

The paper examines the effects of key climatic factors, specifically seasonal rainfall during the winter, pre-monsoon, monsoon, and post-monsoon periods, as well as maximum and minimum average temperatures, on rice yields from 1991 to 2024 in Manipur, located in Northeast India. The study observes a statistically significant downward trend in Total Annual Rainfall (TAR), primarily attributed to a substantial reduction in rainfall during the monsoon season. While there are no prominent long-term trends in seasonal rainfall, considerable variability exists from year to year. The decrease in monsoon rainfall volume is offset by an increased contribution of precipitation from the Pre-monsoon and Winter seasons, which are particularly erratic and unreliable. A considerable number of years have experienced scanty rainfall. Correlation analysis indicates that heightened rainfall during the Winter, Pre-monsoon, and Monsoon seasons is significantly linked to reduced rice yields. A statistical model reveals that monsoon rainfall serves as a significant negative predictor of yield. Conversely, maximum temperature is identified as a crucial positive predictor of yield. The minimum temperature was also recognised as a predictor, exhibiting a marginally significant negative correlation with yield. These findings underscore the importance of monsoon patterns and variations in day-to-night temperatures, particularly the increase in night-time temperatures, as critical climatic factors affecting rice productivity. This insight is essential for formulating effective agricultural adaptation strategies and targeted management of water resources.

Keywords: Climatic factors, seasonal rainfall, average temperature, yield and variability

Introduction

Indian agriculture is predominantly reliant on the vagaries of monsoon rainfall. Climate change has emerged as a serious issue in contemporary Indian agriculture, as farmers across numerous areas are finding it increasingly difficult to adapt to shifting temperature and rainfall patterns (Roy et al. 2021). Climatic conditions have a profound impact on crop production, particularly on the Kharif rice crop, which is one of the most common food crops in India and is vulnerable to fluctuations in annual rainfall and temperature. The rice crop serves not only as the primary food source but also as the principal agricultural output, thereby playing a crucial role in India's food security and rural economy (Das et al., 2020;

Gogoi et al., 2022). Understanding the relationship between seasonal weather changes and rice yield is vital for agricultural planning and food security (Patra & Mishra, 2019). Numerous studies across India have highlighted that variations in monsoon onset, duration, and intensity can drastically alter rice productivity patterns (Rathore et al., 2020). Climatic conditions are increasingly impacting the ultimate harvest results, while factors such as seed variety, fertiliser use, and farming practices are also essential (Kumar & Bhatia, 2022; Choudhury et al., 2023).

The amount and timing of the southwest monsoon rainfall are essential factors influencing rice yield in Manipur, a northeastern state of India (Singh & Devi, 2022; Das et al., 2020). The total water requirement for the entire season can range from 750 mm to 2500 mm, depending on the specific needs of the variety and location (Patra & Mishra, 2019; Rao et al., 2018). The average annual rainfall in Manipur ranges from 1250 mm to 2700 mm, which is sufficient for rice cultivation, although the range varies by location. Adequate and timely rainfall during critical growth phases is crucial for successful harvest. Rainfall in June is particularly essential for the effective germination, transplanting, and initial growth of the rice crop (Das & Hazarika, 2021). Research indicates a positive and significant relationship, suggesting that an increase in June rainfall is correlated with a rise in Kharif rice yield.

Additionally, rainfall in August and September is positively associated with yield, supporting the crop during the vital reproductive and grain-filling periods (Kumar & Bhatia, 2022; Singh et al., 2023). Irregular rainfall patterns, which encompass deficits such as drought conditions and excessive downpours or floods, present considerable risks to rice production. Inadequate or delayed monsoon rains lead to water stress, crop failures, and reduced yields, as most farmers rely on rainfall. Conversely, heavy or excessive rain, especially in July, can adversely affect yield, although this impact may sometimes be statistically insignificant, likely due to flooding, waterlogging, or interruptions to farming practices (Devi et al., 2020; Singh & Thokchom, 2023). Therefore, while moderate rainfall during the late monsoon months benefits yield formation, both deficit and surplus rainfall remain critical challenges for sustaining stable rice productivity in Manipur's rainfed systems (Gogoi et al., 2022; Kumar et al., 2021).

Temperature is a crucial climatic factor that affects rice physiology and yield (Krishnan et al., 2011; Kumar & Bhatia, 2022). Manipur has experienced a consistent increase in average annual temperatures, which is expected to persist, particularly in minimum and maximum temperatures, negatively impacting crop productivity (Devi & Sharma, 2021; Gogoi et al., 2022). Excessively high temperatures, particularly during critical stages such as ripening, can greatly affect the crop. Studies indicate that a rise in minimum (night-time) temperatures can decrease rice yield by increasing spikelet sterility and disrupting grain formation (Peng et al., 2004; Das & Hazarika, 2021). The combined impact of rising temperatures and unpredictable rainfall is heightening the vulnerability of the agricultural sector in Manipur, making it essential for farmers to adopt climate-resilient technologies and high-yielding varieties (HYVs) to reduce potential losses (Devi et al., 2020; Singh & Devi, 2022). These compounded stresses underscore the urgent need to adopt climate-resilient technologies, improve irrigation management, and utilise high-yielding, heat-tolerant rice varieties (HYVs) to safeguard food security and sustain rural livelihoods under changing climatic conditions (Lalrinsanga & Mishra, 2021; Kumar et al., 2021).

Given the impact of climate change, which is altering precipitation patterns and temperature conditions across Northeast India, a focused analysis of these dynamics is essential. This paper investigates the correlation between rice yield and climatic factors in Manipur, utilising historical data from 1991 to 2024. In particular, it seeks to address the issue of varying seasonal rainfall patterns and temperature fluctuations that affect the annual rice yield in the state.

Objective of the study

The main objective of the study is to examine the impact of rainfall and temperature on rice yield in Manipur during 1991-2024

Materials and Methods

Study Area

The present investigation focuses on the state of Manipur, situated in the northeastern part of India, positioned between latitudes 23°83′-25°68′ N and longitudes 93°03′-94°78′ E. This region is characterised by a predominantly subtropical monsoon climate, which receives abundant rainfall from the Southwest Monsoon from June to September (Manglem, A. 2024). Most part of the landscape is mountainous, featuring an intermontane valley at its core, where paddy farming is a prevalent practice. The economy and food security of the state are heavily reliant on monsoon precipitation, rendering it a crucial factor for agro-climatic research. The average annual temperature fluctuates between 16°C and 25°C, while the typical yearly rainfall ranges from 1400 to 2000 mm, influenced by altitude and orographic factors. Consequently, the study area serves as an excellent location for investigating rainfall variability and long-term climate patterns.

Data sources and analysis tools

The study is primarily based on seasonal rainfall and average temperature levels, drawing on secondary sources that cover the period from 1991 to 2024, specifically the Rainfall Statistics of India Series (India Meteorological Department), the Statistical Handbooks of Manipur, and the NER Data Bank. For trend analysis, seasonal and annual totals were calculated using two standard non-parametric methods: the Mann-Kendall Test, which identifies the presence of a monotonically increasing or decreasing trend in the time series, and Sen's Slope Estimator, which measures the magnitude of the trend while being robust to outliers and missing data. Both methods were performed in Python, utilising statistical libraries. Further, descriptive statistics, including the mean, coefficient of variation (CV), and percentage analysis, were employed to assess the variability of rice yield and climatic variables. Finally, multiple regression analysis was performed to evaluate the extent to which the independent covariates influenced the dependent variable, rice yield.

Variables Specification

The quantitative assessment analyses the dependent variable, yield, by examining its correlation with climatic factors using multiple regression analysis to determine the functional relationship between them. It is to estimate and forecast the average output level,

based on the known or fixed values of the explanatory variables (Singh et al., 2016). The dependent variable is the annual rice yield, quantified in thousand metric tonnes. Conversely, the explanatory variables include seasonal rainfall during the winter, pre-monsoon, monsoon, and post-monsoon periods, as well as the average annual maximum and minimum temperatures.

Table 1: Variable Specification

Variable	Specification
Dependent Variable:	
1. Yield	in '000 metric tons
Independent Variable:	
1. Winter rain	in mm
2. Pre-Monsoon Rain	in mm
3. Monsoon Rain	in mm
4. Post Monsoon Rain	in mm
5. Average Maximum Temperature	in ^{0}C
6. Average Minimum Temperature	in ^{0}C

The model assumes a linear relationship between the dependent and independent variables, homoscedasticity of residuals, and the absence of multicollinearity among the predictors. The statistical significance of the coefficients was assessed using t-statistics, while the overall fit of the model was determined through the coefficient of determination (R^2) and F-statistics. Diagnostic tests were carried out to verify the validity of the regression assumptions, which included checking for multicollinearity using the Variance Inflation Factor (VIF) < 5, ensuring the normality of residuals, and confirming the absence of serial autocorrelation. The analysis was executed using Microsoft Excel and cross-validated with SPSS to ensure robustness.

Results and Discussion

Trends and Position of Rainfall

Decadal Rainfall Trends and Shifts in Seasonal Rainfall Share

The seasonal rainfall pattern in Manipur is substantially influenced by the southwest monsoon, which occurs from June to September, accounting for the bulk of the state's annual precipitation; however, notable local differences exist (Dash et al., 2012; Jain et al., 2013; Singh et al., 2016). The post-monsoon period (October-November-December) and the pre-monsoon period (March-May) experience a low quantum of rainfall, whereas the winter months (January-February) are generally arid (Kumar and Rajeevan, 2019; Das et al., 2021). Recent studies have indicated fluctuations and changes in these patterns, particularly after the year 2000 (Guhathakurta & Rajeevan, 2008; Pattanaik & Rajeevan, 2010; Lal et al., 2020). The analysis of rainfall data in Manipur from 1991 to 2024 reveals significant inter-annual and decadal variability, particularly concerning rainfall volume and seasonal distribution. The findings are presented in Table 2, which covers decadal trends and shifts in seasonal contributions. The data were categorised into three decadal periods to assess long-term changes.

Table 2: **Average Decadal and Seasonal Rainfall (mm) and Percentage Share**

Decadal Series	Decadal Average Rain (mm)	Winter Rain (%)	Pre-monsoon Rain (%)	Monsoon Rain (%)	Post-monsoon Rain (%)
1991-2000	1995.48	69.29 (3.47)	505.75 (25.34)	1259.47 (63.12)	160.97 (8.07)
2001-2010	1432.91	35.22 (2.46)	345.83 (24.13)	838.45 (58.51)	213.41 (14.89)
2011-2024	1522.55	33.41 (2.19)	373.46 (24.53)	900.74 (59.16)	214.94 (14.12)

The analysis reveals a considerably sustained shift in the hydro-climatic regime, characterised by a fundamental redistribution of precipitation across the defined seasonal boundaries, demonstrating a robust pattern of declining proportional contribution of the traditional core monsoon rainfall, compensated by a dramatic surge in the proportional contribution of the post-monsoon season. The results indicate a declining trend in total decadal average rainfall from 1995.48 mm during 1991-2000 to 1432.91 mm during 2001-2010, followed by a partial recovery to 1522.55 mm in 2011-2020. The percentage contribution of each season to the total annual rainfall reveals underlying changes in the seasonal timing and intensity of precipitation. The most critical shift is the significant decline in the Monsoon season's relative contribution to the total rainfall. Its share dropped from dominating 63.12% of the annual rainfall in the 1990s to 58.51% to 59.16% in the recent period from 2001 to 2010, and then to 2011-2024. This signals a fundamental change in the state's hydrological cycle (Deka et al., 2013; Halder et al., 2024).

The monsoon season contributes the highest share of annual rainfall across all decades, accounting for about 63.12% in 1991-2000, 58.51% in 2001-2010, and 59.16% in 2011-2024. A slight reduction in monsoon contribution after 2000 suggests increased variability and possible weakening of the monsoon system. The pre-monsoon rainfall contribution shows relative stability, ranging from 24.13% to 25.34%, indicating its consistent role in total annual precipitation. Conversely, winter rainfall remains minimal (2.19-3.47%) throughout, while post-monsoon rainfall doubles from 8.07% in 1991-2000 to around 14% in subsequent decades. Overall, the data reveal a decreasing rainfall trend during 2001-2010 with a moderate recovery in the following decade, suggesting inter-decadal fluctuations possibly linked to regional climatic variability and changes in monsoon dynamics.

This indicates that a larger proportion of the annual rainfall is now occurring earlier in the year (Choudhury et al., 2023; Das & Nath, 2021). This could imply an advance in the onset of rainy weather or a greater intensity of pre-monsoon convective activity, potentially affecting agricultural planning traditionally tied to the Monsoon season (Guhathakurta & Rajeevan, 2008; Bordoloi et al., 2020). While the absolute amount of rainfall is decreasing, the redistribution suggests that water resource management strategies must adapt to a bimodal distribution where the Pre-monsoon season is becoming increasingly crucial for water harvesting and irrigation planning (Chakraborty et al., 2025; Pathak et al., 2020).

Rainfall Trend Analysis

The analysis reveals high interannual variability in rainfall over the 34 years. Annual rainfall ranged from 573 mm (1994) to 2,995 mm (1991), with an average of approximately 1550 mm per year. The Monsoon season contributed nearly 70 % of the total annual rainfall. The Mann-Kendall test statistic ($Z = -1.57$, $p = 0.116$) indicates a weak, non-significant downward trend, supported by a negative Kendall's tau (-0.19). The Sen's slope of -15.43 mm/year suggests a gradual decline in annual rainfall over time. The long-term rainfall trend in Manipur (1991-2024) exhibits a weakly declining trend of approximately 15 mm per year. While statistically non-significant ($p > 0.05$), the consistent negative direction indicates possible early signs of climatic variability and a weakening monsoon pattern. However, the computed p-value (0.116) exceeds the 0.05 significance level, implying that the downward trend is not statistically significant at the 95% confidence level. Therefore, although rainfall shows a decreasing tendency, the evidence is insufficient to confirm a significant monotonic decline during the study period.

Table 3: **Mann-Kendall Test and Sen's Slope Estimate Results**

Mann-Kendall Test	Sen's slope estimate
S = -107	Sen's slope (β) = -15.43 mm per year
Var (S) = 4550.33	Intercept = 32359.79
	Trend equation:
Z = -1.57	Rainfall = 32359.79-15.43 × Year
p-value = 0.116	
Kendall's τ = -0.19	

Although the decreasing trend is not statistically significant, its persistence indicates potential early signs of rainfall decline in Manipur. The high inter-annual variability, characterised by alternating wet and dry years, likely obscures the long-term signal. Such rainfall fluctuations can substantially impact rice-based agriculture, the dominant cropping system in the region. Reduced monsoon intensity or delayed onset could affect transplanting schedules, yield stability, and irrigation planning. From a hydrological perspective, prolonged declines could also influence groundwater recharge and streamflow regimes. The observed tendencies are consistent with other studies in Northeast India, which have reported slight but non-significant decreases in monsoon rainfall over the past few decades (Das & Goswami, 2014; Guhathakurta et al., 2015). This coherence suggests that Manipur may be experiencing similar regional climatic shifts linked to ENSO events, Indian Ocean Dipole, and changes in monsoon circulation dynamics.

Annual and Seasonal Extreme Rainfall

Table 4 presents the highest and lowest rainfall years, as well as seasonal variations, across different periods. The results show that monsoon rainfall largely determines the total annual rainfall in Manipur, with 2994.7 mm and 2914.4 mm recorded in 1991 and 1993, respectively, as the highest yearly totals (Deka et al., 2013; Halder et al., 2024). Conversely, the years 1994 and 2003 experienced the lowest rainfall, at 573.3 mm and 687.7 mm,

indicating deficient monsoon years (Choudhury et al., 2023). Winter rainfall contributes minimally to the annual total, with 1993 showing a seasonal maximum of 297.1 mm and 2004 recording only 1.3 mm (Bordoloi et al., 2020). The pre-monsoon and post-monsoon seasons also display considerable variability, with 1993 and 2019 exhibiting higher rainfall extremes, while 1994 consistently marks a dry year across all seasons (Das & Nath, 2021; Chakraborty et al., 2025). Overall, the data highlight a strong dependence on monsoon rainfall and significant interannual variability, reflecting the climatic sensitivity of Manipur's rainfall patterns (Guhathakurta & Rajeevan, 2008; Jain et al., 2023).

Table 4: **Annual and Seasonal Rainfall Extreme in Manipur during 1991-2024**

Rainfall Category	Year	Total Annual Rainfall (mm)	Seasonal Extreme (mm)	Season
Highest Annual Rainfall	1991	2994.7	1707.8	Monsoon
	1993	2914.4	1545.7	Monsoon
Lowest Annual Rainfall	1994	573.3	300.1	Monsoon
	2003	687.7	351.3	Monsoon
Seasonal Maximum	1993	2914.4	297.1	Winter
Seasonal Minimum	2004	1084.2	1.3	Winter
Seasonal Maximum	1993	2914.4	879.8	Pre-monsoon
Seasonal Minimum	1994	573.3	198.4	Pre-monsoon
Seasonal Maximum	2019	1625	700.6	Post-monsoon
Seasonal Minimum	1994	573.3	26.7	Post-monsoon

Excess, Normal and Deficient Rainfall Frequency

The 34-year rainfall series (1991-2024) was classified based on the India Meteorological Department (IMD) standard, using the calculated Long Period Average (LPA) of approximately 1177.56 mm. The table illustrates the distribution of rainfall over 34 years, categorising each year into three rainfall conditions of excess, normal, and deficient, based on deviations from the long-term average (LPA). Firstly, 17 years (50%) of the study period experienced rainfall levels below 942 mm, which is less than -20% of the LPA, indicating that half of the period was characterised by rainfall deficiency and leaned towards drier conditions, or a recurring trend of inadequate precipitation (Deka et al., 2013; Halder et al., 2024; Choudhury et al., 2023). Such high frequencies of below-normal years are consistent with regional analyses that report increasing interannual variability and prolonged dry spells across Northeast India (Das & Nath, 2021; Jain et al., 2023; Guhathakurta & Rajeevan, 2008).

Table 5: Rainfall classification based on long-period average and total annual rainfall

Rainfall Classification	Criteria (Relative to LPA)	Number of Years (1991-2024)	Frequency (%)
Excess	Less than 20% and above LPA (TAR greater than 1413 mm)	7	20.6%
Normal	-19% to + 19% of LPA (TAR 942 mm to 1413 mm)	10	29.4%
Deficient	Less than - 20% of LPA (TAR less than 942 mm)	17	50.0%
Total		34	100%

Such extended periods of deficient rainfall can significantly impact agriculture, water availability, and the sustainability of ecosystems (Chakraborty et al., 2025; Datta et al., 2022). Approximately 10 years (29.4%) fell within the deviation range of -19% to +19% from the LPA (942-1413 mm). These years demonstrated stable or average rainfall conditions, thereby supporting consistent agricultural productivity and preserving a hydrological balance (Halder et al., 2024). Nevertheless, the relatively low percentage of normal years, which is less than one-third of the total, highlights the instability and inconsistency of rainfall across the decades (Jhajharia et al., 2012; Das et al., 2020). It is noted that 7 years (20.6%) experienced above-normal rainfall exceeding 1413 mm. This analysis confirms the subjective observation from Table 7, which shows a decadal average trend of drying (Choudhury et al., 2023; Halder et al., 2024). Since 2001, the system has experienced a persistent rainfall deficit (Chakraborty et al., 2025). The classification demonstrates a critical shift in the climate regime. The traditional notion of a balanced distribution between Excess, Normal, and Deficient years is no longer valid. The high frequency of deficient years places severe stress on the region's largely rain-fed agricultural system and water resources, leading to increased risk of drought conditions (Datta et al., 2022; Goswami et al., 2006). The data indicate that adaptation strategies must prioritise managing water scarcity and drought resilience, as half of the years will likely fail to meet the historical Long Period rainfall Average (Das et al., 2020; Rao et al., 2023).

Descriptive statistics of Seasonal rainfall and temperature

Table 6 shows that the average winter rainfall dropped sharply from 70.05 mm to 35.25 mm (49.72%). The CV increased significantly (97.15%), showing high instability in winter rain (Choudhury et al., 2019; Singh & Jain, 2021). This reduction may impact soil moisture retention and early crop establishment. Pre-monsoon average rainfall decreased from 496.94 mm to 370.87 mm (25.37%), indicating a weaker pre-monsoon system, which may have affected land preparation and early sowing (Dash et al., 2012; Krishnan et al., 2020). The average monsoon rainfall declined from 1267.78 mm to 887.18 mm (-30.04%) (Chaturvedi et al., 2019). As the primary water source for rice cultivation, this reduction has significant implications for water availability during the peak growth period. However, the reduced variability, as shown by the CV (29.64 to 31.99, 7.94%), indicates relatively stable but lower rainfall. In contrast, post-monsoon average rainfall increased slightly from 163.53 mm to

211.94 mm (29.17%), which may partially compensate for the reduced monsoon rain, supporting late-season water availability (Rao et al., 2020; Singh et al., 2022).

Table 6: **Seasonal rainfall and temperature in Manipur during 1991-99 and 2000-24**

Seasonal Rainfall & Temperature	Descriptive Statistics	Period-I (1991-99)	Period-II (2000-24)	Percentage change
Winter rain (in mm)	Mean	70.08	35.28	-49.65
	CV	120.40	72.86	-39.49
Pre-monsoon rain (in mm)	Mean	496.94	370.87	-25.37
	CV	43.81	37.00	-15.55
Monsoon rain (in mm)	Mean	1267.78	887.18	-30.02
	CV	29.64	31.99	7.94
Post-monsoon rain (in mm)	Mean	163.53	211.24	29.17
	CV	70.03	67.93	-3.00
Average max. Temperature (^{O}C)	Mean	28.92	29.30	1.32
	CV	2.17	4.45	104.84
Average min. Temperature (^{O}C)	Mean	21.99	21.25	-3.35
	CV	3.37	6.64	97.12

Moreover, the redistribution of rainfall, characterised by diminished monsoon precipitation and a rise in post-monsoon rainfall, implies temporal shifts in water availability (Chakraborty et al., 2025; Halder et al., 2024). Despite these adverse climatic trends, the sustained and enhanced rice yield highlights the effectiveness of adaptive measures, including irrigation expansion and improved crop management, in mitigating the impacts of climatic variability on rice production (Ray et al., 2022; Datta et al., 2022; Pathak et al., 2020). Overall, these findings demonstrate a shifting rainfall regime in Manipur, characterised by declining winter, pre-monsoon, and monsoon precipitation, partially offset by an increase in post-monsoon rainfall (Deka et al., 2013; Choudhury et al., 2023). Such changes could significantly influence rice-growing environments, particularly in rainfed lowlands where yield is closely tied to the timing and distribution of rainfall (Bordoloi et al., 2020; Singh et al., 20211).

Further, it reveals that the average maximum temperature level rose slightly from 28.92°C to 29.30°C (1.32%) and CV increased substantially from 2.17 to 4.45 (104.84%), highlighting greater temperature fluctuations in recent years. This could influence heat stress on crops, especially during critical growth stages. Following the same trend, the average minimum temperature level increased from 21.99°C to 21.25°C, representing a reduction of 3.35%. The CV nearly doubled from 3.37 to 6.64, with 97.1% indicating greater variability in night-time temperatures, showing an increasing trend. This could influence heat stress on crops, especially during critical growth stages (Pathak et al., 2011). It can be inferred that rice yield increased dramatically, despite a decline in rainfall and rising temperature levels, which is likely attributable to technological advancements, the adoption of improved rice varieties, and better agronomic management practices (Aggarwal et al., 2008; Pathak et al., 2011; Singh et al., 2020).

Variability in annual yield

The comparative analysis of rice yield, annual rainfall, and temperature is presented in Table 8, comparing the two periods: Period I (1991-1999) and Period II (2000-2024). This analysis indicates substantial agro-climatic transitions in the state. It displays changes in rice yield, annual rainfall, and temperature (maximum and minimum), along with corresponding means and coefficients of variation (CV), showing percentage changes between the two periods.

The average rice yield in Manipur increased markedly from 180.90 thousand metric tons in 1991-1999 to 420.00 thousand metric tons during 2000-24, representing a rise of 32.18%. Simultaneously, the coefficient of variation (CV) declined sharply from 36.34% to 16.50% (a reduction of 54.63%), indicating that yield variability became substantially more stable and consistent over time (Pathak et al., 2020; Ray et al., 2022). In contrast, the total annual average rainfall decreased from 1,998.33 mm (1991-99) to 1,504.58 mm (2000-24), representing a 24.71% drop. The CV of annual rainfall also decreased from 33.30% to 26.12%, with a 7.18% reduction, suggesting a notable decline not only in mean precipitation but also in rainfall variability (Choudhury et al., 2023; Halder et al., 2024). These findings point to a progressive shift towards a relatively drier and more stable climatic regime in Manipur from 2000 onwards, accompanied by improved and more dependable rice yields, reflecting the positive effects of agricultural adaptation strategies, including irrigation development, adoption of stress-tolerant varieties, and improved management practices (Datta et al., 2022; Bordoloi et al., 2020; Singh et al., 2021).

Table 8: Descriptive statistics of rice yield, annual rain and temperature during 1991-2024

Variables	Descriptive Statistics	Period-I (1991-99)	Period-II (2000-24)	Percentage change
Yield	Mean	180.90	420.00	132.18
(in ‘000 tons)	C. V	36.34	16.50	-54.63
Total annual rain	Mean	1998.33	1504.58	-24.71
(in mm)	C. V	33.30	26.12	-21.57
Maximum	Mean	28.92	29.30	1.32
Temperature (^{O}C)	C. V	2.17	4.45	104.84
Minimum	Mean	21.99	21.25	-3.35
Temperature (^{O}C)	C. V	3.37	6.64	97.12

These results align with and contribute to the existing literature on yield-climate relationships. For example, studies of Indian rice cultivation generally find that both rainfall amounts and rainfall variability are key determinants of rice yield and yield variability (Chand & Dhaliwal, 2024; Nath & Mandal, 2018). Chand & Dhaliwal (2024) demonstrate that, despite being a highly irrigated region, Punjab's monsoonal rainfall variability remains positively correlated with rice yields. The authors stress that even years with deficit rainfall impact yields through groundwater recharge effects. Similarly, Nath & Mandal (2018) demonstrated heterogeneous climatic impacts on rice yields across agro-climatic zones in Assam, finding that rainfall variability, in particular, harmed autumn and winter rice yields. In a broader context, it reveals a nonlinear relationship between monsoon rainfall and rice yield

in India, with an optimal rainfall threshold of approximately 1,621 mm, beyond which yields decline, and deficits also reduce yields (Maiti et al. 2024).

Correlation Analysis Between Rice Yield and Climatic Factors

Table 9 presents the Pearson correlation coefficients, which measure the strength and direction of the linear relationship between variables. Rainfall and yield analysis reveal generally negative correlations between rice yield and rainfall in the winter (-0.30), pre-monsoon (-0.30), and monsoon (-0.37) seasons (Bordoloi et al., 2020; Choudhury et al., 2023). This suggests that increased rainfall in these seasons is weak and moderately associated with decreased rice yield, consistent with earlier findings that excessive or poorly distributed rainfall can lead to waterlogging, reduced solar radiation, and yield decline (Das & Nath, 2021; Pathak et al., 2020). Conversely, post-monsoon rain shows a weak positive correlation (0.12), indicating a negligible relationship (Ray et al., 2022).

A moderate positive correlation exists between maximum temperature and yield (r = 0.43), implying that higher daytime temperatures are associated with increased yields within the observed range (Mishra & Datta, 2019; Pathak et al., 2020; Ray et al., 2022). In contrast, the minimum temperature shows a weak negative correlation (-0.12), suggesting that higher night-time temperatures may be slightly unfavourable (Welch et al., 2010; Lobell et al., 2011; Singh et al., 2021).

Table 9: Correlation between rice yield, seasonal rainfall and average temperature levels

Variables	Rice Yield (in '000 tons)	Winter (in mm)	Pre-monsoon (in mm)	Monsoon (in mm)	Post-monsoon (in mm)	Maximum temperature (^{0}C)	Minimum temperature (^{0}C)
Rice Yield	1						
Winter Rain	-0.30	1					
Pre-monsoon	-0.30	0.46	1				
Monsoon	-0.37	0.29	0.52	1			
Post-monsoon	0.12	0.07	-0.01	0.22	1		
Max temp	0.43	-0.04	-0.15	0.02	0.00	1	
Min temp	-0.12	0.03	0.08	0.18	-0.09	0.47	1

However, the table indicates that monsoon rain has a positive correlation with pre-monsoon rain (r = 0.52), and maximum and minimum temperatures are also significantly associated (r = 0.47). These interrelationships are vital as they can influence the regression model (Bordoloi et al., 2020; Choudhury et al., 2023). The descriptive analyses reveal pronounced

interannual variability in seasonal rainfall, which is dominated by the monsoon season, accounting for more than 50% of the total annual precipitation (Deka et al., 2013; Das & Nath, 2021). The long-term temperature trend indicates a rise in both maximum and minimum temperatures, with night-time temperatures increasing more rapidly, resulting in a narrowing diurnal temperature range (Chakraborty et al., 2025; Halder et al., 2024; Singh et al., 2021).

The correlation analysis shows a negative association between rice yield and rainfall during most seasons, suggesting that excessive rainfall may lead to waterlogging, pest outbreaks, or nutrient loss (Bordoloi et al., 2020; Das & Nath, 2021; Pathak et al., 2020). Conversely, higher maximum temperatures are associated with improved yields, possibly due to enhanced photosynthetic activity during grain formation (Mishra & Datta, 2019; Ray et al., 2022).

Impact of annual rainfall and temperature on rice yield

A multiple regression analysis was performed to understand the combined effect of these climatic factors on yield (Pathak et al., 2020; Singh et al., 2021). The regression model has an R-squared value of 0.49, meaning that 49% of the variation in rice yield is explained by the six independent variables, including seasonal rainfall and maximum/minimum temperatures (Choudhury et al., 2023). The Adjusted R Square (0.37) accounts for the number of predictors and suggests a modest explanatory power for the model (Mishra & Datta, 2019). The overall model is significant, as indicated by the F-statistic of 4.25, which is substantial at $p < 0.05$ (Ray et al., 2022). The negative constant term (-784.30) occurs when all independent variables are zero. Winter and pre-monsoon rain have coefficients that are not statistically significant ($p = 0.15$ and 0.56), so we cannot confidently say they influence yield (Bordoloi et al., 2020; Das & Nath, 2021).

Table 10: Regression statistics of rice yield based on seasonal rainfall and average annual temperature

Multiple R	0.70			
R Square	0.49			
Adjusted R Square	0.37			
Standard Error	100.68			
F- value	4.25			
	Coefficients	Standard Error	t Stat	P-value
Intercept	-784.30	460.07	-1.70	0.10
Winter rain	-0.57	0.38	-1.49	0.15
Pre-monsoon	0.08	0.13	0.60	0.56
Monsoon	-0.13	0.06	-2.08	0.05
Post-monsoon	0.16	0.13	1.24	0.23
Max temp	64.77	17.35	3.73	0.00
Min temp	-30.98	15.66	-1.98	0.06

Monsoon rain has a significant negative coefficient (-0.13) and a p-value of 0.05. This confirms the correlation finding, indicating that for every unit increase in monsoon rainfall, rice yield decreases by 0.13 units, holding all other factors constant (Bordoloi et al., 2020;

Choudhury et al., 2023). This finding suggests that after reaching a specific limit, heightened monsoon rainfall may have adverse effects, potentially due to waterlogging, reduced solar radiation, or an increased occurrence of pests and diseases. Higher rainfall reduces the yield variability of rice, whereas an increase in temperature is expected to increase rice yield variability (Verma, 2019; Pathak et al., 2020). This could be due to waterlogging or pest proliferation in excessively wet conditions (Singh et al., 2021).

The post-monsoon rain shows a positive but statistically insignificant coefficient at *p*-value 0.23 (Das & Nath, 2021). The average maximum temperature level has a highly significant positive coefficient (64.77, $p = 0.00$). This suggests that increases in maximum temperature have a strong, positive effect on rice yield (Ray et al., 2022; Mishra & Datta, 2019). Minimum temperature has a negative coefficient (-30.98) that is marginally significant ($p = 0.06$). This aligns with the correlation, hinting that rising minimum (night-time) temperatures could be detrimental to yield, potentially by increasing respiration rates (Welch et al., 2010; Lobell et al., 2011).

Conclusions

Manipur perceived a rising trend in the average temperature level during the two study periods, 1991-1999 and 2000-2024. Similar temperature increase patterns have been reported across Northeastern India, consistent with global and national warming trends (Dash & Hunt, 2007; Kothawale et al., 2010; Krishnan et al., 2020). Monsoon rainfall is the most significant rainfall variable, exhibiting a negative relationship with rice yield. Other seasonal rainfalls do not show a statistically significant impact within this model. Temperature plays a critical and contrasting role. The maximum temperature is an essential positive driver of yield, while the minimum temperature tends to be a negative factor. This underscores the complex role of diurnal temperature variation. The climatic factors examined explain a substantial portion (49%) of the yield variability, with monsoon rain and maximum temperature being the most significant individual predictors.

These findings highlight the vulnerability of rice production to climatic shifts, particularly changes in monsoon patterns and night-time temperatures. Agricultural policies and adaptation strategies should focus on developing resilient crop varieties and effective water management practices to mitigate the negative impacts of excessive monsoon rains and rising night-time temperatures. The finding reflects a transition period in which technological improvements in agriculture have offset the climatic stress of reduced rainfall and higher temperatures, allowing rice yields to be sustained and even enhanced. However, the long-term sustainability of this trend depends on the implementation of effective climate adaptation strategies, particularly in water management and heat resilience. Grasping the factors that influence its yield is essential for effective policy formulation and sustainable agricultural progress.

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Implication of Artificial Intelligence on Service Quality of Banking Sector: A Customer-Oriented Approach using SERVQUAL Model

Nazim Uddin Ahmed*, Sanjio R. Marak, Junybirth T. Sangma

Department of Management,
North-Eastern Hill University, Tura Campus, Meghalaya-794002, India
**Corresponding author: nazimuddin12345@gmail.com*

Abstract

Artificial Intelligence is transforming banking operations, particularly for providing quality services to customers. In the present rapid digital transformation of banks, AI-driven technologies such as chatbots, automated loan processing, fraud detection, and personalized customer services are reshaping operational efficiency and customer experience. The study emphasises the application of Artificial Intelligence on the service quality provided by banks in India for their customer satisfaction. This research paper thoroughly reviews the literature on the numerous promising applications of artificial intelligence and its impact on the banking sector from the customer's perspective. This research is based on primary data collected using a structured questionnaire. The data collected from 200 consumers of public sector banks operating in the Barak Valley of Assam was considered through the convenience sampling method. The service quality parameters have been selected based on the SERVQUAL model. The research findings suggest that the demand for artificial intelligence in the Indian banking sector is essential for the customers' service quality. Further, this study shows that AI has a crucial role to play in the banking sector. It also observes the main factors that influence the adoption of AI in the banking Industry.

Keywords: Artificial intelligence, service quality, customers, banking sector, technologies

Introduction

The initiation of big data necessitated the development of methods to extract valuable insights from vast datasets, which in turn brought Artificial Intelligence (AI) to the forefront (Kok et al., 2009). It became evident that the full potential of big data could only be harnessed through the application of machine learning algorithms. Since the turn of the 21st century, AI, big data (Guerra et al., 2023), machine learning (Wang et al., 2023), cloud computing, and blockchain technologies have gained significant momentum due to advancements in computing systems (Ratia et al., 2018) and the proliferation of big data (Haenlein and Kaplan, 2019). AI has gained rapid traction because its application across various industries has delivered substantial benefits, such as cost reduction, enhanced customer satisfaction, mitigation of fraudulent activities, and more efficient resource utilisation (McKinsey Global Institute's Report, 2018). A comprehensive AI report published by Stanford University in 2023 (Nestor et al., 2023) underscored the global investments in AI and their subsequent growth. The United States leads AI investment with $248.9 billion, followed by China at $95.1 billion, and the United Kingdom in third place with $18.2 billion.

Israel, Canada, and India follow, with India ranking sixth, investing $7.73 billion in AI. Further, India ranks sixth in the deployment of machine learning systems, according to the same report. In addition to AI investments, India's economic and financial development over the years attracted the authors' interest in exploring AI's role in the Indian banking sector. According to Forbes (2024), India's AI market is projected to grow at a rate of 33.28 percent between 2023 and 2028, signalling a promising trajectory for the sector.

In India, one of the biggest challenges facing banks today is poor data and customer segmentation. The emergence of payment technology companies such as Airtel Payments Bank and Paytm Payments Bank, the emergence of neo banks and neo banking platforms, and emergence of NBFCs have made it difficult for banks to survive in the existing paradigm. In the new era, banks are using new technologies to further develop and improve their services to customers. AI is helping banks transform their entire business, from insurance to sales, contracts to cybersecurity. Banks are using analytics, blockchain, and machine learning to future-proof their products and services. AI in banking and finance improves the efficiency and competitiveness of banks and financial institutions (Pattanayak, 2021). Banks are using AI for a variety of purposes, including fraud detection, improving customer experience, monitoring customer behaviour to provide better service, and checking the credit history of users' products to predict loan risk.

Literature Review

AI has revolutionised customer experience by providing personalised banking services and seamless interactions. Pfoertsch & Sulaj (2023) highlighted the role of AI-driven chatbots and virtual assistants in improving customer service through empathetic interactions. Fernandes & Oliveira (2021) emphasised AI's role in offering 24/7 services, financial advice, and efficient portfolio management. Mithra et al. (2023) further discussed AI applications in enhancing customer interactions and addressing fraud detection concerns. According to Sardana & Singhania (2018), while digital banking is transforming customer experiences worldwide, India still relies on traditional banking due to customer preferences for in-person interactions. In this connection, the study suggested that collaboration between traditional banks and fintech firms can create a balanced approach to digital banking adoption. Convenience is a key driver of customer satisfaction. AI enhances convenience by ensuring 24/7 service availability, access to real-time information, and engaging customer interactions through bots (Doorn, 2010). Services that are easily accessible and time-efficient foster stronger customer relationships. Besides, customization involves tailoring services to individual customer preferences. AI facilitates this by leveraging customer data, behavioural insights, and prior interactions to deliver personalized solutions (Bilgihan, 2016; Zanker, 2019; Aguirre, 2015). Incorporating empathetic communication and respecting user privacy further strengthens customer trust. Despite ongoing concerns about data protection, customized AI services enhance brand loyalty and customer retention. Trust or confidence is foundational in banking, where customers rely on secure handling of their financial assets and personal information (McKnight, 2001). AI fosters trust by offering personalized services and secure platforms, enhancing user experience through seamless digital interfaces (Pearson, 2019). Transparent communication and robust data protection measures are crucial in

building long-term customer relationships (Ponder, 2016; Wang, 2018; Keiningham, 2017). Customer retention plays a significant role in sustainable banking success. Regular updates, timely issue resolution, and customized offerings contribute to emotional bonding and brand advocacy (Maharjan, 2017; Pennington, 2016). AI supports retention by detecting consumer needs, preventing fraud, and upgrading services using machine learning. These capabilities foster a competitive advantage and increased customer loyalty. In the same manner, customer experience is crucial for understanding and adapting to customer feedback and expectations (Nobar, 2018). AI facilitates the delivery of secure, efficient, and proactive services that align with user needs, prompt and reliable support, minimal wait times, and personalized service delivery contribute to customer satisfaction. AI-enabled services also offer opportunities for upselling and cross-selling while reducing operational costs. These benefits ultimately enhance firm performance (Ameen, 2021). Customer recovery service refers to the process of addressing customer dissatisfaction, resolving complaints through AI enabled services, and restoring trust between the customer and the business (Keiningham, 2017).

Veerla (2021) pointed out the survey report conducted by Infosys on 1600 business executives in decision making roles, where 75 per cent executives regarded AI as fundamental to the success of organization's strategy. Forbes magazine claimed that application of AI can reduce the operational cost of organizations up to 22 per cent. Further asserted that AI serves as a transformative predictive model in the banking sector and concluded on emphasizing the impact of AI on strategy implementation, customer service enhancement, fraud detection, compliance assurance and credit assessment. Adeyemo & Okoronkwo (2024) examined the effect of AI on the operational efficiency of deposit money banks in Lagos State, Nigeria. Survey research design was adopted covering a randomly selected 450 regular employees across five banks and concluded that AI significantly contributed to the operational efficiency such as Service Innovation, Cost reduction, Service quality and Customer satisfaction. Kurode (2018) evaluated the strategies of adoption and implementations of AI in International banks and the financial services industry in the Indian context using the secondary source of information and concluded that AI's automation capabilities help banks eliminate unproductive and repetitive tasks that require human labour, allowing human employees to focus on more strategic and creative roles, which can ultimately enhance business efficiency.

Pattnaik et al. (2024) analysed how AI is used in banks using machine learning so that the bank can recommend products and services that suit the clients' tastes. They pointed out that the analysis of spending and parameters of behaviour, which ML algorithms are capable of, can forecast products or services that might be interesting to the customer, ranging from credit to investment services. The use of personalisation also helps banks revisit the concept of customer loyalty since customers feel like the products being offered are those they would want personally. The study led by Pattnaik et al to determine that customer segmentation makes the banking sector viable in the developed as well as the emerging markets, in which AI-enabled strategies play a significant role in achieving competitive benefits as well as the customer loyalty brought about by the digital competition.

The empirical study focuses on the front-end customer experience through Chatbots on the basis of three variables namely System, Information and Service. A hypothesis test is carried out to check if the relationship between the three quality dimensions and customer experience

is moderated by perceived risk. The findings help banks to establish the consumer and brand relationship by offering chatbots that fulfil customer requirements. The data collection is performed through a survey. (Trivedi, 2019). One of the most notable applications of AI in banking is the development and deployment of chatbots, which have revolutionized the way banks interact with their customers. Suhel et al. (2020) examine the transition from conventional conversation to automation in banking through chatbots, utilizing artificial machine intelligence language. This shift has not only changed the face of customer interactions but has also played a crucial role in the development of the banking sector, underscoring the importance of AI in meeting the ever-changing needs of customers.

Research Gap

Despite the growing integration of AI in banking operations, a significant research gap exists in understanding its consistent impact on the banking sector on customers' perception. While numerous studies explore AI adoption in banking at a national and global level, limited research specifically examines its implementation, effectiveness within the unique economic and infrastructural landscape. There are also less studies conducted in the Indian context. Additionally, existing literature pays little focus on customers' experience and fraud detection, overlooking operational efficiencies, risk management, and decision-making improvements enabled by AI in banks. This study aims to analyse the implications of AI adoption on service quality to bridge this gap.

Significance of the study

The significance of this research study lies in its exploration of how AI is transforming banking operations, particularly for providing quality service to customers. As the banking industry undergoes rapid digital transformation, AI-driven technologies such as chatbots, automated loan processing, fraud detection, and personalised customer services are reshaping operational efficiency and customer experience. Therefore, this study aims to bridge the knowledge gap by analysing the extent of AI adoption, its benefits, challenges, and its effectiveness in the banking sector. Understanding these factors is crucial for policymakers, banking professionals, and researchers to develop strategic frameworks for AI integration, ensuring improved financial services, security, and operational excellence. Additionally, the research will provide insights into the impact of AI on service quality and customer satisfaction, thereby contributing to the broader discourse on technology-driven banking reforms.

Service Quality Dimensions

Service quality denotes the way to fulfil or exceed client expectations. It can coordinate with, encounter or supersede customer preferences and likings. The SERVQUAL instrument has been extensively applied in a variety of service industries (Yoo & Park, 2007). Parasuraman et al. (1988) constructed a 22-item instrument called SERVQUAL for measuring consumer perceptions of service quality. SERVQUAL addresses many elements of service quality divided into the dimensions of tangibility, reliability, responsiveness, assurance and empathy.

According to the SERVQUAL model, service quality can be measured by identifying the gaps between customers' expectations of the service to be rendered and their perceptions of the actual performance of service (Barsky, 1992). The researchers have applied the SERVQUAL model to measure service quality in different industry settings with modified constructs to suit specific situations (Bhatt & Bhanawat, 2016; Saleh & Ryan, 1992). SERVQUAL model is based on five dimensions of service:

Tangibility: Tangibility discusses facilities, equipment, employees and communicable commodities that are examples of physical dimensions (Kasiri, 2017). In other words, these criteria include sophisticated equipment, physical facilities, well-dressed employees and well-organized papers (such as booklets, ledgers, billing material, etc.).

Reliability: Reliability is the capacity to deliver services securely and regularly to meet consumer requirements. This includes consistently delivering the stated job or service, demonstrating an interest in resolving customer issues, implementing service improvements for the first time and offering and delivering service at the promised time.

Responsiveness: This service quality component stresses responsiveness and vigilance towards client requests, inquiries and complaints to assist customers. This includes instances such as employees communicating to customers about what they will do, providing immediate services to customers, always being willing to assist customers, and always being prepared to answer customers' questions.

Assurance: Assurance encompasses ability and the capacity of workers to instill customers with a feeling of the organization's integrity (Genieys et al, 2004). The assurance is high if consumers feel safe interacting with the business, the staff are always courteous while interacting with the customers and the employees possess sufficient expertise to answer the customers' questions (Moerke et al, 2017).

Empathy: It involves engaging with consumers according to their essence to feel like the company understands them. The empathy aspects include personal attention to customers, good business hours for all customers, workers demonstrating individual attention to customers, and employees recognizing the specific consumer demands.

According to Parasuraman et al. (1991), this instrument may be used in various fields, including financial institutions, libraries, hotels, restaurants, medical centres, banks, the tourist sector, hospitals, libraries, transportation services, postal services and the insurance business. It has been argued that expectation is self-motivated and that it can therefore change according to customers' experiences and consumption situations. (Nadiri & Hussain, 2005). However, the SERVQUAL model is generally considered a robust measure of service quality. Hence, the dimensions of this model with some modifications have been considered for identifying 22 items of research variables for this study.

Objectives of the Study

The specific objective of the study is to examine the implications of Artificial Intelligence on bank service quality.

Research Methodology and Approach

The study assumes a descriptive research design to explore the influence of Artificial Intelligence on service quality. Based on the highest market capitalisations as on March 2024, a total of 3 public sector banks operating in Barak Valley, Assam and which were listed in both the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) were considered purposely for the study. The sample consisted of 200 bank customers taking 2 each from the considered bank branches. Table 1 shows the selection of respondents for the purpose of the study.

Table 1: Bank Branches Considered and Sampling Frame

Sl. No.	Public Sector Banks	Bank Branches	No. of customers Considered
1.	State Bank of India (SBI)	39	78
2.	Punjab National Bank (PNB)	40	82
3	Central Bank of India (CBI)	20	40
Total		99	200

Source: *Researcher's Sample selection.*

The sample included individuals from diverse demographic backgrounds such as age, gender, educational qualifications, and employment status, to ensure a comprehensive understanding of customer perspectives. The data were collected using a structured questionnaire through a convenience sampling technique. Based on the SRVQUAL model, respondents' opinions on 22 items indicating agree/disagree were measured on a Likert scale. The aforesaid 22 measuring parameters probe into five dimensions; the tangibility dimension comprising 5 items, the reliability of bank dimension consisting of 5 items, the assurance provided by the bank with 4 items, the responsiveness of banks towards bank customers comprising 4 items and the final dimension viz., empathy shown by the bank comprising 4 item parameters considered to measure the implication of AI on customers service quality paradigms and their relationship. The data analysis was performed using Statistical Package for the Social Sciences (SPSS) software using both descriptive and inferential statistics. The secondary data has been collected from various books, journals, websites, etc.

Data Analysis and Discussions

Demographic Structure of Respondents

The study governs the determination of customers' perceptions based on various services provided by the banks, particularly for an in-depth understanding of the customer taste and preference factors, which can enrich the top management in their decision-making process. In this research investigation, the demographic characteristics such as age, gender, education, occupation, and income of the respondents are considered primary variables influencing customer perceptions. Table 2 depicts the demographic attributes of the sample respondents.

The analysis of the demographic profile confirms the research participants' characteristics. It is observed that out of the total respondents, 50 percent are under the age group of 31-50, followed by 25 percent in the age group of 51- above, and 19.5 percent in the age group of 21-30. It is also revealed that only 5.5 percent of the total respondents are under the 20-below age group. Most respondents are found female, comprising 57.5 percent, and the remaining 42.5 percent are under the male category. Furthermore, the education-wise distribution of the respondents indicates that 40 percent of the total respondents are at graduate level followed by 39 percent at high school level, 9.5 percent at the postgraduate level, and 7.5 percent of respondents at the secondary level.

Table 2: Demographic Features of Sample respondents

Demographic Features	Category / Status	Frequency	Percent	Cumulative Percent
Age (years)	20 -Below	11	05.5	05.5
	21-30	39	19.5	25.0
	31-50	100	50.0	75.0
	51-Above	50	25.0	100.0
Gender	Male	85	42.5	42.5
	Female	115	57.5	100.0
Education	Primary	02	01.0	1.0
	High School	78	39.0	40.0
	Secondary	15	07.5	47.5
	Graduate	80	40.0	87.5
	Postgraduate	19	09.5	97.0
	Others	06	03.0	100.0
Occupation	Cultivator	46	23.0	23.0
	Service	107	53.5	76.5
	Business	28	14.0	90.5
	Home Maker	14	07.0	97.5
	Others	05	02.5	100.0
Area of residence	Urban	110	55.0	55.0
	Semi-urban	57	28.5	83.5
	Rural	33	16.5	100

Source: *Computed from primary data*

The occupation-wise distribution reveals that 53.5 percent of the respondents are engaged in the service sector followed by cultivators comprising 23.0 percent, business, i.e.14 percent, homemakers, i.e.7.0 percent, and others, i.e. 2.5 percent. Besides, 55 percent of the respondents have an urban orientation, followed by semi urban i.e., 28.5 percent and rural based 16.5 percent. The analysis of these demographic characteristics leads to an accurate representation of research participants and indicates that respondents have been drawn from the required group to support suitable research inferences.

Reliability Analysis

It is crucial to pledge the scales included in the questionnaire are consistent. In order to determine data consistency, a data reliability test was conducted based on the performance score of the items of each construct with Cronbach's alpha coefficient values to verify the data integrity. Normally, Cronbach's alpha coefficient value of a scale should be 0.7 or higher (Pallant, 2010). The analysis results are presented in Table 3.

Table 3: Reliability Test for Constructs

Components	Cronbach's Alpha	Number of items
• **Independent Variable: Artificial Intelligence**	0.823	4
• **Dependent Variables: Service Quality Constructs**	0.872	22
◦ Tangibility (TN)	0.843	5
◦ Reliability (RL)	0.786	5
◦ Responsiveness (RP)	0.822	4
◦ Assurance (AR)	0.819	4
◦ Empathy (EM)	0.744	4

Source: *Computed from primary data.*

The values of Cronbach's alpha coefficients of the constructs are more than 0.7, which confirms an acceptable and satisfactory range of the reliability scales, indicating the items that make up the scale are consistent and appropriately measure the underlying constructs.

Descriptive Analysis

Descriptive statistical analysis is a method used to summarise and organise the characteristics of a dataset. It provides a way to present raw data in a meaningful and interpretable form and focuses on describing the data rather than making predictions or inferences about a larger population. Descriptive statistics are essential for summarising data before moving to inferential statistics, which involve hypothesis testing and generalising findings to a larger population. According to the descriptive analysis as presented in Table 4, it can be noted that the standard deviation (σ) of AI is 0.71266, and the Standard deviation error mean reached 0.04337. In the same way, the mean (μ) value of service quality is 3.7714, the standard deviation is 0.69602, and the standard error mean is 0.04218. Furthermore, the standard error mean for all the dimension service quality constructs, viz, tangibility (0.0588), reliability (0.0563), responsibility (0.04600), assurance (0.04524) and empathy (0.04620) indicate that the data set a meaningful interpretable form.

Table 4: Descriptive Analysis of the Constructs/Dimensions

Variables	N	Mean (μ)	Std. Deviation (σ)	Std. Error Mean
AI	200	3.8988	.71266	.04337
TAN	200	3.8207	.86888	.05288
REL	200	3.8259	.83197	.05063
RES	200	3.9991	.75586	.04600
ASS	200	3.7731	.74342	.04524
EMP	200	3.4380	.75914	.04620
SQ	200	3.7714	.69602	.04218

Source: *Self-calculation by the researchers.*

Analysis of T Statistics

Table 5 presents the results of the t-test for AI and service quality constructs. The t-test result shows that the 95% confidence interval is not very wide at the lower and upper levels against each of the variables, clearly indicating that the confidence interval helps to assess the practical significance of the results.

Table 5: T-test Results of the Constructs

Variables	t	df.	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the difference	
					Lower	Upper
AI	89.893	199	.000	3.89877	3.8134	3.9842
TAN	72.255	199	.000	3.82074	3.7166	3.9248
REL	75.564	199	.000	3.89593	3.7262	3.9256
RES	86.936	199	.000	3.99907	3.9085	4.0896
ASS	83.398	199	.000	3.77315	3.6841	3.8622
EMP	74.415	199	.000	3.43796	3.3470	3.5289
SQ	89.420	199	.000	3.77137	3.6883	3.8544

Source: *Self-calculation by the present researchers*

Correlation Matrix Analysis

This research employed correlation analysis to examine the correlations between use of AI (independent variable) and service quality (dependent variables). Table 6 depicts the correlation matrix analysis of AI and service quality constructs. The dependent variable, i.e., AI, is correlated strongly with all the independent variables i.e., service quality dimensions. The correlation value of Tangibility (r=.753) is significant at $p<0.01$ and $p<0.05$ with artificial intelligence. The Reliability correlated at r= (.710) $p<0.01$, Responsiveness correlated at r= (.722), $p<0.01$, Assurance correlated at r= (.607) $p<0.01$, and Empathy correlated at r= (.594), $p<0.01$. It can be seen from the above analysis that all independent variables have significant and positive relationships with artificial intelligence.

Table 6: Correlation between Average AI and Service Quality Dimensions

Variables	AI	TAN	REL	RES	ASS	EMP
AI	1.00					
TAN	0.753**	1.00				
REL	0.710**	0.822**	1.00			
RES	0.722**	0.805**	0.770**	1.00		
ASS	0.607**	0.672**	0.670**	0.785**	1.00	
EMP	0.594**	0.641**	0.655**	0.623**	0.600**	1.00

Source: *Self-calculation by the present researchers*

Furthermore, the results reveal that no perfect correlation among the independent variables is higher than (0.90), which is a good initial indicator that there will be no collinearity diagnostic among the independent variables. Moreover, it is evident from the above results that the highest correlation exists between tangibility and reliability (r=0.822) indicating sophisticated equipment and facilities of banks are able to resolve customer issues and deliver service at the promised time. The high correlation between tangibility and responsibility (r=0.805) indicates that the tangible facilities of banks are able to communicate with the customers and provide immediate services to customers. The relatively low correlation coefficient of AI with empathy (r=0.594) showed that personal attention to customers, and recognizing the specific consumer demands etc compensate for lesser consideration.

Nevertheless, high correlation between artificial intelligence and service quality dimensions indicates that better quality of services provided by banks due to application of AI.

Results and Implications

The primary objective of this study was to examine the influence of artificial intelligence on service quality in the banking sector. The analysis of various items relating to various dimensions of services indicates that the perceptions of customers are positive in regard to usage of AI. The scenario of application of AI has been further confirmed with their respective mean and standard deviation values on selected parameters. The correlation analysis result indicates that there is an interrelationship between the inducing factors, namely tangibility, reliability, assurance, responsiveness and empathy, and determines that the variables exhibited a linear relationship relating the factors to each other. Public sector banks prioritise the use of AI and have verified a correlation between the bank services being current and the existence of physical facilities, an interactive website and applications, as well as the need for bank employees to be familiar with IT applications. The research examined the positive association between AI and service quality dimension dependability in terms of whether or not banks fulfil customer expectations. It assures consumers that banks delivering services on time would maintain customer transparency. The findings demonstrated a statistically significant association between AI and service quality dimension responsiveness as measured by the staff's willingness to assist clients and notify them when their services will be completed. The assurance component correlates well with AI since the bank's staff provides courteous, confidential and professional client service. To demonstrate the link between AI and empathy, show that banks provide personalised service to consumers during business hours by recognising their unique requirements. The study will enable the bank management to get a comprehensive range of understanding and empower their strategies effectively to reach out the benefits of use of AI to the customers.

Directions for Future Research

The customers of only public sector banks have been considered to examine the use of AI and their relationship with service quality dimensions. The comparative studies may be undertaken considering customers of private sector banks to gain further insights into the subject. The bank employees' perceptions may also be studied to find out the gap between customer perception and employee perceptions to develop better approaches for improving service quality. This research is limited to the five service quality dimensions based on SERVQUAL to measure customers perception on use of AI; consideration of more parameters may propose a different result.

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Navigating the Transformative Landscape of Accounting, Finance and Sustainability: An Exploration

Jaynal Uddin Ahmed*

Department of Management,
North-Eastern Hill University, Tura Campus, Meghalaya-794002, India
**Corresponding author: juahmednehu@gmail.com*

Abstract

The finance and accounting landscape has undergone a radical transformation and has been redefining the business operation and the role of accounting and finance professionals. It is, therefore, vital to recognise these changes and hold opportunities for upskilling. The general awareness of environmental and social issues has intensified, and stakeholders now demand a broader range of information that reflects a company's true impact on society. Companies are proactively embracing sustainability reporting and enhances their brand reputation, attracts investment, mitigates regulatory risks, and drives long-term value creation. Realising these changes, the present paper is an attempt to investigate the transformative landscape of accounting, finance and sustainability. The technological advancements, changing consumer behaviours, and global economic shifts could disrupt traditional finance models. Hence, staying proactive and practical is essential for navigating these changes. Embracing innovation, investing in talent, and focusing on sustainability are key strategies for achieving long-term success in accounting and finance. Finance and accounting are no longer just about numbers; it's about insight, agility, strategy, and resilience. The trends shaping the profession reflect a broader shift toward digital-first, purpose-driven, and value-focused operations. Upskilling in data analytics, embracing new technologies, and understanding the strategic implications of finance are essential for success in this evolving landscape.

Keywords: Technological innovation, accounting and finance, sustainability, navigating, convergence.

Introduction

The finance and accounting landscape is undergoing an unprecedented transformation, driven by technological innovation, shifting regulatory frameworks, ever-changing workforce dynamics, and evolving stakeholder demands (Bebbington, Unerman & O'Dwyer, 2017). These changes are redefining the business operation and the role of accounting and finance professionals. From automation to sustainability, staying informed about these trends is no longer optional—it's essential for remaining competitive and resilient in today's dynamic market (Khan, Serafeim & Yoon, 2019). Therefore, it is vital to recognise these shifts and embrace opportunities for upskilling.

Historically, the business performance was measured almost exclusively in financial terms—profit margins, balance sheets, and quarterly earnings for decades (Ellise & Limbu, 2024). But the past twenty years have witnessed a profound transformation in how we define

value and success. Societal awareness of environmental and social issues has intensified, and stakeholders now demand a broader range of information that reflects a company's true impact on the world. This is not merely a trend; it is a fundamental restructuring of corporate accountability. The global trend toward mandatory sustainability reporting is accelerating at an unprecedented pace. From California's Climate Disclosure Rules to the EU Omnibus and proposals from the International Sustainability Standards Board (ISSB), organisations are now being compelled to provide standardised, verifiable data on their environmental, social, and governance (ESG) performance (Trotta, Rania & Strano, 2024). This shift is not just about compliance; it is about resilience and opportunity. Companies that proactively embrace sustainability reporting are finding that it enhances their brand reputation, attracts investment, mitigates regulatory risks, and drives long-term value creation.

Therefore, the role of finance professionals has evolved dramatically. No longer confined to historical financial data, accountants are now at the forefront of measuring and managing sustainability performance. They are being called upon to quantify the unquantifiable—from carbon emissions to social impact—and to integrate these metrics into strategic decision-making (Porter & Kramer, 2019). This expansion of responsibility represents both a challenge and an opportunity to validate leadership and innovation among finance professionals. With this end in view, the article is an exploration of transformative trends of accounting, finance and sustainability.

Contemporary Landscape of Accounting

Conventionally, accounting has been perceived as a discipline focused on financial record-keeping, compliance with regulations, and the preparation of financial statements. Though these aspects remain crucial, the emerging role of accounting encompasses a broader and more dynamic set of responsibilities (Asif et al, 2023). Since the contemporary business landscape is characterised by rapid technological advancements, globalisation, sustainability concerns, and data-driven decision-making, accounting has evolved to play several new and pivotal roles.

The accounting landscape is being revolutionised by a suite of emerging technologies that are streamlining processes and enhancing accuracy. Cloud computing, for instance, has become a game-changer, allowing firms to store and access vast amounts of data remotely (Nefla & Jellouli, 2025). This not only reduces the need for physical storage but also facilitates real-time collaboration among team members, regardless of their geographical location. Tools like QuickBooks Online and Xero are leading the charge, offering robust cloud-based solutions that cater to businesses of all sizes.

Robotic Process Automation (RPA) is another technology making waves in the accounting sector. By automating repetitive tasks such as data entry and invoice processing, RPA frees up accountants to focus on more strategic activities (Bhardwaj et al, 2025). Software like UiPath and Automation Anywhere are being widely adopted to handle these everyday tasks, significantly reducing the margin for human error and increasing operational efficiency (Viale & Zouari, 2020). The Internet of Things (IoT) is also beginning to find its place in accounting (Rayes & Salam, 2018). IoT devices can track and record transactions in real-time, providing a more accurate and timelier financial picture (Chen et al, 2019). For example, smart sensors in inventory management systems can automatically update accounting records, ensuring that

financial statements reflect the most current data. This level of automation and real-time data collection is invaluable for maintaining accurate financial records and making informed business decisions (Holst, 2019).

Therefore, accounting is not static; it's a dynamic field that adapts to the evolving needs of businesses and society. The emerging role of accounting goes beyond number-crunching; it involves strategic decision support, risk management, data analytics, sustainability reporting, technology integration, and compliance. Embracing these roles positions accountants as valuable assets in navigating the challenges and opportunities of the modern business world.

Theoretical Underpinning

Recent works highlight the reflective impact of digitalization on accounting practices. The adoption of technologies such as artificial intelligence (AI), blockchain, and big data analytics is revolutionising the way financial information is recorded, processed, and reported (Dai & Vasarhelyi, 2017). These advancements are enhancing accuracy, efficiency, and transparency in accounting processes. However, they also raise concerns about data security, privacy, and the need for continuous upskilling of accounting professionals (Wang & Li, 2020). Contemporary issues in finance revolve around financial sustainability and the integration of environmental, social, and governance (ESG) criteria into investment decisions (Eccles & Klimenko, 2019). The rise of fintech and digital currencies is also reshaping financial markets, offering new opportunities and risks. Regulatory challenges and the need for robust cybersecurity measures are critical considerations in this evolving landscape (Gomber, Koch & Siering, 2018). In this field, the integration of ESG criteria into investment decisions is becoming increasingly important. Eccles and Klimenko (2019) argue that investors are prioritizing companies with strong ESG performance, which can lead to long-term financial benefits. Additionally, the rise of fintech and digital currencies is reshaping financial markets.

However, the transition to these technologies requires significant investment in technology and training. There are also concerns about data security and the potential for job displacement (Dai and Vasarhelyi, 2017). Hence, the move towards digitalization in accounting has also led to the emergence of new ethical considerations. Accountants must navigate issues related to data privacy and security, as well as the ethical implications of using AI and machine learning in decision-making processes. In addition, the ESG criteria are increasingly influencing investment decisions, reflecting a shift towards sustainable finance. Investors are prioritizing companies with strong ESG performance, which can lead to long-term financial benefits. This shift is driven by a growing recognition of the financial risks associated with environmental and social issues, as well as increasing demand from stakeholders for more sustainable and ethical business practices (Eccles & Klimenko, 2019). The emergence of fintech, including blockchain and cryptocurrencies, presents both opportunities and regulatory challenges. Ensuring cybersecurity and adapting to regulatory changes are crucial for leveraging fintech innovations (Eccles & Klimenko, 2019; Gomber et al., 2018). The glimpse of this transformative setting in accounting and finance may be presented in the following section.

Transformative Landscape of Accounting and Finance

Impact of Artificial Intelligence and Machine Learning Applications

Artificial Intelligence (AI) and Machine Learning (ML) are revolutionising accounting and finance by automating routine tasks, reducing errors, and offering deeper insights (Wang, 2020). These technologies are not just automating routine tasks but are also enabling accountants to derive predictive insights from vast datasets. For example, AI-powered tools can streamline data entry, flag anomalies, and even predict financial trends. Moreover, AI is transforming the way financial statements are prepared and analysed. Natural language processing (NLP) algorithms can read and interpret complex financial documents, extracting relevant information and generating reports in a fraction of the time it would take a human (Anil & Misra, 2022). This capability is particularly beneficial for compliance and regulatory reporting, where accuracy and timeliness are paramount. In the realm of customer service, AI chatbots are becoming increasingly prevalent. These chatbots can handle a wide range of client inquiries, from basic account information to more complex financial advice, freeing up human advisors to focus on higher-value tasks. For example, platforms like Drift and Intercom are being integrated into accounting firms to provide instant, 24/7 customer support, enhancing client satisfaction and operational efficiency. Furthermore, automation has become indispensable in financial reporting. Intelligent automation tools are enabling finance teams to focus more on analysis and decision-making rather than data entry (Almaskati, 2022). Cloud-based platforms now allow for real-time collaboration and automated tax compliance, ensuring businesses meet regulatory requirements efficiently.

Blockchain Applications in Finance

Blockchain technology is making a significant direct impact on the financial sector, offering a new level of transparency, security, and efficiency. At its core, blockchain is a decentralised ledger that records transactions across multiple computers, ensuring that the data is absolute and transparent (IFA, 2020). One of the most promising applications of blockchain in finance is in the realm of cross-border payments. Traditional methods for international money transfers are often slow and expensive, involving multiple intermediaries. Blockchain can streamline this process by enabling peer-to-peer transactions that are faster, cheaper, and more secure. For example, Ripple is a blockchain-based payment protocol that facilitates real-time cross-border payments, significantly reducing the time and cost associated with traditional banking methods. Beyond payments, blockchain is also transforming the way financial contracts are executed through the use of smart contracts, which eliminates the need for intermediaries, reduces the risk of fraud, and ensures that all parties adhere to the agreed terms (Abakah, 2023b). Ethereum is a leading platform in this space, providing a robust framework for developing and deploying smart contracts across various financial applications. The potential of blockchain extends to asset management as well. Tokenization, the process of converting physical assets into digital tokens on a blockchain, is opening up new avenues for investment.

Demand for ESG Compliance and Sustainability

Environmental, Social, and Governance (ESG) metrics have been encouraged to the top of the financial agenda. With increasing pressure from investors, regulators, and consumers, finance departments are now central to ESG data management and reporting. Nowadays, sustainability reporting is no longer optional, but it's a compliance requirement. Therefore, ESG compliance is becoming a priority for businesses. Stakeholders are demanding more accountability in addressing environmental and social issues, making ESG reporting a critical component of financial management (Trotta, Rania & Strano, 2024). Moreover, Green finance initiatives are driving investments into sustainable projects to promote environmentally positive activities, such as the purchase of ecologically-friendly goods and services or the construction of green infrastructure (Kelkar, 2025). Companies embracing renewable energy, waste reduction, and carbon offsetting are attracting more investors who value long-term impact. Companies with strong ESG performance are experiencing improved access to capital, especially as banks and investors adjust portfolios to align with sustainability goals.

Data Analytics for Financial Decisions

Data analytics enables businesses to make more informed decisions. By analysing large volumes of financial data, organisations can identify patterns and trends that inform strategic planning and budgeting. Advanced analytics techniques, such as predictive modelling and trend analysis, enable companies to forecast future financial performance with greater accuracy. Predictive analytics is transforming budgeting, forecasting, and performance tracking. It helps finance teams anticipate risks and develop mitigation strategies. This is particularly valuable in volatile markets, where rapid responses can mean the difference between loss and profitability (Aloulou et al, 2024). The integration of data analytics into financial decision-making processes also enhances risk management. By analysing historical data and identifying trends, companies can better anticipate and mitigate risks. For example, credit risk assessment models can evaluate the likelihood of default by analysing a borrower's financial history and market conditions. This proactive approach to risk management not only safeguards the company's assets but also builds investor confidence.

Cybersecurity in Financial Services

The rise in cyber threats necessitates robust cybersecurity measures. Cyber threats are evolving in complexity and frequency, posing significant risks to financial data integrity and confidentiality. Financial services firms are prime targets for cyberattacks due to the sensitive nature of the data they handle. Finance professionals must prioritise data encryption, secure authentication protocols, and employee training to prevent breaches. Cyber risk insurance is becoming a vital component of financial risk management. It helps organisations recover from breaches while minimising financial losses (Oluokun, 2024). The finance teams are working closely with IT departments to implement multi-factor authentication (MFA), encryption protocols, and access controls. They are also integrating cyber risk assessments into their broader enterprise risk management (ERM) strategies.

Integration of Fintech Tools in Traditional Finance

Fintech is transforming the accounting industry. It helps accountants work more efficiently and accurately. Fintech innovations, such as digital wallets and peer-to-peer lending platforms, are reshaping traditional finance . These tools offer convenience, lower costs, and greater accessibility. Fintech platforms are providing financial services to underserved populations, enabling greater inclusion and economic growth. This trend is particularly impactful in developing economies. The integration of fintech tools into financial systems not only enhances efficiency but also provides a competitive edge in the tech-driven business landscape (Arner, et al, 2020). By leveraging fintech solutions, tech managers can streamline operations, improve decision-making, and drive innovation in financial processes. This synergy between technology and finance is reshaping the future of accounting and creating new opportunities for tech-savvy leaders.

Cryptocurrency and Decentralised Finance

The rise of cryptocurrency and digital assets is reshaping the financial landscape. Decentralised Finance (DeFi) is making waves beyond the cryptocurrency world. Cryptocurrencies like Bitcoin and Ethereum are gaining traction in mainstream finance and offer a decentralized alternative to traditional currencies, enabling peer-to-peer transactions without the need for intermediaries. This has significant implications for the financial industry, from reducing transaction costs to increasing financial inclusion. However, the volatility and regulatory uncertainty surrounding cryptocurrencies pose challenges for widespread adoption (Rejeb et al, 2021). Businesses are exploring ways to incorporate digital assets into their operations. The finance teams are exploring smart contracts for automating transactions, improving auditability, and increasing transparency.

Implications of Cloud Accounting and Computing

Cloud accounting is a modern approach to managing financial data using cloud-based software, allowing businesses to access their financial information anytime and anywhere. Cloud accounting works by storing financial data on secure servers managed by cloud service providers. Users can access this data through web-based applications, allowing for real-time collaboration among team members, regardless of their physical location. This system eliminates the need for individual installations of accounting software on each computer, streamlining processes and enhancing accessibility. Cloud accounting represents a significant shift in how businesses manage their financial data, offering enhanced accessibility, scalability, automatic updates, and improved collaboration.

The Rise of Remote Work in Finance Teams

Workforce dynamics in finance are shifting toward hybrid and distributed models. The remote work policies and flexible work options are becoming standard across finance departments globally. Finance teams must navigate issues like data security, time zone differences, and maintaining team cohesion. Digital tools such as Slack, Zoom, and

cloud-based accounting software are enabling seamless virtual collaboration. Implementing structured workflows and regular check-ins helps maintain productivity and alignment.

Growing Standards and Regulations

Regulatory bodies are introducing new standards to address emerging risks and opportunities. Staying informed about these changes is crucial for compliance and strategic planning. Updates to the International Financial Reporting Standards (IFRS) are influencing how businesses present their financial statements. These changes aim to improve transparency and comparability across markets.

The Role of Accountants as Strategic Advisors

The rapid evolution of technology in accounting is also transforming talent management within firms. As automation and AI take over routine tasks, the role of accountants is shifting towards more strategic and analytical functions. Today's accountants are expected to offer strategic advice, guiding businesses through financial challenges and opportunities. Their role has expanded to include forecasting, budgeting, and risk assessment. By leveraging data insights, accountants can help businesses navigate uncertainties and build long-term resilience. This requires a new set of skills, including data analytics, cybersecurity, and a deep understanding of emerging technologies. Accounting firms must invest in continuous learning and development programs to equip their employees with these skills.

Balancing Profitability and Social Responsibility

Finance professionals often face ethical dilemmas when balancing profit motives with social responsibilities. Transparency and accountability are key to addressing these challenges. Ensuring unbiased advice is critical for maintaining trust in the industry. Clear guidelines and ethical standards help professionals navigate potential conflicts of interest.

Innovations in Microfinance and Inclusive Banking

Microfinance institutions are leveraging technology to provide affordable financial services to low-income populations. This innovation promotes financial inclusion and economic empowerment. Developing economies are experiencing a surge in financial services. Digital banking and mobile money are driving this growth, offering new opportunities for investment.

Navigating the Future of Accounting and Finance

Technological advancements, changing consumer behaviours, and global economic shifts could disrupt traditional finance models. Hence, staying proactive and practical is essential for navigating these changes. Embracing innovation, investing in talent, and focusing on sustainability are key strategies for achieving long-term success in accounting and finance. Finance and accounting in the present day are no longer just about numbers. It's about insight, agility, strategy, and resilience. The trends shaping the profession reflect a broader shift toward digital-first, purpose-driven, and value-focused operations. Whether you are a CFO steering corporate strategy or an entry-level accountant navigating your career path, staying ahead of these trends will be key to remaining competitive. Upskilling in data

analytics, embracing new technologies, and understanding the strategic implications of finance are essential for success in this evolving landscape.

Strategic Implications for Finance Professionals and Institutions

The emerging trends of transformative paths demand a proactive approach to building capabilities, refining strategies, and transforming operations.

First, transition planning is moving from a voluntary commitment to a core business necessity. Credible and ambitious transition plans are essential to turn net-zero pledges into concrete action. These plans must outline specific, measurable steps for reducing emissions, managing climate-related risks, and aligning business models with a sustainable future. Finance professionals are uniquely positioned to develop these plans, ensuring they are grounded in robust financial analysis and integrated into the overall corporate strategy.

Second, regulatory compliance has become a dynamic and complex frontier. Staying current on evolving accounting standards and sustainability regulations is no longer a back-office function—it is a strategic priority. Non-compliance carries significant risks, including financial penalties, reputational damage, and loss of investor confidence. Conversely, effective compliance enhances transparency, builds stakeholder trust, and can even reveal opportunities for efficiency and innovation.

Third, the rise of Client Advisory Services (CAS) represents a shift from traditional compliance-focused roles to strategic partnership. Accounting and finance firms are increasingly serving as advisors on everything from financial planning and ESG integration to technology implementation and sustainability reporting. This evolution allows professionals to build deeper client relationships and provide greater value by addressing a wider range of business challenges.

Connection between Accounting, Finance, and Sustainability

In accounting and finance, the outlook has expanded from a narrow focus on maximising short-term shareholder return to optimising long-term, risk-adjusted value for a broad set of stakeholders. The most profound change is the understanding that climate risk is financial risk. Financial analysts now must price in unpriced risks like water scarcity, extreme weather events (physical risk). A company's cost of capital and credit rating are increasingly tied to its ESG performance (ACCA, 2021). This has given rise to entirely new landscapes of capital allocation.

Sustainable finance—including green bonds, sustainability-linked loans (where interest rates drop if ESG targets are hit), and impact investing—has moved from a niche sector to the mainstream. Capital is now actively and forcefully seeking positive environmental and social outcomes, making finance a powerful public tool for driving systemic change rather than a private function for maximising gain. It has been transformed from a qualitative narrative into a ‘rigorously quantitative, data-driven function’. The language of sustainability is now the language of business: metrics, targets, and key performance indicators (KPIs) for carbon, water, waste, and diversity. It's no longer about writing a nice CSR report; it's about managing and reporting data with the same rigor as financial statements.

This function is now a recognized source of competitive advantage. It drives innovation in products and processes, attracts top talent who seek purpose, and secures a company's "license to operate" from an increasingly conscious public and stringent regulator. The focus

has also expanded from a company's own operations to its entire ‘value chain’, requiring engagement and transparency from suppliers through to customers.

Convergence of Accounting, Finance and Sustainability

Ultimately, the most important vista is the complete erosion of the boundaries between these three fields. We are no longer looking at three separate views but one single, integrated landscape. The basic principles in the convergence process are

- One cannot be a CFO without understanding the accounting and strategy of sustainability.
- One cannot be a sustainability officer without speaking the language of finance and risk.
- One cannot be an accountant without the skills to ensure non-financial data.

The new horizon is one of convergence, where the health of a company is measured by the health of its finances, its people, and the planet it operates on (Trinh & Pham, 2025). This is the new landscape we must learn to navigate in the right direction.

Concluding Note

In conclusion, the convergence of accounting, finance, and sustainability is not a distant future. It is reshaping our professions, our organisations, and our global economy. We have the opportunity and the responsibility to lead this transformation. Let us embrace technological innovation to enhance our capabilities and efficiency. Let us advocate for global interoperability to create a reporting system that is consistent and coherent. Let us commit to continuous learning to stay ahead of the curve. And, most importantly, let us uphold the ethical values that are the foundation of trust in our professions.

In this way, we need to build a future where financial prosperity is inextricably linked with environmental health and social well-being, so that transparency, accountability, and sustainability are not competing priorities, but are intertwined into the very fabric of doing business.

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Households' Willingness to Pay for Improved Solid Waste Management Services: Evidence from Dhangadhi Sub-Metropolitan City, Nepal

Govinda Raj Upadhyay[1,*], Ashutosh Priya[2]

[1]*Department of Economics, Aishwarya Multiple Campus,*
Tribhuvan University, Kailali- 10900, Nepal
[2]*Department of regional and Applied Economics,*
Mahatma Jyotiba Phule Rohilkhand University, Bareilly, Uttar Pradesh-243006, India
**Corresponding author: megovinda@gmail.com*

Abstract

Solid waste management (SWM) remains one of the most pressing urban environmental challenges worldwide, particularly in developing countries where rapid urbanization, population growth, and limited municipal capacity have overwhelmed existing waste systems. In Nepal, these challenges have become increasingly visible in medium-sized cities such as Dhangadhi, where inadequate collection and disposal practices pose serious threats to environmental quality and public health. This study examines households' willingness to pay (WTP) for improved SWM services in Dhangadhi Sub-Metropolitan City using primary data collected from 411 households during 2024. The Contingent Valuation Method (CVM) was employed to elicit households' maximum WTP, while a Tobit regression model was used to identify the socioeconomic and service-related factors influencing payment decisions.

Results indicate that approximately 89% of households are willing to contribute financially for better waste management, with reported monthly WTP ranging from NRs. 25 to 100 (mean = NRs. 53.25). Education, household income, home ownership, gender, and satisfaction with current services significantly influence WTP, suggesting that both economic capacity and user experience shape environmental behavior. The study's findings are consistent with evidence from similar urban contexts in South Asia and sub-Saharan Africa, highlighting the critical role of awareness, trust in local institutions, and perceived service reliability in determining household participation. Overall, the results provide empirical insights for local policymakers seeking to design equitable, community-based, and financially sustainable solid waste management systems. This research contributes to the limited empirical literature on household valuation of municipal SWM services in Nepal and other developing urban settings.

Keywords: Solid waste management, Willingness to pay, Contingent Valuation Method, Tobit regression, urban services

Introduction

Rapid urbanization has become a defining feature of developing and least-developed countries, exerting significant pressure on urban infrastructure and service delivery systems (Aryal & Adhikary, 2024). Among the critical challenges associated with this urban

expansion is the management of municipal solid waste (SWM), which has become increasingly complex due to the rising population density, changing consumption patterns, and growing economic activities in urban centers (Gebreeyosus, 2018). As cities expand, they generate large quantities of waste that must be efficiently collected, transported, and disposed of to maintain environmental health and urban livability. However, in most developing countries, including Nepal, the institutional capacity and financial resources of local governments are insufficient to address these challenges effectively.

Solid waste management is essential for public health, environmental protection, and sustainable urban development. Inefficient waste management systems often lead to indiscriminate dumping, roadside burning, and contamination of soil and water resources, severely affecting human health and environmental quality (Bhardwaj et al., 2020). Despite its importance, SWM has historically received less policy attention compared to other urban environmental issues such as air pollution and wastewater treatment (Girma at al., 2022). Even where municipalities allocate a substantial portion of their budgets to waste management, only 50–70% of residents receive waste collection services, and a large share of the generated waste remains uncollected (Abdel-shafy et al., 2018). Consequently, uncollected waste is often burned or disposed of in open spaces and waterways, exacerbating environmental degradation and posing serious health risks to urban populations (Sembiring & Nitivattananon, 2010).

In Nepal, the Solid Waste Management Act of 2011 assigns local bodies including metropolitan and sub-metropolitan cities the responsibility for providing waste collection and disposal services. These services can be managed directly by local governments, outsourced to private or community organizations, or operated under public-private partnerships. Service providers are authorized to levy user fees to recover costs and ensure sustainability (Government of Nepal, 2011). However, due to inadequate technical and financial resources, most municipalities struggle to deliver consistent and efficient SWM services (Bhattarai et al., 2017). Budgetary constraints, lack of trained personnel, and inadequate infrastructure further aggravate the problem (Ren et al., 2020). As a result, large amounts of waste remain unmanaged, contributing to air, water, and soil pollution (Bharadwaj et al., 2020).

The challenge of SWM is particularly acute in Dhangadhi Sub-Metropolitan City, one of the major urban centers in far-western Nepal. The city has experienced rapid urbanization over the past decade, resulting in increased household and commercial waste generation. However, the waste collection and disposal system remains inefficient, with irregular collection schedules, limited coverage, and insufficient disposal facilities. Many households resort to open dumping and burning, reflecting both infrastructural deficiencies and limited public awareness about proper waste disposal practices. Despite these challenges, households' participation in waste management through behavioral change and willingness to contribute financially remains a potential solution for sustainable urban sanitation.

Understanding households' willingness to pay (WTP) for improved SWM services is therefore essential. Measuring WTP helps policymakers assess the potential for cost recovery and the feasibility of introducing user-based service charges that reflect public preferences (Tassie & Endalew, 2020). From an economic perspective, assessing WTP provides insight into the perceived value of public goods such as SWM, which are non-excludable and non-rival in nature (Afroz et al., 2009). Since SWM services are not traded in conventional

markets, the Contingent Valuation Method (CVM) has been widely used to estimate the monetary value residents assign to improved waste management (Afroz et al., 2009). This valuation enables municipalities to design efficient pricing mechanisms, allocate resources effectively, and implement demand-driven waste management strategies (Tassie & Endalew, 2020).

Empirical studies from developing countries have consistently shown that a significant proportion of households are willing to pay for improved SWM services. For instance, Parini, (2022) found that 79.8% of households in Kathmandu, Nepal, were willing to pay for better waste collection services, while Afroz et al. (2009) reported an average WTP of 13 Bangladeshi Taka per month in Dhaka City. Similarly, Ezebilo (2013) found that over 80% of respondents in Nigeria supported residential waste management services, with a mean WTP of USD 24 per year. These findings underscore that when residents perceive the benefits of improved waste management, they are often willing to contribute financially to sustain such services.

In the Nepalese context, empirical evidence on WTP for improved SWM remains limited. While several municipalities have introduced nominal garbage fees, these are often irregularly collected, poorly enforced, and insufficient to cover operational costs. Moreover, there is limited research examining the socio-economic determinants of WTP for improved SWM at the household level. Given the growing urbanization pressures and environmental concerns in Dhangadhi, understanding the economic and behavioral aspects of residents' participation in waste management is crucial for designing sustainable policies and user-based cost recovery mechanisms.

Dhangadhi Sub-Metropolitan City has undertaken several initiatives to improve the efficiency of solid waste management (SWM) in response to rapid population growth and accelerating urbanization. However, the overall performance remains inadequate, as uncollected waste continues to accumulate along streets, in marketplaces, and around residential areas. This situation underscores the need for inclusive and sustainable waste management strategies that ensure equitable benefits, particularly for vulnerable communities. Streamlining various components of the waste management system can lead to more effective waste disposal while optimizing the use of limited financial resources.

Against this backdrop, the present study aims to assess households' willingness to pay (WTP) for improved solid waste management services in Dhangadhi Sub-Metropolitan City, Nepal. Specifically, it seeks to (i) examine the current status of SWM in the study area, (ii) estimate households' WTP for improved services, and (iii) identify the socio-economic and perceptual factors influencing WTP. By doing so, this study contributes to evidence-based policymaking for sustainable urban waste management and provides empirical insights into the potential for demand-side financing in Nepalese municipalities.

Methodology

Study Area

This study was conducted in Dhangadhi Sub-Metropolitan City, the administrative center of Sudurpashchim Province, Nepal. Located in Kailali District at an altitude of 109 m (28°41′–28°44′ N, 80°33′–80°37′ E), the city covers 271.74 km² and is divided into 19 wards.

Established as a municipality in 1976 and upgraded to sub-metropolitan status in 2015, Dhangadhi lies 750 km west of Kathmandu and shares its southern border with India. According to the 2021 Census, it has a population of 204,788 across 32,249 households, with a near-equal gender distribution. As one of the fastest-growing urban centers in far-western Nepal, the city faces mounting challenges in solid waste management due to rapid population growth, rural urban migration, and increasing waste generation. Constraints such as limited landfill capacity, inadequate segregation, and irregular collection heighten environmental and public health risks, making Dhangadhi a critical case for assessing households' willingness to pay (WTP) for improved solid waste management services.

Study Design and Sampling Procedure

This study employed a cross-sectional research design based primarily on primary data, supplemented by secondary sources such as published reports and journal articles to strengthen contextual understanding. Data collection was conducted between June and July 2025 after obtaining formal authorization from the Dhangadhi Sub-Metropolitan City Office. A structured questionnaire was administered through direct household surveys to collect relevant information. A multi-stage stratified random sampling technique was adopted to ensure representativeness. In the first stage, Dhangadhi Sub-Metropolitan City was purposively selected due to its rapid urban expansion and escalating challenges in solid waste management. In the second stage, five wards (Wards 2, 5, 8, 13, and 19) were purposively chosen to capture areas characterized by higher population density and visible waste accumulation. According to the National Population and Housing Census, 2021, Dhangadhi consists of approximately 32,249 households. Among these, the five selected wards comprise around 11,620 households, which constituted the sampling frame for this study. The required sample size was determined using the Cochran (1977) formula for sample size estimation, expressed as: $n_0 = \frac{(Z)^2(p)(1-p)}{(e)^2}$

$$= \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2}$$

$$= 384$$

Where n_0 denotes the initial sample size, Z represents the standard normal value corresponding to a 95% confidence level (1.96), p is the assumed proportion of households willing to pay for improved solid waste management services, and e indicates the margin of error, set at 5%. The final adjusted sample size incorporated the finite population correction and an allowance for potential non-response to enhance statistical reliability. Consequently, the effective sample size for this study was 411 households.

A structured questionnaire, adapted from Bhattarai (2015) with contextual modifications, was developed to achieve the study objectives. A pilot survey involving 40 households in Dhangadhi Sub-Metropolitan City was conducted to test its reliability and clarity. Feedback from the pilot led to revisions in question sequencing and wording. Based on the pilot results, four bid amounts NPR 25, 50, 75, and 100 per month were established for the contingent valuation exercise. The contingent valuation (CV) scenario formed the core of the questionnaire, providing respondents with a realistic description of the proposed improved solid waste management (SWM) service. The scenario stated that waste would be collected by a truck or tractor two times a week on predetermined days. The vehicle would

stop briefly at designated junctions while collectors visited each household to collect waste containers or plastic bags, emptying containers neatly at the curbside. Residents would simply place their waste outside before collection, and in return for this improved service, households would be required to pay a fixed monthly fee to the service provider. This scenario ensured respondents clearly understood the nature of the proposed service, allowing for accurate elicitation of their willingness to pay (WTP) under the contingent valuation framework.

Empirical Model

This study applies the Contingent Valuation Method (CVM), a well-established stated preference technique used to estimate households' willingness to pay (WTP) for non-market environmental services. CVM constructs a hypothetical market framework that allows respondents to express their preferences for improved environmental quality, such as enhanced waste collection and disposal (Adhikari et al., 2017). Unlike revealed preference methods, CVM directly elicits monetary valuations of service improvements, providing a reliable measure of user demand and perceived benefits (Adhikari et al., 2017).

CVM is particularly appropriate for urban public goods like solid waste management (SWM) services, where market signals are absent. It captures the full range of benefits including health, aesthetic, and environmental gains thereby supporting integrated SWM planning (Tassie & Endalew 2020). This study adopts a single-bounded dichotomous choice design, followed by an open ended question to refine WTP estimates and reduce starting-point bias (Maskey & Singh 2017). Respondents were asked whether they would pay a proposed bid for improved SWM services, consistent with the utility framework (Khadka, 2023). The resulting WTP estimates reflect households' perceived value of service enhancements and provide key insights for designing cost-recovery schemes and financially sustainable SWM systems. Applying CVM in Dhangadhi Sub-Metropolitan City provides evidence to guide municipal policy decisions, promote community-based waste initiatives, and strengthen demand-side financing mechanisms essential for achieving sustainable urban waste management in Nepal and other developing countries.

Tobit Model

To identify the determinants of households' willingness to pay (WTP) for improved solid waste management (SWM) services, this study employs the Tobit regression model. Originally proposed by Tobin (1958), the Tobit model is appropriate when the dependent variable is censored, as in WTP data where many responses are zero. Unlike Logit or Probit models, which handle binary outcomes, the Tobit model utilizes both the probability of participation and the intensity of payment, yielding unbiased and consistent estimates (Vij, 2012; Girma et al., 2022). In the context of SWM, WTP values derived from open-ended contingent valuation responses are typically continuous but truncated at zero, justifying the use of Tobit regression (Upadhyay, 2022; Thapa et al., 2022). The model captures how demographic and socio-economic factors jointly influence both the likelihood of being willing to pay and the magnitude of the stated amount (Getachew & Fufa, 2018). Formally, the Tobit model is specified as:

$WTP_i^* = \beta X_i + \mu_i, \quad \mu_i \sim N(0, \sigma^2)$

Where WTP_i^* is a latent (unobserved) variable representing the household's true willingness to pay, Xi is a vector of explanatory variables, β is a vector of coefficients, and μ_i is a normally distributed error term. The observed variable WTPi is defined as:

$$WTP_i = \begin{cases} WTP_i^*, & \text{if } WTP_i^* > 0 \\ 0, & \text{if } WTP_i^* \leq 0 \end{cases}$$

The model parameters are estimated using maximum likelihood estimation (MLE). The Tobit specification allows simultaneous assessment of (i) the probability that a household is willing to pay and (ii) the expected payment amount, conditional on being willing to pay. The mean WTP for the sample is calculated as the arithmetic mean of the reported WTP values.

The log-likelihood function for the Tobit model is given by (Khadka, 2023)

$$\log L = \sum_{Y_i>1} -\frac{1}{2}\left[log(2\pi) + log\sigma^2 + \frac{(Y_i - X_i\beta)^2}{\sigma^2}\right] + \sum_{Y_i=0} log\left[1 - \phi\left(\frac{X_i\beta}{\sigma}\right)\right]$$

Where, ϕ is the standard normal cumulative distribution function. The maximum likelihood estimates of the parameters are calculated by maximizing the likelihood function with respect to β and σ. In the case of open- ended questions, the mean value of WTP can be calculated by averaging the total amount that the households are willing to pay, which is given as:

$$\textbf{Mean WTP} = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

Where, n is the sample size, and each Y is a reported WTP. A wide range of factors can influence households' willingness to pay (WTP) for improved solid waste management (SWM) services. Based on theoretical insights from environmental economics and empirical evidence from valuation studies in developing-country settings (Shahzadi et al 2018), the explanatory variables included in the Tobit model were selected to reflect both economic capacity and behavioral attitudes (Khadka, 2023). Economic variables such as income, education, and household size represent the ability and opportunity cost dimensions of WTP, while perceptual factors such as satisfaction with existing SWM, perceived importance of environmental quality, and awareness of waste-related health risks capture the behavioral and informational aspects of decision-making. Table 1 provides a detailed description of the variables used in the model, including their definitions, measurement scales, and hypothesized effects on WTP.

Table 1: Variables and Definitions

Variable	Description	Mean	VIF
Bid amount	Respondents were offered monthly garbage fee ranging from Rs 25 to Rs 100 per month	Rs 53.234	1.12
Age	Age of the respondent in years	43 years	1.27
Gender	Sex of the respondent (Male = 1; otherwise = 0)	0.367	1.10
Household size	Household size of the respondent, i.e., total no. of people living in respondent's household	5.428	1.09

Education	Highest level of education attained by the respondent Non formal education = 1, secondary level education = 2, bachelor degree and above =3,	0.574	1.80
Marital status	Marital status of respondent; married = 1 otherwise = 0	0.936	1.14
Present waste collection service	Waste collection service received by respondent; yes = 1, otherwise = 0	0.51	1.22
Household income	Monthly household income of respondent in Rs	16496.35	1.73
Ownership of house	Ownership of house 1= Own house; 0 = In rent	1.22	0.52
Solid waste problem	The problem of solid waste collection 0 = There is no problem, 1 = Yes, there is problem.	1.23	0.63
Frequency of collection	Frequency of collection service 1 = Once a week; 2 = Otherwise	1.929	1.10
Service Satisfaction	Level of satisfaction with current collection service 1 = Very satisfied; 2 = Not satisfied	1.32	1.21
Mean VIF			1.30

Source: Author's creation.

Based on the given variables discussed in the table 1, the final regression model can be expressed as:

WTPi = α + β1 bid amount + β2 age + β3 sex + β4 household size + β5 education + β6 marital status + β7 waste collection service +β8 household income + β9 ownership of house + β10 waste problem +β11 frequency of collection +β12 Service Satisfaction + ui

Where α is the constant and βi are the coefficients of explanatory variables.

Results and Discussion

Socio-Demographic and Economic Characteristics of Respondents

A total of 411 households were surveyed, yielding a high response rate of 93%, which enhances the representativeness and reliability of the findings. Of these, 90.27% of respondents expressed a willingness to pay (WTP) for improved solid waste management (SWM) services, while 9.73% were unwilling to pay. This high level of positive response suggests broad recognition of the importance of improved waste management in Dhangadhi Sub-Metropolitan City. The mean bid amount offered for monthly waste collection was NPR 53.23, with proposed fees ranging from NPR 25 to NPR 100. The average household income was NPR 16,496 per month, reflecting a predominantly low to middle-income urban population. The mean household size was 5.43 persons, and the average age of respondents was 43 years, indicating that middle-aged individuals largely represent household decision-makers. Approximately 36.7% of respondents were male, and 93.6% were married, which implies stable household structures and shared responsibility in waste management decisions. The educational attainment level averaged 0.57 on a scale from 1 (non-formal) to 3 (bachelor's degree or above), showing moderate literacy levels among respondents. About 51% of households reported receiving regular waste collection services, though only 1.32 (on a scale of 1–2) expressed satisfaction, suggesting room for service quality improvement.

In terms of housing characteristics, most respondents owned their homes (mean = 1.22), while the average frequency of waste collection was once per week (mean = 1.93). A large proportion of participants reported solid waste problems in their neighborhood (mean = 1.23), highlighting inefficiencies in the current waste management system. The mean Variance Inflation Factor (VIF) across explanatory variables was 1.30, well below the conventional threshold of 10, indicating no significant multicollinearity among the variables included in the model.

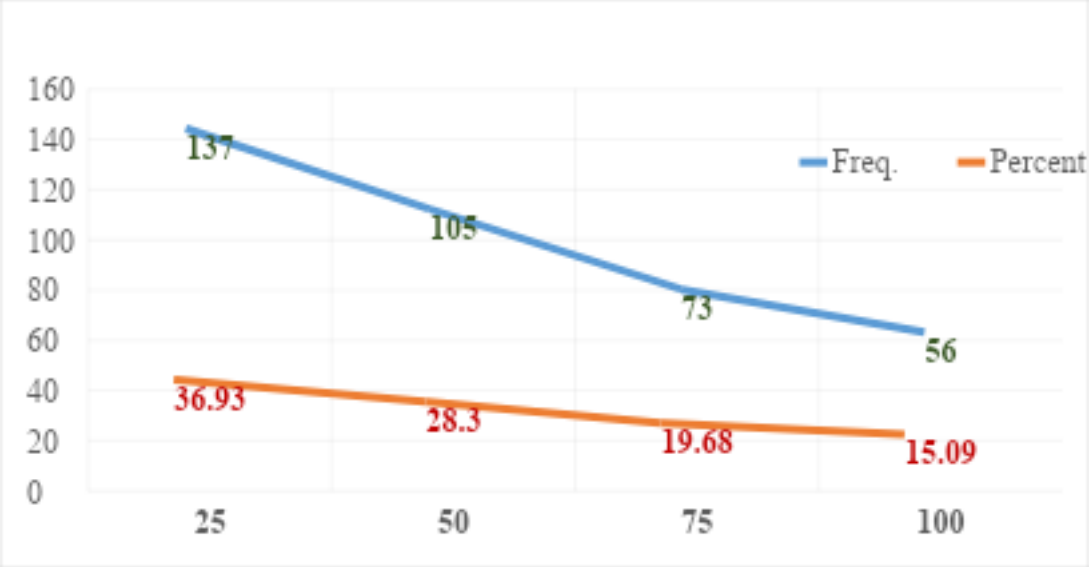
These socio-demographic trends are broadly consistent with findings from similar urban contexts in South Asia and sub-Saharan Africa. For example, studies by Khadka, (2023) in Nepal, Suthar and Singh (2015) in India, Afroz et al. (2009) in Bangladesh, and Ma et al., (2017), in China also reported that middle-aged, married, and moderately educated household heads exhibited higher awareness and WTP for improved waste services. Similarly, Kassim and Ali (2006) in Tanzania found that household income and family size were key determinants shaping public participation in municipal waste programs. The current results, therefore, align with the general empirical evidence that socio-economic status and service satisfaction strongly influence households' WTP for better solid waste management (Kim & Kim 2023).

Table 2: Household Solid Waste Generation, Satisfaction, and Environmental Awareness (Dhangadhi Sub-Metropolitan City, Nepal)

Variables	Description	Frequency (%)
Solid waste generated (per week)	< 5 kg	265 (64.47)
	6 kg to 15 kg	c. (24.57)
	> 15 kg	45 (10.95)
Perceived satisfaction (n = 411)	Not very satisfied	17 (4.14)
	Not satisfied	34 (8.27)
	Neutral	25 (6.08)
	Satisfied	115 (27.98)
	Very satisfied	220 (53.53)
Awareness about the environment	Good awareness	270 (65.67)
	Poor awareness	141 (34.30)

Source: Author's calculation, 2025.

The majority of households (64.5%) generated less than 5 kg of waste per week, while 11.0% produced over 15 kg. Most respondents were satisfied with current services (53.5% very satisfied, 28.0% satisfied), although approximately 12.4% expressed neutral or negative satisfaction. Environmental awareness was relatively high, with 65.7% of households demonstrating good awareness of proper waste management practices. These findings underscore the importance of integrating service quality improvements with community awareness programs to enhance participation and WTP for solid waste management in Dhangadhi Sub-Metropolitan City.



Source: Author's calculation, 2025.

Figure 1: Effect of increase in bid amount on the improved solid waste management

The Tobit regression results (Table 3) reveal several key determinants influencing households' willingness to pay (WTP) for improved solid waste management (SWM) services in Dhangadhi Sub-Metropolitan City. The overall model is statistically significant (Prob > χ^2 = 0.000), confirming that the explanatory variables collectively affect WTP. The Gender variable is statistically significant at the 1 percent level. Since male respondents were coded as 1 and female as 0, the positive coefficient (31.53) indicates that male respondents exhibit higher WTP for improved SWM than females. This aligns with Chinh et al. (2021) and Khatoon, (2020) found similar gender-based differences in WTP behavior.

The Age and Household Size variables are negative but not statistically significant, suggesting that these demographic factors have minimal influence on payment decisions. In contrast, House Ownership is positive and significant at the 1 percent level (β = 49.44), implying that homeowners are more willing to contribute to SWM improvement than tenants. This reflects stronger place attachment and property-related concern for environmental cleanliness. The Education Level of respondents is highly significant ($p < 0.01$) with a coefficient of 20.78. Each higher level of education increases WTP by roughly 21 units, suggesting that education enhances environmental awareness and appreciation of service quality. Similarly, Household Income positively affects WTP (β = 18.26, $p < 0.01$), confirming that households with higher earnings are more capable and willing to pay for better waste collection services. This finding is consistent with Mulat et al. (2019).

Finally, Service Satisfaction is significant at the 1 percent level, demonstrating that satisfied users are more willing to pay to maintain or enhance service standards. Overall, the findings highlight that socioeconomic capacity (income, education, ownership of house) and service perception (satisfaction) are the principal drivers of WTP for improved SWM services. Policymakers should therefore emphasize public awareness, equitable tariff systems, and customer satisfaction to strengthen sustainable waste management financing in urban Nepal.

Table 3: Tobit regression results of factors affecting willingness to pay for improved waste management services

VARIABLES	Max WTP		
Age	-0.564	Ownership of house	49.44***
	(1.878)		(13.94)
Gender	84.06*	Solid waste problem	18.26***
	(42.81)		(4.37)
Marital_Status	-125**	Frequency of collection	-19.21***
	(87.53)		(9.7)
Education	0.375***	Service Satisfaction	16.90***
	(0.067)		(5.54)
HH_size	-19.50**	Constant	-149.6
	(9.898)		(128.3)
HH_Income	6.19***	Prob > chi2	0.000
	(1.35)	Pseudo r-squared	0.028
WCS	50.21**	Akaike crit. (AIC)	5547.530
	(22.50)	Bayesian crit. (BIC)	5587.716
	(21.41)	Observations	411

*** *p<.01, ** p<.05, * p<.1*

Source: Author's calculation, 2025.

Conclusion

The study findings confirm that households in Dhangadhi Sub-Metropolitan City demonstrate a clear willingness to pay (WTP) for improved solid waste management (SWM) services, although the amount they are willing to contribute varies across socioeconomic and service-related factors. Education, household income, and service satisfaction emerged as the most influential determinants of WTP. The strong positive association between education and WTP suggests that enhancing public environmental awareness through education and outreach programs can significantly improve participation in waste management initiatives. Hence, local governments should prioritize continuous community education campaigns and ensure access to schooling for all children, as education fosters long-term behavioral change toward environmental stewardship. Income level also plays a critical role, indicating that households with higher earnings are more capable of supporting service costs. Therefore, implementing income-generating and livelihood-improvement programs can indirectly strengthen households' capacity to contribute financially to sustainable SWM systems. Furthermore, service quality and user satisfaction were found to directly affect payment willingness. Improving the reliability, frequency, and efficiency of collection services would not only enhance public trust but also justify moderate fee adjustments to maintain cost recovery and service sustainability.

Overall, the results emphasize that an integrated and participatory approach is essential for effective SWM in urban Nepal. Local governments should design policies that combine infrastructural improvement, financial incentives, and public awareness initiatives. Introducing equitable and transparent user-fee systems, along with targeted subsidies for low-income households, could ensure both social fairness and environmental sustainability. Strengthening institutional capacity and citizen engagement will ultimately lead to cleaner, healthier, and more resilient urban environments.

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Research Productivity of North-Eastern Hill University Indexed in Scopus (2011-2020)

Florence Guite[1], Angom Jeevan Singh[2,*]

[1]Dept. of Library and Information Sciences, Central University of Punjab, Bathinda, Punjab-151401, India
[2]Ratan Tata Library, Delhi School of Economics, University of Delhi, Delhi-110007, India
**Corresponding author: ajsingh@duls.du.ac.in*

Abstract

The present study aims at finding out the research publication outputs of faculty members, research scholars and students, and other academic staff of North-Eastern Hill University (NEHU), India, indexed in Scopus during 2011-2020. The findings show that during the study period, there were 1,570 publications with a total of 13,962 citations. The maximum number of publications was recorded in 2020, with 206 publications receiving 671 citations, despite the global pandemic. Out of the 1570 publications, only 40 were single-authored and 1530 were two or more co-authored publications. The study also found that the majority of publications were journal articles, primarily from the discipline of Chemistry. The Journal of Organometallic Chemistry (USA) was found to be the most preferred journal for publication.

Keywords: Bibliometric study; North Eastern Hill University; Research Publications; North East India.

Introduction

The North-Eastern Hill University (NEHU) was established in the year 1973, passed by an Act (24 of 1973) by both Houses of Parliament. It is a central university which has received an 'A' grade accreditation from the National Assessment and Accreditation Council (NAAC).NEHU comprises two Campuses, namely the Shillong and Tura Campuses. It is affiliated with 66 Undergraduate colleges, including 8 professional institutes. NEHU currently has 44 academic departments under 8 different Schools, which offer Under-Graduate, Post-Graduate, Diploma, and Doctoral level programmes across various disciplines (NEHU, 2021).

The North Eastern Hill University (NEHU) is a university in the north eastern part of India, which has dynamic faculty members, hardworking research scholars and ambitious Academic staff and students who have been productive in the fields of research and publications since its inception.

A bibliometric study is the use of statistical methods to analyse books, articles and other publications. It helps in determining the level of use of collections (Nongrang & Tariang,

2013) or any published information sources. In other words, Bibliometric study is a quantitative analysis of publications to identify and ascertain desired objectives (Simte and Phuritsabam, 2021). Bibliometric study covers methods such as the analysis of references cited in articles/research works published by the faculty members, research scholars, other academic staff, and students of North Eastern Hill University in order to obtain an estimate of the use of those published information sources.

Literature Review

In trying to find the research output of faculty members of the Botany Department to manage journal collection in the North Eastern Hill University library, Nongrang and Tariang (2014) found that the highest number of publications was in the years 2009 to 2010, which accounts for 24 (15.58 per cent) out of 154. The study also reveals the three-authored papers numbering 61 (39.61 per cent) top the list in ten years. In terms of authorship productivity, the findings showed that 22 authors received one citation each, and again, 22 authors received two citations.

Nongrang (2015) conducted a study on authorship trends and collaborative research at North Eastern Hill University (NEHU), based on data collected from the Annual Report and the NEHU Institutional Repository published between 2000 - 2010. The study shows that multi-authored articles 64.93% prevail over single-authored articles 35.07%. The degree of collaboration in NEHU is 0.65. The average number of authors per paper varies from 2.29 to 3.44. In 10 years, from 2000 to 2010, the average number of authors per paper is 2.72. The study supports the fact that NEHU faculty members preferred collaborative trends for their research and publication work.

Publications output of Dibrugarh University was found to be increasing through the study period, that is, from 2006 to 2015, although a decreasing trend is seen in the year 2015 in the study titled "Trends in Research Productivity: A Bibliometric Analysis of Dibrugarh University Publications using Scopus" by Gogoi, Mozinder and Kalita (2016).

In a study conducted by Nongrang and Laloo (2016), the authors worked on finding the research output of Biochemistry teachers in North Eastern Hill University (NEHU) using bibliometric methods. The study sample comprises 11 faculty members from the Biochemistry Department and the papers published by them during the period 2000 to 2010. In the period 2005 to 2006, the faculty members of Biochemistry were found to have produced the maximum research papers with 14.47 per cent of the total publications. The most common type of authorship pattern was two in which 34 percent collaboration is seen.

In conducting a study on "Research Productivity and its Impact Analysis of the Central Universities of North East India", Kalita (2017) evaluated about three primary fronts of research, viz., productivity, impact and funding source of the nine central universities situated in North East India in the period from 2006 to 2015. During this period, the total cumulative publications from the nine universities were 4011. The research productivity, as counted via publication output, has seen a Combined Annual Growth Rate (CAGR) of 23% while the same for research impact is 52% in the citation time window from 2007 to 2016. Universities

received funding from 56 Indian and 48 foreign agencies from 17 different countries. Chemistry was found to be the most productive research area with the most number of publications (25% of total publications) followed by Physics.

Das, Yadav, and Verma (2020) conducted a study to analyse the pattern of authorship, geographical distribution, and types of documents in research publications from Mizoram University from 2002 to 2018. The total number of publications during the study period was 586. The study found that 2016 and 2017 were the most productive years for this university, with 108 (18.43%) and 84 (14.33%) publications, respectively. The maximum documents published during the study period were in the form of research articles (545, 93%), followed by review papers (17, 2.9%).

A bibliometric study of research trends in library and information science in north eastern region of India during 1989-2018 was carried out by Simte and Phuritsabam (2021) and found that the most productive year in the region was 2017 with fifteen (15) doctoral theses published, closely followed by 2018 with fourteen (14) doctoral theses produced.

Statement of the Problem

From the review of the literature, it has been found that a number of studies on a similar field have been conducted, but so far, no study has been conducted on the current topic. Despite the large number of publications emanating from North Eastern Hill University (NEHU), no study has been conducted on this aspect of Faculty Members, research scholars, students, and Academic Staff of the university.

Objectives of the Study

1. To find out the publications and citation pattern during 2011-2020
2. To find out the most preferred document types for publication during the period
3. To find out the most preferred Journals for publications during the period

Methodology

The study used the Scopus database to extract relevant data of publications and citations of Faculty members, Research Scholars, Academic Staff, and Students of North Eastern Hill University (NEHU) indexed during 2011-2020. The search strings such as "**Affiliation**", "**North-Eastern Hill University**" were used to download the relevant data for the study. Further, the data was downloaded "subject-wise" as indexed in the Scopus database. The first subject classified by Scopus was chosen to determine the total number of publications in each subject domain. Additionally, the author's department affiliation was used to group the subject in cases where publications were classified (indexed) into multiple subjects by the Scopus database. The downloaded data was refined by removing duplicate data (publications). During the study period, 1,570 publications with 13,962 citations were indexed in Scopus as of December 31, 2020. The downloaded data was transferred into an Excel sheet and fitted into the SPSS (Statistical Package for the Social Sciences) software for the analysis and interpretation of the results.

Data analysis and interpretation

During the study period (2011-2020) there were 1570 publications and 13962 citations indexed in Scopus core collection. The citations may vary from time to time since the Scopus database is updated periodically.

Publications and Citation Pattern during 2011-2020

The study found that there is a gradual increase in publications from the year 2015 to 2020. The publications have slightly decreased in the year 2014 with 133 publications only. The highest publication was in the year 2020 with 206 publications, having 671 (4.81%) citations, followed by the year 2019 with 200 publications having 969 (6.94%) citations. The study also found that the highest citation was received in the year 2013 with 155 publications having 1889 (13.53%) citations, followed by 105 publications having 1692 (12.12%) publications in the year 2011.

Table 1: **Publications and citation pattern during 2011-2020**

Sl.No.	Year	Publications	Citations	Percentage
1.	2011	105	1692	12.12
2.	2012	126	1528	10.94
3.	2013	155	1889	13.53
4.	2014	133	1300	09.31
5.	2015	144	1440	10.31
6.	2016	145	1345	09.63
7.	2017	164	1476	10.57
8.	2018	192	1652	11.83
9.	2019	200	969	06.94
10.	2020	206	671	04.81
Total =		1570	13962	100.00

*source: Scopus

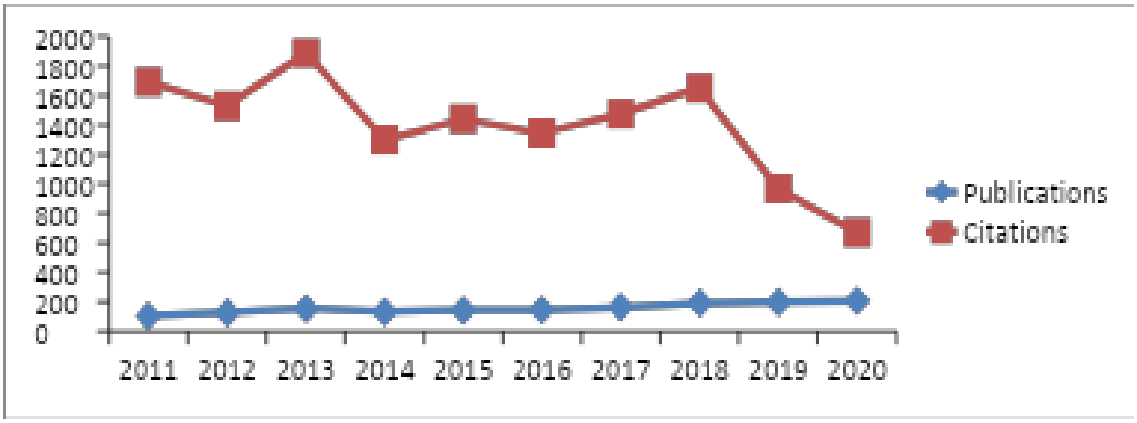

Fig. 1: Publications and citation pattern during 2011-2020

The total no. of publications along with the citations year-wise are shown in Table-1 and Fig. 1 above.The study also found that only 40 publications are single-authored and 1530 are two or more authored publications.

Most Preferred Document Types for Publication

The study found that these 1570 publications were published in 10 (ten) different document types. The most preferred documents type was Journal article with 1459 (92.93%) publications, followed by Review article with 47 (2.99%) publications and Editorial material with 18 (1.15%) publications, Meeting abstract with 17 (1.08%) publications, Proceedings with 9 (0.57%) publications, Correction with 8 (0.51%) publications, Letter with 7 (0.45%) publications, Biographical-Item & Book Review with 2 (0.13%) each publications and News Item with 1 (0.06%) publications.

Table 2: Most preferred document types for publications

Sl. No.	Document Types	Publications	Percentage
1.	Article	1459	92.93
2.	Review	47	02.99
3.	Editorial Material	18	01.15
4.	Meeting Abstract	17	01.08
5.	Proceedings	09	00.57
6.	Correction	08	00.51
7.	Letter	07	00.45
8.	Biographical-Item	02	00.13
9.	Book Review	02	00.13
10.	News Item	01	00.06
	Total =	1570	100.00

*source: Scopus

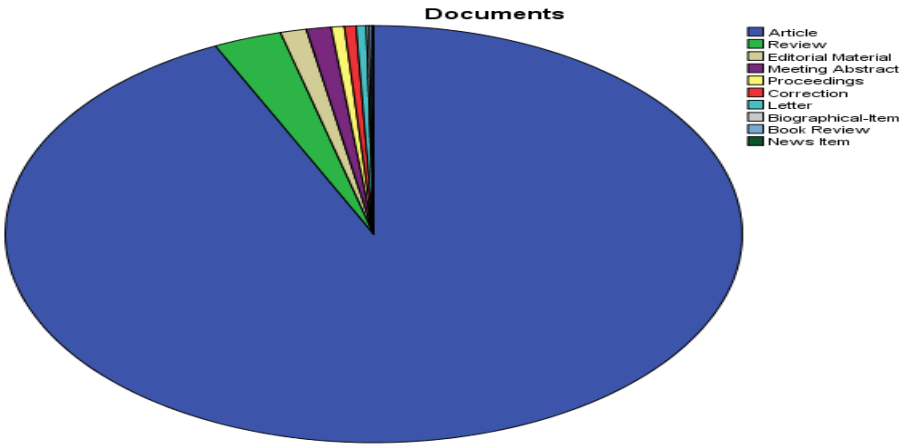

Fig. 2: Most preferred document types for publications

The different document types with highly preferred levels are shown in Table-2 and Fig.-2 above for their research publications during 2011-2020.

Publications of the University in Different Academic Journals

The present study also found that these 1570 publications were published in 616 academic journals across the globe. From the top twenty journals, the highest publication was in the Journal of Organometallic Chemistry (USA) with 33 (2.10%) publications, followed by Journal of Molecular Structure (Netherlands) with 26 (1.66%) publications and RSC Advances (UK) with 23 (1.46%) publications.

Table 3: Top twenty academic journal with highest publications

Sl. No.	Name of Journals	Publications	Percentage	Rank
1.	Journal of Organometallic Chemistry	33	02.10	1
2.	Journal of Molecular Structure	26	01.66	2
3.	RSC Advances	23	01.46	3
4.	Current Science	21	01.34	4
5.	Plos One	21	01.34	4
6.	Journal of Coordination Chemistry	20	01.27	5
7.	Journal of Chemical Sciences	19	01.21	6
8.	Oxidation Communications	18	01.15	7
9.	Inorganica Chimica Acta	17	01.08	8
10.	Journal of Biomolecular Structure & Dynamics	17	01.08	8
11.	International Journal of Biological Macromolecules	16	01.02	9
12.	Physical Review E	16	01.02	9
13.	Applied Organometallic Chemistry	15	00.96	10
14.	ChemistrySelect	15	00.96	10
15.	Gene	15	00.96	10
16.	Spectrochimica Acta Part A-Molecular and Biomolecular Spectroscopy	15	00.96	10
17.	Indian Journal of Traditional Knowledge	14	00.89	11
18.	Journal of Molecular Liquids	14	00.89	11
19.	New Journal of Chemistry	13	00.83	12
20.	Tropical Ecology	13	00.83	12
	Total =	361	22.99	

*source: Scopus

The top twenty journals which were highly preferred are shown in Table- 3 above. There were 361 (22.99%) publications in these top twenty journals during 2011-2020.

Publications in Different Subjects

The study found that 1570 publications were published in 76 different subject areas during the study period. The highest publication was in Chemistry with 511 (32.55%) publications, followed by Biochemistry & Molecular Biology with 147 (9.36%) and Botany with 91 (5.80%) publications.

Table 4:Top twenty publications in different subject areas during 2011 -2020

Sl. No.	Subjects	Publications	Percentage
1.	Chemistry	511	32.55
2.	Biochemistry & Molecular Biology	147	09.36
3.	Botany	91	05.80
4.	Biology	80	05.10
5.	Physics	80	05.10
6.	Multidisciplinary Sciences	69	04.39
7.	Biotechnology & Applied Microbiology	49	03.12
8.	Engineering	49	03.12
9.	Environmental Sciences	41	02.61
10.	Parasitology	34	02.17
11.	Materials Science	28	01.78
12.	Ecology	26	01.66
13.	Computer Science	23	01.46
14.	Genetics & Heredity	20	01.27
15.	Mathematics	18	01.15
16.	Zoology	18	01.15
17.	Anthropology	17	01.08
18.	Microbiology	16	01.02
19.	Spectroscopy	16	01.02
20.	Food Science & Technology	15	00.96
	Total =	1348	85.86

*source: Scopus

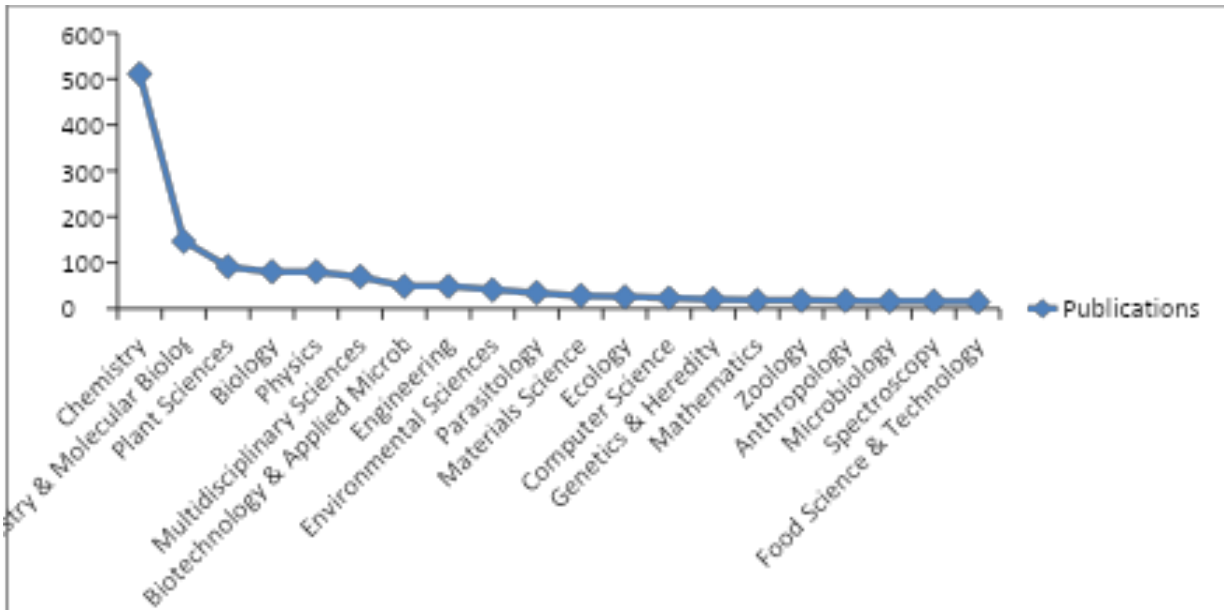

Fig. 3: Top twenty subject areas during 2011-2020

The top twenty subjectareas and research publications are shown in Table- 4 and Fig. -3 and above. There were 1348 (85.86%) publications in these top twenty journals during 2011-2020.

Highly cited article during 2011 -2020

It was also seen that there were 13962 citations received for these 1570 publications during the study period. There were 1856 (13.29%) citations received by these top twenty publications during 2011-2020. The highly cited publications were "L-Proline as an efficient catalyst for the multi-component synthesis of 6-amino-4-alkyl/aryl-3-methyl-2,4-dihydropyrano[2,3-c]pyrazole-5-carbonitriles in water" by Mecadon, H et al. (2011) with 179 citations, followed by "Gamma-Alumina as a recyclable catalyst for the four-component synthesis of 6-amino-4-alkyl/aryl-3-methyl-2,4-dihydropyrano[2,3-c]pyrazole-5-carbonitriles in aqueous medium" by Mecadon, H et al. (2011) with 147 citations and "Cyanobacteria: A Precious Bio-resource in Agriculture, Ecosystem, and Environmental Sustainability" by Singh, JS et al. (2016) with 152 citations.The top twenty highly cited publications are shown in Table- 5 below.

Table 5: **Highly cited publications during 2011 – 2020**

SL. No.	Author (s)	Publication	Citations	Year
1.	Mecadon, H et al.	L-Proline as an efficient catalyst for the multi-component synthesis of 6-amino-4-alkyl/aryl-3-methyl-2,4-dihydr opyrano[2,3-c]pyrazole-5-carbonitriles in water	179	2011
2.	Mecadon, H et al.	Gamma-Alumina as a recyclable catalyst for the four-component synthesis of 6-amino-4-alkyl/aryl-3-methyl-2,4-dihydr opyrano[2,3-c]pyrazole-5-carbonitriles in aqueous medium	147	2011
3.	Singh, JS et al.	Cyanobacteria: A Precious Bio-resource in Agriculture, Ecosystem, and Environmental Sustainability	152	2016
4.	Chongtham, N et al.	Nutritional Properties of Bamboo Shoots: Potential and Prospects for Utilization as a Health Food	108	2011
5.	Adhikari, D et al.	Habitat distribution modelling for reintroduction of Ilex khasiana Purk., a critically endangered tree species of northeastern India	102	2012
6.	Sharan, RN et al.	Association of Betel Nut with Carcinogenesis: Revisit with a Clinical Perspective	96	2012

7.	Ahmed, N et al.	Internet of Things (IoT) for Smart Precision Agriculture and Farming in Rural Areas	96	2018
8.	Ravikumar, S et al.	Mapping the intellectual structure of scientometrics: a co-word analysis of the journal Scientometrics (2005-2010)	92	2015
9.	Liang, P et al.	Genome-wide survey reveals dynamic widespread tissue-specific changes in DNA methylation during development	90	2011
10.	Roy, PS et al.	New vegetation type map of India prepared using satellite remote sensing: Comparison with global vegetation maps and utilities	84	2015
11.	Bihani, M et al.	Amberlyst A21 Catalyzed Chromatography-Free Method for Multicomponent Synthesis of Dihydropyrano[2,3-c]pyrazoles in Ethanol	82	2013
12.	Saha, M & Pal, AK	Palladium(0) nanoparticles: an efficient catalyst for the one-pot synthesis of polyhydroquinolines	76	2011
13.	Lal, P et al.	The dark cloud with a silver lining: Assessing the impact of the SARS COVID-19 pandemic on the global environment	76	2020
14.	Kalita, P et al.	Design of a peptide-based subunit vaccine against novel coronavirus SARS-CoV-2	75	2020
15.	Mittal, AK et al.	Bio-synthesis of silver nanoparticles using Potentilla fulgens Wall. ex Hook. and its therapeutic evaluation as anticancer and antimicrobial agent	70	2015
16.	Kumar, A et al.	Current and novel therapeutic molecules and targets in Alzheimer's disease	70	2016
17.	Bhattacharyya, P et al.	Start Codon Targeted (SCoT) marker reveals genetic diversity of Dendrobium nobile Lindl., an endangered medicinal orchid species	69	2013
18.	Verma, R et al.	A novel thermophotocatalyst of mixed-phase cerium oxide (CeO2/Ce2O3) homocomposite nanostructure: Role of interface and oxygen vacancies	67	2015
19.	Khatua, S & Schmittel, M	A Single Molecular Light-up Sensor for Quantification of Hg2+ and Ag+ in Aqueous Medium: High Selectivity toward Hg2+ over Ag+ in a Mixture	65	2013
20.	Chatterjee, A	Reduced Glutathione: A Radioprotector or a Modulator of DNA-Repair Activity?	60	2013
Total =			1856	

*source: Scopus

Among the top twenty highly cited publications, there were 5 publications from the year 2011, 4 publications each from the year 2013 and 2015, 2 publications each from the year 2012, 2016 and 2020 and 1 publication from the year 2018. There were no publications in the year 2014, 2017 and 2019 in the top twenty highly cited publications during 2011-2020.

Findings of the Study

The study has found that the highest publication was in the year 2020, with 206 publications having 671 (4.81%) citations, despite the global pandemic, and the highest citation was recorded in the year 2013, with 155 publications having 1889 (13.53%) citations. These 1570 publications were published in 10 (ten) different document types. The most preferred document type was found to be Journal articles with 1459 (92.93%) publications and 111 (7.07%) in other document types during 2011-2020.

The study also found that these 1570 publications were published in 616 academic journals across the globe. The highest publication was in the Journal of Organometallic Chemistry (USA) with 33 (2.10%) publications. The 1570 publications were published in 76 different subjects' areas during the study period. The highest publication was in Chemistry, with 511 (32.55%) publications. Only 40 publications were single-authored, and 1530 were two or more co-authored publications. From within the single-authored publications, Das, G and Sharma, BK have the highest publications with 4 (four) each publication, followed by Kma, L with 3 (three) publications, Bhattacharjee, S; Haloi, A; Shankar, U and Shukla, P with 2 (two) publications each during the study period.

It was also found that there were 13962 citations received for these 1570 publications during the study period. The highly cited publication was by Mecadon, H et al. (2011) with 179 citations. Among the top twenty highly cited publications, there were 5 publications from the year 2011, 4 publications each from the year 2013 and 2015, 2 publications each from the year 2012, 2016 and 2020 and 1 publication from the year 2018. There were no publications in the year 2014, 2017 and 2019 in the top twenty highly cited publications during 2011-2020.

Conclusion

Information retrieval and Bibliometrics can be considered as two of the primary concerns of Library and Information professionals. Bibliometric study helps to analyse the pattern of authorship, geographical distribution, types of document, citation rates of publications etc. In an Academic institution like North Eastern Hill University, Faculty, Research Scholars and Students, depend heavily on the journals for their information needs. Since the users in a university are from different fields of study such as Science, Social Science, Law, Management, Engineering, Computer Applications, Arts, etc. the cost of journal subscription for all these subjects can be very high. The bibliometric analysis also provides tools which help in deciding titles of journals to be acquired, to continue or discontinue a particular subscription.

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