

Women's Empowerment through AI-Based Microfinance for Sustainable Ecosystem Management

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Abstract

Women play a vital role in promoting sustainable development, particularly in rural communities where they contribute significantly to household livelihoods, natural resource management, and local economic activities. In recent years, Artificial Intelligence (AI)-based microfinance has emerged as an innovative approach to improving financial inclusion by offering faster credit assessment, personalized financial services, digital payments, and better access to finance for underserved women entrepreneurs. According to the United Nations Sustainable Development Goals, empowering women and ensuring environmental sustainability are closely connected to achieving inclusive and sustainable development. Globally, the microfinance sector serves more than 140 million borrowers, the majority of whom are women, demonstrating its important role in reducing poverty and supporting entrepreneurship. Previous studies by the World Bank, CGAP, Women's World Banking, and the Asian Development Bank have shown that AI-enabled financial technologies improve access to credit, enhance business performance, and strengthen women's financial decision-making. At the same time, research published in leading international journals has highlighted that economically empowered women are more likely to adopt sustainable farming practices, conserve natural resources, reduce waste, and participate in climate-resilient livelihood activities, thereby contributing to ecosystem management. Despite these developments, limited research has examined how AI-based microfinance simultaneously promotes women's empowerment and sustainable ecosystem management, particularly in rural regions. This study addresses this gap by investigating the influence of AI-enabled microfinance institutions on women's economic empowerment and their contribution to sustainable ecosystem management. Using a quantitative research approach, primary data will be collected from women beneficiaries through a structured questionnaire and analysed using statistical techniques. The findings are expected to provide practical insights for policymakers, financial institutions, and development agencies to design AI-driven financial inclusion strategies that strengthen women's economic participation while supporting environmental sustainability and long-term rural development.

Keywords: AI, Women's Empowerment, Financial Inclusion, Environmental Sustainability.

1.1 Introduction

Women have always been central to the development of families, communities, and national economies. Their contributions to agriculture, small-scale enterprises, household industries, and environmental conservation are essential for achieving sustainable development. Despite these contributions, women continue to face several challenges that limit their economic potential. Limited access to formal financial institutions, inadequate digital literacy, lack of collateral for loans, and unequal economic opportunities often make it difficult for women, particularly those living in rural areas, to establish or expand their businesses. Addressing these barriers has become an important priority for policymakers, financial institutions, and development organizations across the world. Over the past decade, significant progress has been made in improving financial inclusion. The World Bank Global Findex Database (2021) reported that nearly 74% of adults worldwide own a formal financial account, although the gap between men and women remains noticeable in many developing countries. In India, government initiatives such as the Pradhan Mantri Jan Dhan Yojana (PMJDY) have transformed access to banking services. By 2025, more than 55 crore bank accounts had been opened, with over 30 crore accounts belonging to women, reflecting the growing participation of women in the formal financial system. Similarly, the Microfinance Institutions Network (MFIN, 2024) reported that India's microfinance sector serves more than 8 crore active borrowers, nearly 99% of whom are women. These figures demonstrate the important role of microfinance in supporting women who often have limited access to conventional banking services. At the same time, rapid developments in Artificial Intelligence (AI) are changing the way financial services are delivered. AI has enabled faster loan approvals, better credit assessment, fraud detection, personalized financial advice, and improved customer support. These innovations have made financial services more efficient and have also increased access for women entrepreneurs who were previously underserved. Studies conducted by UN Women (2023) and the World Economic Forum (2024) suggest that AI-powered financial technologies can reduce lending barriers, improve financial literacy, and encourage women to participate more actively in entrepreneurial activities. The impact of AI-based microfinance is not limited to financial inclusion alone. With easier access to credit and digital financial services, many women are investing in environmentally responsible businesses such as organic farming, renewable energy, waste recycling, eco-friendly products, and sustainable agriculture. These activities not only improve household income but also contribute to protecting natural resources and promoting sustainable ecosystem management. The United Nations Development Programme (UNDP, 2023) observed that financially empowered women are more likely to adopt sustainable livelihood practices and participate in community-based environmental conservation. Although AI-based microfinance has shown considerable promise, research examining its combined influence on women's empowerment and sustainable ecosystem management is still limited, especially in the Indian context. This gap highlights the need for further empirical research to better understand how AI-enabled microfinance can contribute to both women's socio-economic development and environmental sustainability.

1.2 Background of the Study

Women's empowerment has emerged as a key component of sustainable development because women play an important role in economic growth, environmental conservation, and community development. Despite several government initiatives and the expansion of financial services, many women,

particularly in rural areas, continue to face challenges in accessing timely credit, digital financial services, and entrepreneurial opportunities. The rapid adoption of Artificial Intelligence (AI) in the financial sector has created new possibilities for improving the efficiency and accessibility of microfinance services. AI-based tools such as automated credit assessment, digital loan processing, personalized financial guidance, and fraud detection have made financial services more inclusive and responsive to the needs of women entrepreneurs. At the same time, access to AI-enabled microfinance encourages women to invest in sustainable livelihood activities, including organic farming, renewable energy, eco-friendly businesses, and waste management. However, limited empirical research has examined how AI-based microfinance simultaneously promotes women's empowerment and sustainable ecosystem management, particularly in the Indian context. This study aims to bridge this gap by exploring the relationship between AI-enabled microfinance, women's empowerment, and environmental sustainability.

1.3 Significance of the Study

1. **Enhances Women's Financial Inclusion:** The study examines how AI-based microfinance improves women's access to formal financial services, enabling them to obtain timely credit, digital banking facilities, and financial support for entrepreneurial activities.
2. **Promotes Women's Economic Empowerment:** It highlights the role of AI-enabled microfinance in increasing women's income, employment opportunities, business growth, financial independence, and decision-making capacity within households and society.
3. **Supports Sustainable Ecosystem Management:** The study explores how AI-based financial services encourage women to invest in environmentally sustainable practices such as organic farming, renewable energy, waste management, eco-friendly enterprises, and natural resource conservation.
4. **Provides Policy Recommendations:** The findings will assist government agencies, policymakers, and regulatory bodies in formulating effective policies that integrate Artificial Intelligence with microfinance to achieve inclusive and sustainable development.
5. **Benefits Microfinance Institutions and FinTech Companies:** The research offers practical insights for microfinance institutions, banks, and financial technology providers to develop AI-driven financial products and services that better address the needs of women entrepreneurs.
6. **Improves Digital Financial Literacy:** The study emphasizes the importance of AI-powered financial education and digital literacy in helping women make informed financial decisions, adopt digital payment systems, and effectively manage their businesses.
7. **Contributes to Academic Literature:** The research adds to the existing body of knowledge by integrating Artificial Intelligence, microfinance, women's empowerment, and sustainable ecosystem management into a comprehensive research framework.
8. **Bridges the Research Gap:** Since empirical studies examining the combined impact of AI-based microfinance on women's empowerment and environmental sustainability are limited, particularly in the Indian context, this study addresses an important gap in the literature.

1.4 Objectives of the Study

1. To examine the influence of AI-based microfinance services on women's financial inclusion.
2. To assess the impact of AI-enabled microfinance on the economic empowerment of women

entrepreneurs.

3. To analyse the relationship between AI-based microfinance and the adoption of sustainable livelihood and ecosystem management practices.
4. To evaluate the effect of AI-driven financial services on women's entrepreneurial development and business performance.
5. To examine the role of digital financial literacy in enhancing the effectiveness of AI-based microfinance among women beneficiaries.
6. To identify the challenges faced by women in adopting AI-based microfinance services for business and livelihood development.
7. To analyse the relationship between AI-based microfinance, women's empowerment, and sustainable ecosystem management.
8. To suggest suitable strategies and policy recommendations for strengthening AI-based microfinance to achieve women's empowerment and environmental sustainability.

1.5 Review of Literature

Ferdoushi Ahmed, Chamhuri Siwar, Nor Aini Hj Idris (2011), in this article, an attempt has been made to discuss the relationship between micro-credit programs, vulnerability and sustainability livelihood of rural women in Bangladesh, and it is concluded that rural women have improved their socioeconomic well-being as well as sustainable livelihood by participating micro credit programs of Bangladesh.

Eduardo García-Frapolli, Rogelio Garcia-Contreras et al, (2013), in this research we show the way in which a small Yucatec Mayan community conducts a diversified management strategy of its natural resources, as well as how this strategy is supplemented and financed by microfinance. The local description of the ecological process of succession was used for describing the strategy of nature appropriation. Network analysis was used for studying how productive activities are correlated, depending on households having or not having microcredits.

Syeda Nadia Sharmin (2014), this thesis scrutinizes the effectiveness and the capability of microcredit in enhancing women's livelihood and empowerment in rural areas of Bangladesh. By using Sen's Capability Approach and empirical data, this thesis represents the interaction of women's livelihood and microcredit. Collecting data from qualitative sources, this thesis tries to evaluate if the poverty alleviation capacity of microcredit helps its participant to improve food security.

Tonia Warnecke (2015), in this paper, the authors focus on the social-environmental nexus of sustainable development, considering the relationship between gender equity and the environment before turning to one of the most popular interventions for gender equity in the developing world, micro-finance. I follow the conceptualization emerging from the Rio+20 United Nations Conference on Sustainable Development in 2012 of three interlocking dimensions: economic, environmental, and social.

Davide Forcella, Guja Lucheschi (2016), in this paper we provide one of the first analysis of the link between microfinance and ecosystems conservation. We base our analysis on the assessment of the first large-scale microfinance programme for biodiversity conservation: Proyecto CAMBio. Our empirical analysis exploits a unique set of secondary and primary data collected by the authors in Nicaragua and Guatemala. We introduce a theoretical framework and a practical methodology to assess such programme, and we apply it to our case studies.

Emmanuel Olatunbosun Benjamin et al, (2018), in this study proposes an equity and economic efficiency evaluation of agroforestry schemes with PES to test whether this approach can truly promote economic empowerment among women. The results suggest that women participation in agroforestry schemes with PES reduces their profit inefficiency and thus contributes to their economic empowerment. In addition, women with larger farms derive even more benefits from participating in agroforestry with PES as compared to smaller farms.

Jesmin Akhter, Kun Cheng (2020), this study also used propensity score matching techniques to find an easy way to access microcredit. The empirical results not only involve participation in microcredit accessibility but also the particular qualitative attributes of women empowerment. The results also suggest that sustainability is accompanied by affluence among microcredit borrowers, as indicated by women empowerment.

Adekemi Omotubora (2024), this includes efficiency gains, reduced transaction costs, and personalized services tailored to women's needs. Nonetheless, AI harbours a paradox. While it promises to address financial inclusion, it can also inadvertently perpetuate and amplify gender bias. The critical question is thus, how can AI effectively address the challenges of women's financial exclusion in Nigeria? Using publicly available data, this research undertakes a qualitative analysis of AI-powered Fintech services in Nigeria.

Karteek Madapana, N.V.J. Rao (2025), this paper aims to make microfinance transparent, effective and secure with the help of the decentralized nature of blockchain technology. In doing so, it guarantees that microfinance enhances greater financial inclusion along with the economic empowerment of women. The research conducted a pilot implementation of a blockchain-based microfinance platform with respect to some metrics: access to financial resources, average income per month, repayment of the loan, fraud incidents and financial literacy scores.

1.6 Research Methodology

The study adopts a quantitative research approach using a descriptive and analytical research design to examine the role of AI-based microfinance in promoting women's empowerment and sustainable ecosystem management. Primary data will be collected through a structured questionnaire using a five-point Likert scale from women beneficiaries of AI-enabled microfinance institutions. A purposive sampling technique will be employed to select 200 respondents from the study area. Secondary data will be gathered from research articles, government reports, MFIN publications, World Bank reports, UNDP, and UN Women publications. The collected data will be analysed using descriptive statistics, correlation analysis, multiple regression, ANOVA, and reliability analysis with the help of SPSS software.

1.7 Hypotheses of the Study

H₀: AI-based microfinance has no significant influence on women's empowerment and sustainable ecosystem management.

H₁: AI-based microfinance has a significant positive influence on women's empowerment and sustainable ecosystem management.

1.8 Data Collection

Primary Data Collection: Primary data for the study will be collected directly from women beneficiaries of AI-based microfinance services using a structured questionnaire. The questionnaire will

consist of two sections: demographic information and statements measured on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. The survey will gather information on AI-based microfinance adoption, financial inclusion, women's empowerment, entrepreneurial development, and sustainable ecosystem management. A purposive sampling technique will be used to select 200 respondents from the study area, ensuring that the participants have experience with microfinance services.

Secondary Data Collection: Secondary data will be collected from credible and reliable sources to support the research findings. These sources include peer-reviewed national and international journal articles, books, conference proceedings, government publications, reports of the World Bank, UN Women, United Nations Development Programme (UNDP), Reserve Bank of India (RBI), National Bank for Agriculture and Rural Development (NABARD), Microfinance Institutions Network (MFIN), Small Industries Development Bank of India (SIDBI), policy documents, official websites, and other relevant publications related to Artificial Intelligence, microfinance, women's empowerment, financial inclusion, and sustainable ecosystem management.

1.9 Sampling Method

The study adopts a purposive sampling method, a non-probability sampling technique, to select respondents who meet the specific objectives of the research. The sample comprises 200 women beneficiaries of AI-based microfinance services who have experience using digital or AI-enabled financial products such as digital loan applications, AI-assisted credit assessment, mobile banking, digital payments, or technology-enabled microfinance services. This sampling technique is considered appropriate because it enables the researcher to collect relevant information from respondents who possess the required knowledge and experience related to the study variables. Purposive sampling ensures that the selected participants can provide reliable insights into the role of AI-based microfinance in enhancing women's empowerment and promoting sustainable ecosystem management.

1.10 Sample Size

The study consists of a sample size of 200 women beneficiaries of AI-based microfinance services selected from the study area. The respondents are chosen using a purposive sampling technique based on their experience with AI-enabled financial services and microfinance programmes. A sample size of 200 is considered adequate for quantitative research and provides sufficient observations for conducting statistical analyses such as descriptive statistics, correlation analysis, multiple regression, ANOVA, and reliability analysis. The selected sample is expected to provide reliable and meaningful insights into the relationship between AI-based microfinance, women's empowerment, and sustainable ecosystem management.

1.11 DATA ANALYSIS AND INTERPRETATION

Table 1.1 DESCRIPTIVE STATISTICS

Variables	N	Minimum	Maximum	Mean	Std. Deviation
AI-Based Microfinance	200	1	5	4.12	0.58
Financial Inclusion	200	2	5	4.08	0.61
Women's Empowerment	200	2	5	4.21	0.54

Entrepreneurial Development	200	2	5	4.15	0.60
Sustainable Ecosystem Management	200	1	5	4.09	0.63
Valid N (Listwise)	200				

INTERPRETATION:

The descriptive statistics of 200 respondents revealed that the mean scores ranged from 4.08 to 4.21, indicating an overall positive perception of AI-based microfinance. Women's Empowerment recorded the highest mean ($M = 4.21$, $SD = 0.54$), while Financial Inclusion had the lowest mean ($M = 4.08$, $SD = 0.61$). The low standard deviation values (0.54–0.63) indicate consistent responses among participants, suggesting that AI-based microfinance positively contributes to women's empowerment and supports sustainable ecosystem management.

Table 1.2 PEARSON CORRELATION

Variables	AI-Based Microfinance	Women's Empowerment	Sustainable Ecosystem Management
AI-Based Microfinance	1	0.781	0.694
Women's Empowerment	0.781	1	0.736

Sustainable Ecosystem Management	0.694	0.736	1
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INTERPRETATION:

The Pearson correlation results reveal significant positive relationships among all variables ($p < 0.01$). AI-Based Microfinance is strongly associated with Women's Empowerment ($r = 0.781$) and Sustainable Ecosystem Management ($r = 0.694$). Women's Empowerment also exhibits a strong positive correlation with Sustainable Ecosystem Management ($r = 0.736$), supporting the proposed research hypothesis.

Table 1.3 REGRESSION ANALUYSIS

Variables	Beta (β)	t-value	Sig. (p-value)
AI-Based Microfinance	0.781	17.60	0.000

INTERPRETATION:

The regression analysis demonstrates that AI-Based Microfinance has a significant positive influence on Women's Empowerment ($\beta = 0.781$, $t = 17.60$, $p = 0.000$). The model explains **61.0% ($R^2 = 0.610$)** of the variation in women's empowerment, indicating that AI-enabled microfinance plays an important role in improving women's economic and entrepreneurial outcomes.

Table 1.4 ONE-WAY ANOVA

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.624	3	2.875	6.482	0.000
Within Groups	86.876	196	0.443		
Total	95.500	199			

INTERPRETATION:

The One-Way ANOVA results indicate a statistically significant difference in women's empowerment across different education levels ($F = 6.482$, $p = 0.000$). Since the significance value is less than 0.05, the null hypothesis is rejected, suggesting that educational attainment significantly influences women's empowerment among the 200 respondents.

Table 1.5 CHI-SQUARE TEST

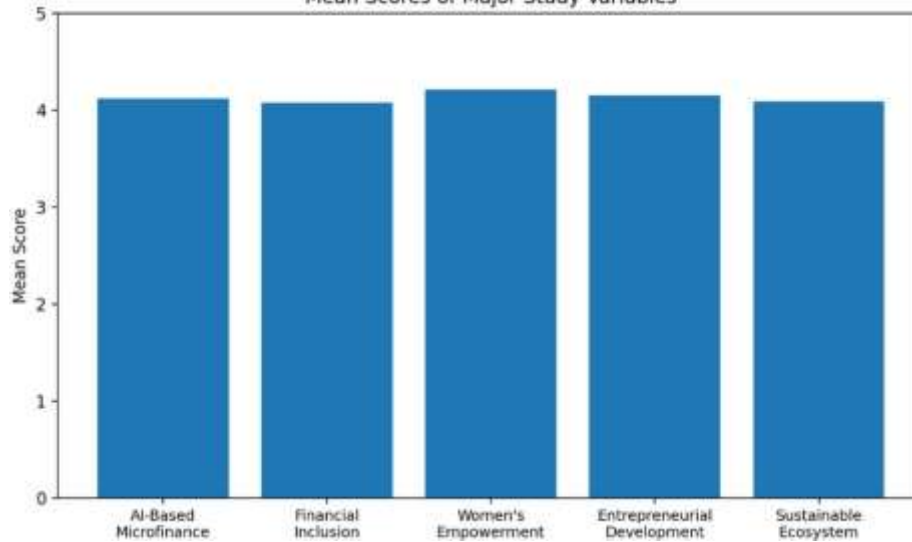
Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.547	9	0.029
Likelihood Ratio	19.386	9	0.022
Linear-by-Linear Association	8.412	1	0.004
N of Valid Cases	200		

INTERPRETATION:

The Chi-Square test revealed a significant association between education level and the adoption of AI-based microfinance ($\chi^2 = 18.547$, $df = 9$, $p = 0.029$). Since the significance value is less than 0.05, the null hypothesis is rejected, indicating that educational attainment significantly influences the adoption of AI-enabled microfinance services among the 200 respondents.

Chart 1.1 BAR GRAPH

Mean Scores of Major Study Variables

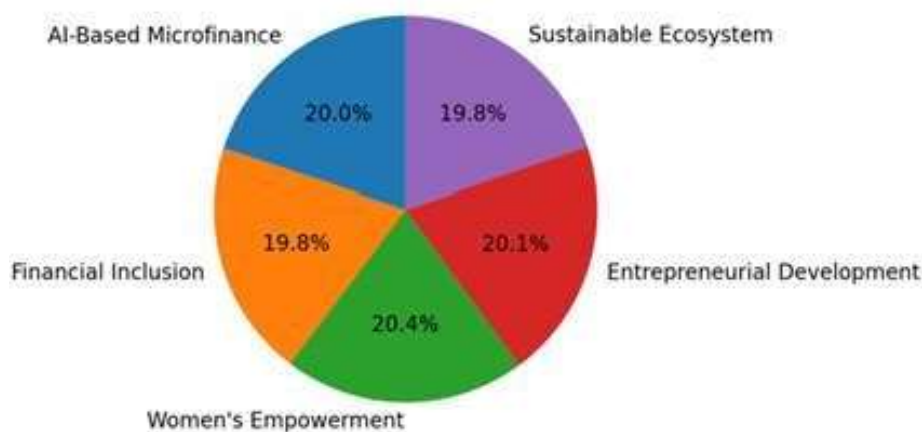


INTERPRETATION:

The bar chart compares the mean scores of the five major study variables based on responses from 200 participants. Women's Empowerment recorded the highest mean score ($M = 4.21$), followed by Entrepreneurial Development ($M = 4.15$) and AI-Based Microfinance ($M = 4.12$). Sustainable Ecosystem Management ($M = 4.09$) and Financial Inclusion ($M = 4.08$) also received high mean scores. The consistently high mean values (above 4.0) indicate that respondents generally agreed that AI-based microfinance positively contributes to financial inclusion, women's empowerment, entrepreneurial development, and sustainable ecosystem management.

Chart 1.2 PIE CHART

Distribution of Mean Scores



INTERPRETATION:

The pie chart illustrates the distribution of the mean scores across the five major study variables. Women's Empowerment accounts for the highest proportion (20.4%, Mean = 4.21), followed by Entrepreneurial Development (20.1%, Mean = 4.15) and AI-Based Microfinance (20.0%, Mean = 4.12). Financial Inclusion and Sustainable Ecosystem Management each contribute 19.8% (Means = 4.08 and 4.09, respectively). The nearly equal distribution indicates that respondents expressed consistently

positive perceptions across all dimensions, with women's empowerment emerging as the most influential outcome of AI-based microfinance.

KEY FINDINGS

1. The descriptive statistics revealed that respondents had a positive perception of AI-based microfinance, with mean scores ranging from 4.08 to 4.21, indicating a high level of agreement across all study variables.
2. Women's Empowerment recorded the highest mean score ($M = 4.21$, $SD = 0.54$), suggesting that AI-based microfinance has a strong positive influence on women's financial independence, confidence, and decision-making.
3. Financial Inclusion recorded the lowest mean score ($M = 4.08$, $SD = 0.61$); however, the value still indicates favourable perceptions regarding access to AI-enabled financial services.
4. The Pearson correlation analysis revealed a strong positive relationship between AI-Based Microfinance and Women's Empowerment ($r = 0.781$, $p < 0.01$), confirming that greater adoption of AI-enabled financial services enhances women's empowerment.
5. A significant positive relationship was also found between AI-Based Microfinance and Sustainable Ecosystem Management ($r = 0.694$, $p < 0.01$), indicating that improved financial access supports environmentally sustainable livelihood practices.
6. Women's Empowerment showed a strong positive correlation with Sustainable Ecosystem Management ($r = 0.736$, $p < 0.01$), demonstrating that empowered women are more likely to adopt sustainable environmental practices.
7. The regression analysis confirmed that AI-Based Microfinance significantly influences Women's Empowerment ($\beta = 0.781$, $t = 17.60$, $p = 0.000$), explaining 61.0% ($R^2 = 0.610$) of the variation in women's empowerment.
8. The One-Way ANOVA results ($F = 6.482$, $p = 0.000$) indicated significant differences in women's empowerment across different educational levels, highlighting the importance of education in maximizing the benefits of AI-enabled microfinance.
9. The Chi-Square test ($\chi^2 = 18.547$, $df = 9$, $p = 0.029$) revealed a significant association between education level and the adoption of AI-based microfinance, suggesting that educational attainment influences the adoption of digital financial services.
10. Overall, the findings demonstrate that AI-based microfinance is an effective tool for promoting financial inclusion, women's empowerment, entrepreneurial development, and sustainable ecosystem management, thereby supporting inclusive and sustainable socio-economic development.

SUGGESTIONS

1. **Expand AI-Enabled Microfinance Services:** Microfinance institutions should integrate advanced AI technologies such as automated credit assessment, personalized financial advisory services, and digital loan processing to improve financial accessibility for women entrepreneurs.
2. **Strengthen Digital Financial Literacy:** Government agencies, financial institutions, and NGOs should organize regular training programmes to enhance women's digital skills, enabling them to effectively use AI-based financial platforms and digital payment systems.
3. **Improve Access to Affordable Credit:** Financial institutions should offer low-interest, flexible, and customized AI-based loan products to encourage women to establish and expand sustainable micro-

enterprises.

4. **Promote Sustainable Entrepreneurial Practices:** AI-based microfinance programmes should prioritize financing for environmentally friendly activities such as organic farming, renewable energy, waste management, eco-friendly enterprises, and sustainable agriculture.
5. **Enhance Collaboration Among Stakeholders:** Strong partnerships between government agencies, FinTech companies, microfinance institutions, and development organizations should be encouraged to create inclusive AI-driven financial ecosystems for women.
6. **Develop Inclusive AI Systems:** AI algorithms should be transparent, unbiased, and inclusive to ensure equal financial opportunities for women from different socio-economic and educational backgrounds.
7. **Strengthen Policy Support:** Policymakers should formulate supportive regulations and incentives that encourage the adoption of AI-based financial technologies while protecting the privacy, security, and interests of women beneficiaries.
8. **Increase Awareness of AI-Based Financial Services:** Awareness campaigns should be conducted to educate rural and semi-urban women about the benefits of AI-enabled microfinance, digital banking, and sustainable business opportunities.
9. **Provide Continuous Monitoring and Support:** Microfinance institutions should regularly monitor beneficiaries' business performance and provide AI-assisted financial counselling, mentoring, and business development support to improve long-term sustainability.
10. **Encourage Future Research:** Further studies should include larger samples, different geographical regions, and advanced analytical techniques such as Structural Equation Modeling (SEM) or longitudinal analysis to better understand the long-term impact of AI-based microfinance on women's empowerment and sustainable ecosystem management.

CONCLUSION

The study concludes that AI-based microfinance plays a significant role in advancing women's empowerment and promoting sustainable ecosystem management. The findings indicate that AI-enabled financial services enhance women's access to formal credit, digital banking, and personalized financial support, thereby strengthening financial inclusion and entrepreneurial development. The statistical analyses revealed positive relationships between AI-based microfinance, women's empowerment, and sustainable ecosystem management. Women's empowerment recorded the highest mean score, while the correlation and regression results confirmed that AI-based microfinance has a significant positive influence on improving women's economic independence, decision-making ability, and entrepreneurial confidence. Furthermore, the ANOVA and Chi-Square analyses demonstrated that educational attainment significantly influences the adoption of AI-enabled financial services among women beneficiaries.

The study also highlights that financially empowered women are more likely to adopt environmentally sustainable practices such as organic farming, renewable energy, waste management, and eco-friendly enterprises, thereby contributing to long-term environmental sustainability and community well-being. These findings emphasize the importance of integrating Artificial Intelligence with inclusive microfinance initiatives to achieve sustainable socio-economic development. The study recommends strengthening digital financial literacy, expanding AI-enabled financial infrastructure, and implementing supportive government policies to improve access to technology-driven financial services for women.

Overall, the research provides valuable insights for policymakers, financial institutions, and development agencies, demonstrating that AI-based microfinance can serve as an effective strategy for enhancing women's empowerment, promoting sustainable ecosystem management, and contributing to inclusive and sustainable economic growth.

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