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Unpacking the Mediating Role of Financial Literacy between Women's Economic Empowerment and Green Microfinance Initiatives

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Abstract. The goal of this study is to understand how financial literacy (FL) mediates the relationship between women's economic empowerment (WEE) and green microfinance (GMF). The study defines women's economic empowerment as the explanatory, financial literacy as the mediator, and green microfinance as the outcome variable by using a conceptual framework. The data for the study has been collected in the second quarter of 2024 using both Google forms and offline survey method, from 500 working women in North India. To analyse the direct and indirect relationship, Partial Least Square Structural Equation Modelling (PLS-SEM) was used in the study. The study emphasizes how crucial locally relevant financial literacy is to advancing women's empowerment in community development settings. The study provides valuable insight to stakeholders by emphasizing sustainable development and financial inclusion and also by highlighting how gender-specific programmes with pro-literacy policies are necessary to improve sustainability in green microfinance initiatives.

Keywords: sustainability, microfinance, green finance, mediation, women's economic empowerment, financial literacy

JEL Classification: G21, G53, Q01

1. Introduction

Microfinance is providing financial services, such as money transfers, micro-insurance, microcredit, and micro savings to people with low income. Frequently, these endeavours transform into all-encompassing schemes designed to promote equitable and enduring growth prospects (Van et al., 2012). The microfinance sector stands out as one of the most vibrant industries within the realm of development

cooperation, playing a pivotal role in efforts to combat poverty. Its dynamic nature underscores its significance in facilitating economic empowerment and fostering sustainable progress in marginalized communities. Fostering inclusive growth and social development involves enhancing individual understanding of financial concepts and ensuring equitable access to economic opportunities (Chen et al., 2025). Microfinance institutions (MFIs) are acknowledged as entities capable of promoting social initiatives in emerging economies by enhancing the financial prospects and standards of living for individuals at the grassroots level (Hudon, 2007). Due to their capacity to foster micro-entrepreneurship through microloans, they play a crucial role in stimulating economic growth and fostering progress within impoverished regions. Within the Sustainable Development Goals (SDGs) framework, financial literacy is not specifically highlighted, yet around nine out of the 17 SDGs necessitate a foundational level of economic wellbeing. Financial literacy is a fundamental requirement for attaining economic wellbeing and thereby enhancing one's overall quality of life. Moreover, gender equality remains unattainable unless women are provided with the necessary resources to achieve economic empowerment. Empowering women economically not only benefits them individually but also contributes to broader societal progress by leveraging the talents and potential of half of the population.

Nowadays, microfinance is playing an important role in poverty reduction and women's empowerment, despite which there are very few studies in India that discuss the relationship between FL, WEE, and GMF. Many developing regions have been the focus of the studies that show that green microfinance is providing sustainable financial solution, but this remains unexplored in India (Moser et al., 2016). Existing literature has studied the environmental and financial inclusion benefits arising due to financial literacy (Garikipati, 2012). Yet the role of financial literacy in green microfinance and women's empowerment has not been examined much, especially in the Indian context (Lee and Huruta, 2022). Prior studies examined the role of microfinance in enhancing women's autonomy and financial decision making in household (Nawaz, 2015), but very few studies discussed how financial literacy helps women to make sustainable financial choices (Atahau et al., 2021). By this study, we provide empirical evidence that women's empowerment, when combined with financial literacy, not only can help them make sustainable choices or in green microfinance but can also foster sustainable environmental choices that will lead to long-term socio-financial stability (Sun et al., 2022; Schäfer, 2017).

Numerous prior research endeavours have employed quantitative methodologies to analyse the connections among microfinance, financial literacy, and women's economic empowerment (Atahau et al., 2020, 2021; Garikipati, 2012; Nawaz et al., 2012). Over the past two decades, there has been an extensive examination of the evolution of MF, FL, and WEE. But there are very few studies in the Indian

context that discuss the intersections between "women's economic empowerment", "financial literacy", and "green microfinance". The present research investigates how FL acts as a mediator in the link between WEE and GMF in India. The study employs the notion of "green microfinance", which merges the separate concepts of microfinance and climate change to address environmental concerns (Moser et al., 2016).

A study conducted by Atahau et al. (2020) sheds light on how green microfinance initiatives in East Sumba act as intermediaries in linking renewable energy initiatives with the empowerment of women. The insights gleaned from previous studies were utilized to provide insights into the evolution of microfinance and its impact on the economic and social landscape of rural communities. Atahau et al. (2021) claim that East Sumba's "green microfinance institutions" (MFIs) were crucial in promoting WE (SDG 5) and climate action (SDG 13). When integrated with FL initiatives, MFI emerges as a potent tool for empowering women. Building on the foundation of earlier research, it is anticipated that promoting "financial inclusion" (SDG 4) will bolster policies that are conducive to climate action and "women's empowerment" in East Sumba. This highlights the interconnectedness of various sustainable development goals and the potential synergies that can arise from addressing them collectively.[1] This study also emphasizes the social and environmental benefits of accessing green microfinance services. Empowered women, having financial literacy, can get access to various eco-friendly financial initiatives, such as energy adoption and sustainable financial solution through microfinance, which will lead to economic growth and environmental benefits as well (Moser et al., 2016). The study focuses on how women's empowerment and structured financial literacy programme ensures sound financial choices and leads to sustainable development (Tsalis et al., 2020).

Through this research, the author tried to study the different dimensions of sustainable development goals. The main focus of this research is to investigate the impact of women's economic empowerment on financial literacy programmes and green microfinance initiatives. The study also focused on the mediating role of financial literacy between women's empowerment and green microfinance to provide valuable insights in this context. The study has been conducted in North India, and the target population for the study were working women. The reason for selecting North India for this study is its diverse socio-cultural background. The states selected for the study represent both urban (Delhi, Chandigarh) and rural areas (Punjab, Haryana, Himachal Pradesh) – the study makes use of both

1 The relevant SDGs include No Poverty (SDG 1), Zero Hunger (SDG 2), Good Health and Wellbeing (SDG 3), Quality Education (SDG 4), Gender Equality (SDG 5), Clean Water and Sanitation (SDG 6), Affordable and Clean Energy (SDG 7), Decent Work and Economic Growth (SDG 8), Industry, Innovation, and Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities and Communities (SDG 11), Responsible Consumption and Production (SDG 12), Climate Action (SDG 13), Life Below Water (SDG 14), Life on Land (SDG 15), Peace, Justice, and Strong Institutions (SDG 16), and Partnerships for the Goals (SDG 17).

types for the representation of the whole of North India. Delhi and Chandigarh, where women have greater opportunities for jobs and decision making, as well as Haryana and Punjab, where women have historically faced gender disparities and other social and cultural barriers that have impeded their empowerment, were chosen to investigate the mediating impact of financial literacy on women's economic empowerment and green microfinance. The Government of India has implemented many schemes to empower women in this area.

This research is guided by a set of key questions aimed at exploring the interconnections between women's economic empowerment (WEE), financial literacy, and green microfinance (GMF). Firstly, it seeks to examine whether and to what extent women's economic empowerment influences financial literacy programmes. Understanding this relationship is crucial in assessing how empowerment initiatives contribute to enhancing women's knowledge and skills in managing finances. Secondly, the study aims to explore how WEE affects green microfinance initiatives, particularly in terms of women's participation, access, and the overall impact on sustainable financial practices. Lastly, the research investigates whether financial literacy serves as a mediating factor between women's economic empowerment and green microfinance, shedding light on the mechanism through which empowerment translates into active and effective involvement in environmentally sustainable financial initiatives.

The structure of the paper is as follows. We discuss the theoretical background in Section 2. Section 3 presents the research methodology while Section 4 the results and discussion. Section 5 concludes, and Section 6 discusses the limitations and future scope of the study.

2. Theoretical Background

Providing women with the opportunities to make decisions, to control and access resources in the social, political, legal, and economic domains is termed as women's empowerment. This empowerment enables women to participate in productive activities, make strategic decisions, and bring positive changes in their social and economic lives (Kabeer, 2001). Providing these opportunities to women helps them to manage, control, and understand economic choices and enables them to make independent decisions, free from gender barriers (Duflo, 2012). For achieving gender equality and the better financial wellbeing of women, financial services and inclusion programmes played a pivotal role (Swain and Wallentin, 2009). For measuring economic empowerment and independence, scholars focused on social norms and structural changes along with access to financial resources (Kabeer, 2001). Economic empowerment is a fundamental aspect of women's empowerment that helps women to make financial decisions

through which they can also access microfinance services. MFI provides financial services to the marginalized communities, especially women (Attanasio et al., 2015). Microfinance plays a pivotal role in poverty reduction by providing access to financial services to the deprived, especially women (Lee and Huruta, 2022). MFIs not only influence the financial stability but also impact household welfare and strengthen the financial network (Garikipati, 2012). The economic empowerment of women is hindered by their exclusion from the financial system. The SDG of gender equality and poverty reduction can be achieved by providing access to financial services to women or achieving their financial inclusion (Junankar et al., 2016). Studies found a connection between women's economic empowerment and financial literacy, as empowered women have more opportunities to make decisions regarding financial training and learning programmes (Nawaz, 2015).

GMF is playing a pivotal role in achieving the sustainable economic development. GMF also contributes to climate action by offering environmentally friendly services such as microcredits for renewable energy adoption, eco-friendly enterprises, and organic farming (Moser et al., 2016; Atahau et al., 2021). The shift from environmental goals to microfinance represents a recent development, even though companies have generally incorporated environmental aims into their CSR strategies. To achieve this goal, some microfinance organizations have adopted creative tactics such as creating financial products that promote environmentally friendly practices and technologies, launching campaigns to promote pro-environmental behaviour, and integrating environmental standards into loan application reviews. One well-known example is Grameen Shakti, which has used microcredit to provide solar power to hundreds of thousands of homes in rural Bangladesh (Komatsu et al., 2011). Another instance is Ge'nesis in Guatemala. In early 2012, a total of 4,000 microcredits were extended at subsidized rates to small-scale coffee and cocoa producers who implemented eco-friendly production methods such as agroforestry, organic fertilizers, and soil protection.

In order for women to receive these services, they must be aware of the benefits of the various financial products and must be empowered enough to make informed investment choices. Financially independent and empowered women are more likely to seek financial education and participate in investment activities; hence, women's empowerment has a positive impact on financial literacy (Junankar et al., 2016). Historically, women have been facing numerous social and cultural barriers restricting their decision-making power and their economic participation in North India. Nowadays, the government has implemented plenty of training and financial literacy programmes designed for women to enhance their economic participation and to remove these traditional barriers (Haque and Zulfiqar, 2016). Women having a solid understanding of financial services and sufficient education regarding different microfinance services leads to greater economic participation and to sustainable financial practices (Boehe and Cruz, 2013). Thus, women's

financial knowledge impacts their access to GMF, as having an acceptable level of financial literacy promotes informed decision making regarding loan structure, repayment options, and environmentally friendly investment options (Garikipati, 2012). Financial literacy consists of relevant knowledge, attitude, behaviour, skills, and awareness of financial products and services (OECD, 2020). Individuals with a higher level of financial literacy make sound and effective financial choices that lead to their financial wellbeing. FL not only includes financial awareness but also the skill and ability to make financial decisions in real-life situations (Lusardi and Mitchell, 2014). Financial decision making requires the knowledge and understanding of different financial concepts such as interest rates, risk management, inflation etc. (Lusardi and Mitchell, 2011). Financial skills reflect the individual's ability to manage money by investing, budgeting, and saving. Financial attitude is a person's belief regarding money management and financial planning. The practical aspects of money management are termed as financial behaviour (Xiao and O'Neill, 2016). Financial literacy impacts the financial and retirement planning (Mitchell and Lusardi, 2023). High financial literacy leads to effective financial behaviour such as saving, budgeting and planning (Almenberg and Dreber, 2015). Due to social norms, differences in financial socialization, and a lower level of empowerment, women exhibit a low level of knowledge and confidence compared to men (Lusardi and Mitchell, 2014). Due to lower confidence, greater risk aversion, and the lack of financial management skills, women are less likely to participate in capital markets and informed financial decision making (Almenberg and Dreber, 2015; Lusardi and Mitchell, 2014). In bridging the gender gap, financial literacy is important, as with increased financial literacy gender disparities in investment and financial behaviour tend to decrease (Cupák et al., 2018; Brixiová et al., 2020).

Financial literacy plays a crucial role in financial wellbeing along with the social and economic development of women (Hendriks, 2019). Women's empowerment and financial literacy are closely related, as the former helps women to select the right financial literacy education programme to improve their financial self-efficacy, ensure sustainable development and financial inclusion (Boisclair et al., 2017; Niu et al., 2020). To better understand this correlation, the study uses financial literacy as a mediating variable between women's economic empowerment and GMF. Local and grassroots initiatives enhance financial literacy by empowering women. Strategies like self-help groups, microfinance-led entrepreneurship programmes and women's farming cooperatives have been actively enhancing women's financial knowledge and their financial skills in selecting the best financial services (Lee and Huruta, 2022). The Kudumbashree programme in Kerala and the SEWA (Self-Employed Women's Association) in Gujarat have shown that women who are empowered and have an adequate level of financial literacy exhibit greater engagement with green financial products (Garikipati, 2012). Deccan Development Society, a women's

farming cooperative in India, has integrated FL in their microfinance model to help women in climate-resilient entrepreneurship and sustainable agriculture (Garikipati, 2012). By providing these real-life examples, this study helps in understanding how local strategies enhance financial literacy and how women can get access to green microfinance.

Despite the growing significance of green microfinance, women in rural areas still face many barriers while accessing these services (Nawaz, 2015). The major barriers are the lack of financial literacy, collateral requirements, difficult loan procedures, and limited knowledge about green financial solutions (Moser et al., 2016). The lack of gender-sensitive loan structure by MFI makes it difficult for women with low financial literacy to qualify for sustainable financing (Sun et al., 2022). To address these barriers and to create a greener microfinance ecosystem, an adequate financial education and a simple loan procedure are necessary.

After so many developments, there are just as many challenges restricting financial literacy for all segments of the society. Rural women of North India, due to cultural, geographical, and economic constraints, lack access to financial education. To address these issues, policymakers, MFI, and NGO must implement inclusive financial literacy programmes. Financial literacy is an important tool to increase access to GMF, and empowered women have more choices to receive different financial trainings and education programmes. In conclusion, it can be said that financial literacy is crucial in the link of WEE and green microfinance. By providing women more opportunities of financial literacy, their participation in green microfinance and other financial inclusion initiatives can be enhanced, which will help in achieving sustainable development goals.

2.1. Women's Economic Empowerment and Financial Literacy

Academic studies have demonstrated the connection between women's financial literacy and their empowerment (Lindahl and Mokvist, 2020; Nawaz et al., 2012). Through training programmes offered by the government and MFI, women can enhance their financial literacy. These initiatives seek to improve women's performance in the public sector and their involvement in education (Akinsemolu and Olukoya, 2020). Without including education, microfinance alone might not be effective to empower women.

The ability of women to deal with financial difficulties has been adversely impacted by the COVID-19 pandemic. Therefore, in order to address these inequities, it is crucial for financially educated women to make use of various financial products like risk management, credits, savings, and payments. The FL of female entrepreneurs in rural areas is critical to their success. Achieving gender parity in terms of education, work prospects, financial accessibility, and participation in national and international decision-making processes is necessary to support

women's economic empowerment (Marini et al., 2018; Lindahl and Mokvist, 2020; Allgood and Walstad, 2016). Upholding women's rights and advancing broader development goals, including alleviating poverty and promoting welfare, education, economic growth, and health, depend on this empowerment (Haque and Zulfiqar, 2016). In summary, the relationship between financial literacy and women's economic empowerment has previously been the subject of extensive research.

However, the present study is based on the impact of women's economic empowerment on financial literacy, as suggested by Lee and Huruta (2022). The goal of this study is to determine whether the results would hold true in an Indian context. Empowering women is crucial for them to effectively manage their households and get involved in local initiatives (Lee and Huruta, 2022). Once empowered, they can improve their FL through a combination of academic education in addition to their own native wisdom. In rural areas, a grassroots approach grounded in local wisdom has been adopted to empower women. Initiatives such as women's farming groups demonstrate effectiveness, as they not only sustain themselves but also expand in terms of membership and financial management (OECD, 2013). The utilization of local knowledge enhances their FL through activities like savings, investing, and loans.

2.2. Financial Literacy (FL) and Green Microfinance (GMF)

The study suggests a correlation between adequate financial literacy and access to microfinance services (Lindahl and Mokvist, 2020; Marini et al., 2018), with a specific focus on green microfinance, which addresses the impact of climate change. Transitioning into the green finance sector presents both opportunities and challenges for microfinance institutions, requiring adjustments in various aspects such as administration, product offerings, and credit evaluation techniques. However, many women find the procedures associated with green finance daunting and perceive them as barriers. Financial literacy is crucial for engaging with green financial products. To enhance the accessibility of MFI, there is a need for simplified, digitally-assisted loan applications for women with a low financial literacy level (Schäfer, 2017) and a community-based financial mentorship to educate new borrowers with the help of experienced women entrepreneurs in green finance (Jehan et al., 2020). Mobile-based FL programs are needed for equipping women with sustainable financial solutions such as organic farming credits and solar energy financing (Tsalis et al., 2020). Grameen Bank and Bangladesh's Solar Home System programme have shown that a simplified procedure and adequate financial knowledge improve green finance adoption rates. Thus, it is hypothesised that women need to possess financial literacy to navigate the complexities of

accessing microfinance services, including microcredit, microinsurance, and in-kind loans, particularly in the context of green finance.

2.3. WEE and GMF

The fact that WEE serves as a crucial foundation for a peaceful, prosperous, and environmentally sustainable world is widely acknowledged, especially within the framework of the fifth Sustainable Development Goal (SDG). One exemplary model illustrating this link is the success of Grameen Bank, which has demonstrated how empowering women through MFIs, offering micro savings and loans can significantly impact communities (Yunus, 1998). These MFIs serve as invaluable channels for sponsors seeking to reach the most vulnerable populations, particularly those disproportionately affected by climate change.

Moreover, the emergence of green MFIs has further underscored their role as intermediaries in distributing resources, particularly among marginalized groups, with a special focus on women (Hammill et al., 2008; Moser et al., 2016). Many sponsors have recognized the potential of MFIs in advancing sustainable development, leading to a commitment to supporting them in adopting green microfinance initiatives. Such support not only aids in the development of environmentally friendly financial products but also includes provisions for financial literacy programmes and advisory services, thereby promoting a holistic approach to sustainability. As MFIs and similar entities continue to evolve, they are increasingly recognized as essential instruments for women's economic empowerment through the provision of microfinance services (Lindahl and Mokvist, 2020). Hence, this study formulates the hypothesis that by fostering the growth of green finance products and facilitating access to financial resources and knowledge, MFIs can further economically empower women and contribute to broader societal development objectives.

2.4. Women's Economic Empowerment, Financial Literacy, and Green Microfinance

Financial literacy, in conjunction with microfinance initiatives, has traditionally directed attention towards broader financial frameworks rather than emphasizing its role in enhancing access to microfinance services (Lindahl and Mokvist, 2020). A lack of financial literacy often hinders women's ability to access financial resources. Initiatives such as climate change adaptation, response to natural disasters, and the promotion of environmentally sustainable practices through microfinance programmes have gained traction (García et al., 2020). Microfinance institutions are introducing a range of environmentally friendly financial products to fund their clients' sustainable endeavours, aiming to bolster access to microcredit for savings groups.

Recent research by Lindahl and Mokvist underscores the positive correlation between financial literacy and women's access to MF in developing nations. It suggests that financial literacy is more pivotal than mere credit access and advocates for future MF endeavours to prioritize it (Nawaz, 2015). The empowerment of women through improved economic standing and altered power dynamics is feasible through microfinance but is contingent upon concurrent financial literacy initiatives (Lindahl and Mokvist, 2020). The interplay between financial literacy, women's economic empowerment, and green microfinance underscores its potential for substantial impact.

Hypothesis Development

After establishing the study's objectives rooted in the research gaps found in the literature review, the researchers have put forth the following hypotheses:

H1: Financial literacy is positively impacted by women's economic empowerment.

H2: Green microfinance is positively impacted by financial literacy.

H3: Green microfinance is positively impacted by women's empowerment.

H4: The relationship between GMF and WEE is mediated by FL.

3. Research Methodology

3.1. Conceptual Framework

Figure 1 depicts the conceptual research framework constructed by the authors upon reviewing the literature. In this framework, 'WEE' represents "Women's Economic Empowerment", 'FL' denotes "Financial Literacy", and 'GMF' stands for "Green Microfinance".

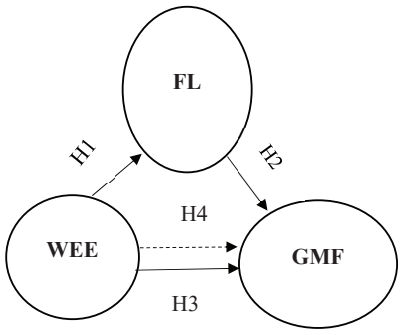

Figure 1. *Path model*

3.2. Data Collection

The research methodology employed in this study aimed to explore the relationship between FL, GMF, and WEE in the northern region of India, encompassing Punjab, Haryana, Chandigarh, Delhi, and Himachal Pradesh. Using a purposive sampling technique, 560 questionnaires were distributed to working women, with 500 usable responses obtained after excluding 60 incomplete submissions. The questionnaires were distributed in both forms: online and offline. The data were collected during the second quarter of 2024. The questionnaire, utilizing a 5-point Likert scale, assessed respondents' viewpoint on financial literacy, green microfinance, and women's economic empowerment.

The demographic profile of respondents is shown in *Table 1*. The table shows that data has been collected from different demographic backgrounds for the representation of the entire population under study. Both urban (Chandigarh, Delhi) and rural (Haryana, Punjab, Himachal Pradesh) regions were purposively selected to see the impact of the interrelated variable. In urban areas, women are more literate and independent as compared to rural areas. The sample selected is diverse and appropriate for the study.

Table 1. *Demographic profile of the respondents*

	Frequency	**Percentage**
Age (in yrs)		
Up to 25	137	27.4
25–25	153	30.6
35–45	144	28.8
Above 45	66	13.2
Educational qualifications		
Graduation	193	38.6
Post-graduation	187	37.4
Professional courses	120	24
Sector		
Public	233	46.6
Private	267	53.4
Region		
Punjab	99	19.8
Haryana	103	20.6
Chandigarh	95	19
Delhi	107	21.4
Himachal Pradesh	96	19.2

Source: primary data

Construct Definition and Measurement

The statement for the questionnaire has been adapted from the literature with the necessary changes as required by the present study. *Table 2* shows the constructs, codes, means, and items used in the survey.

Table 2. *Construct definition and measurement*

Construct	Code	Mean	Items
Women's Economic Empowerment	WEE1	3.14	1. Strong financial literacy among women correlates with increased engagement in MFIs.
	WEE2	3.12	2. Improved financial knowledge empowers women to influence MFI decisions.
	WEE3	3.15	3. Proficient financial literacy among MFI members leads to higher earnings.
	WEE4	3.18	4. Growing financial literacy among women fuels MFI growth.
	WEE5	3.17	5. Increasing female members' income enhances MFIs' financial capacity.
Financial Literacy	FL1	3.18	1. A low-interest loan will help my business.
	FL2	3.27	2. Creating a fund for unexpected expenses is crucial.
	FL3	3.21	3. Buying life insurance safeguards against accidents and disasters.
	FL4	3.20	4. Planning a budget helps decide where the money goes.
	FL5	3.19	5. Diversifying savings lessens the risk of loss.
Green Microfinance	GMF1	3.36	1. MFIs provide eco-friendly businesses with low-interest loans.
	GMF2	3.36	2. MFI members prioritize affordability by efficiently completing tasks.
	GMF3	3.28	3. MFIs contribute to preventing grassland and forest fires.
	GMF4	3.25	4. Utensils are reused within MFIs.
	GMF5	3.33	5. MFIs implement recycling policies.

Source: adapted from Atahau et al., 2020, 2021; Garikipati, 2012; Nawaz et al., 2012

3.3. Data Analysis

The utilization of Smart PLS software facilitates the application of Partial Least Squares (PLS) Analysis to scrutinize the hypothetical model proposed by the authors. To conduct Structural Equation Modelling (SEM) effectively, experts advise employing a two-stage analytical approach. This involves assessing both the measurement model and the structural model. Three reflecting latent variables make up the measuring model in this specific study. Partial Least Square is widely recognized as a robust tool for computing path coefficients across various research

models, particularly in behaviour studies. Its efficacy has been demonstrated and validated by contemporary scholars due to an exceptional capacity to represent latent components in a variety of scenarios such as those with small to medium sample sizes and non-normal data distributions (Hair et al., 2013).

4. Results and Discussion

4.1. Measurement Model

In this research, a reflective measurement model is utilized, which necessitates all latent constructs in the study to be reflective. The model is considered reflective when indicators or items are caused by its latent construct and formative when the latent construct is caused by its indicators. As per Hair et al. (2011), to ensure the suitability of the reflective measurement model for PLS-SEM investigations, reliability and validity testing must be conducted. To check if all of the instruments have convergent validity, the outer measurement model is first evaluated.

Indicator Reliability

A strong outer measurement model was indicated by all loadings exceeding the recommended threshold of 0.7, as per the recommendations put forward by Chin et al. (2008) and Hair et al. (2013). The factor loading for financial literacy items ranges from 0.823 to 0.887, for GMF from 0.839 to 0.880, and for women's economic empowerment from 0.773 to 0.883. The researchers therefore determined that the model might be considered moderately good after examining all factor loadings, as shown in *Table* 3.

Composite Reliability and Convergent Validity

According to Henseler et al. (2015), reliability is deemed sufficient if α is greater than 0.70, and composite reliability needs to be greater than 0.70. The study's composite reliability and Cronbach's alpha scores for the variables under examination were both above 0.70, a sign of reliable data. Moreover, AVE values ought to be higher than 0.60 (Kim and Shim, 2018). Convergent validity was indicated in this investigation because the AVE value was higher than the cut-off point.

Table 3. *Factor loading, reliability, and convergent validity*

	Cronbach's alpha	Factor loading	CR (rho_a)	CR (rho_c)	AVE
FL	0.901		0.905	0.927	0.717
FL1		0.834			
FL2		0.853			
FL3		0.823			
FL4		0.837			
FL5		0.887			
GMF	0.91		0.911	0.933	0.734
GMF1		0.839			
GMF2		0.853			
GMF3		0.862			
GMF4		0.851			
GMF5		0.880			
WEE	0.876		0.882	0.91	0.67
WEE1		0.773			
WEE2		0.855			
WEE3		0.759			
WEE4		0.815			
WEE5		0.883			

Source: processed data

Discriminant Validity

The next analysis focuses on the outer measurement model's discriminant validity once the reliability and AVE values have been determined. Two tests were used to evaluate the discriminant validity of the data: the Fornell and Larcker Criteria and the HTMT ratio (see *Table 4*). The data exhibit discriminant validity if the HTMT ratio is less than 0.90. The results showed that the HTMT ratio for every construct was less than 0.90, indicating the existence of discriminant validity between the variables. In the same way, each column's top value should exceed its bottom values in accordance with the Fornell and Larcker Criteria (Franke and Sarstedt, 2019). Given that the requirements for this test have been satisfied, *Table 4* shows that discriminant validity is present.

Table 4. *Discriminant validity and collinearity analysis*

Fornell and Larker Value			HTMT Matrix				VIF values
FL	GMF	WEE		O	**2.5%**	**97.5%**	
0.847			**GMF <-> FL**	0.533	0.450	0.614	1.242
0.484	0.857		**WEE <-> FL**	0.491	0.400	0.574	1.000
0.441	0.525	0.818	**WEE <-> GMF**	0.586	0.507	0.661	1.242

Source: processed data (original sample)

4.2. Structural Model

The fundamental connections between the different elements of a study are referred to as the structural model. Researchers usually examine the path coefficients, sometimes referred to as beta coefficients, and the coefficient of determination in order to assess it. Once these results have satisfied the proposed cut-off points, researchers can use bootstrapping to estimate similar t-values by using a resample of a minimum of 5,000 (as advised by Hair et al., 2013). Bootstrapping is a non-parametric method that facilitates the assessment of the statistical significance of different PLS-SEM outcomes such as path coefficients, Cronbach's alpha, HTMT, and R^2 value.

Collinearity Analysis

The structural model was evaluated using a collinearity analysis, which yielded the structural model's relevance (Cohen, 1988). A tool called Variance Inflation Factors (VIF) was used to assess the constructions' multicollinearity (Henseler et al., 2015; Hair et al., 2013). VIF values linked to the latent variable scores, as shown in *Table* 4, were all lower than 5, indicating the lack of multicollinearity (Hair et al., 2013). The importance of the association between the constructs was confirmed by validated collinearity values.

Mediation Analysis

Researchers must first understand the significance of looking into mediation effects in PLS-SEM before evaluating their significance. According to Nitzl et al. (2016) and Baron and Kenny (1986), an antecedent exogenous construct and a mediating construct are examined causally in mediation analysis, as this influences the study's endogenous construct. The researchers in this study use the three-step technique (Shrout and Bolger, 2002; Hayes and Scharkow, 2013; Zhao et al., 2010; Rucker et al., 2011; Aguinis et al., 2017) in order to stay up to date with the most recent methods.

The *first step* includes examining the direct impact of an independent construct on a dependent one when a mediator is not present. If deemed substantial, the evaluation of the indirect relationship's relevance also takes place to consider every possible option for testing mediation. The most appropriate technique for examining the possibility of mediating relationships in cases where direct relationship evidence is lacking in the literature is bootstrapping, which involves estimating confidence intervals (Cheung and Lau, 2008; Aguinis et al., 2017; Mahfud et al., 2020). In the absence of a mediator, WEE has a significant and positive influence on GMF, with a

positive figure of 27.6% and with a path coefficient of 0.526. To go on to the second stage, it is clear that the endogenous construct has a major direct impact on the external construct. *Figure 2* shows the result of the structural model; it shows the t-values, p-values, path coefficient, and R square value of the constructs.

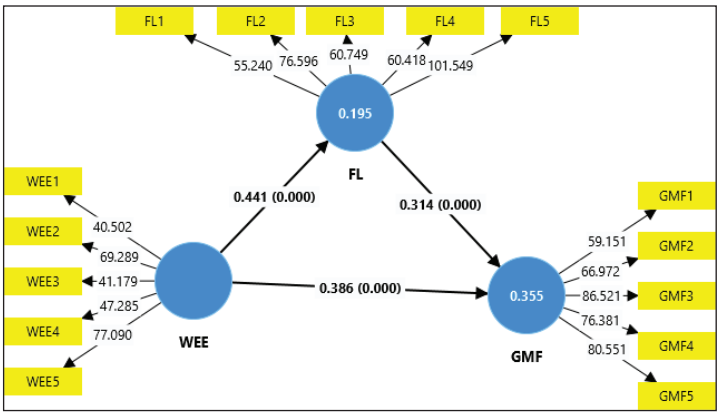

Figure 2. *Structural model*

Second step: Subsequent to verifying the significance of the direct effect, the magnitude of the mediating effect is ascertained by evaluating the indirect effect and total effect strength. The variance accounted for (VAF) ratio, which shows the proportion of the indirect effect to the total effect, is used to calculate the size of the mediating effect (Hair et al., 2013).

Table 5 displays the computed overall effect of WEE on GMF, which can be acquired from the program findings. The VAF is then determined by dividing the Indirect Effect by the Total Effect (Hair et al., 2013). This yields 0.2623 when 0.138 is divided by 0.526. The third stage will look more closely at the partial level of mediation indicated by this VAF number. As a result, the ratio of the indirect effect to the total effects – or VAF – is determined in the current study to be 0.2623.

Table 5. *Direct and indirect effect of women's empowerment on green microfinance*

	FL	GMF
WEE	0.441(indirect effect)	0.525 direct effect)
FL		0.314 (direct effect)
WEE*FL		0.138 (indirect effect)

Source: processed data

Notes: Direct effects represent the immediate relationship between variables, indirect effects include mediation pathways, and total effects sum both direct and indirect effects. Values are standardized path coefficients.

Third step: Choosing the type of mediation (full (VAF is above 0.8), partial (VAF is between 0.2 and 0.8), or none (VAF is between 0 and 0.2)) in accordance with Hair et al's (2013) guidelines is the third stage. They suggest that, in line with H4, FL plays a mediating role in the relationship between working WEE and GMF. As a result, the statistical proof of the mediating effect supports H4.

Hypothesis Testing

The bootstrapped model indicates positive associations between WEE and FL, FL and GMF, and WEE and GMF, supported by significant t-statistics of 11.368, 7.189, and 8.786 respectively. While p-values indicate the significance of associations, they do not provide information about their absolute effect sizes, hence the importance of F^2 values in this context. Looking at the path coefficients in *Table 6*, we can see that women's economic empowerment (WEE) has a positive effect on financial literacy (FL). This is indicated by a coefficient (β1) of 0.441, which is significant at the $p < 0.01$ level and accounts for 19.5% of the variance in FL. This statistical data is consistent with H1. Furthermore, FL confirms H2 by having a positive influence on green microfinance (GMF) with a coefficient (β2) of 0.314, significant at $p < 0.01$. Additionally, WEE exerts a considerable influence on GMF, as seen by a coefficient (β3) of 0.386, significant at $p < 0.01$. When combined, WEE and FL account for 35.5% of the variance in GMF. This statistical result supports H3's validity. As a result, there is enough empirical and statistical support for the researchers' hypothetical model of path coefficients and coefficients of determination.

Table 6. *Hypothesis testing*

	B	t-statistics	p-values	f^2 values	Effect size	Decision
H1: WEE -> FL	0.441	11.368	***	0.242	Larger	Supported
H2: FL -> GMF	0.314	7.189	***	0.123	Medium	Supported
H3: WEE -> GMF	0.386	8.786	***	0.186	Larger	Supported
H4: FL mediates WEE and GMF	0.138	5.812	***			Supported

Source: processed data

Note: *** $p < 0.01$.

F^2 values: To assess effect sizes, f^2 values are employed. Values below 0.02 suggest small effects, while those medium effects are shown by values between 0.02 and 0.15. Large effects fall within the range of 0.15–0.35 and beyond (Cohen, 1988). This approach considers both substantive significance and statistical significance together, providing researchers with a more comprehensive understanding of the results.

R Square and Q Square Values

The prediction ability of the structural model is evaluated for each dependent construct using the coefficient of determination (R square). The blindfolding approach is also used to evaluate the structural model's predictive relevance (Q square). According to Hair et al. (2017), the Q square values in *Table 7* are significantly above zero, meaning that the structural model has verified predictive relevance.

Table 7. *R square and Q square values*

	R^2	Q^2
FL	0.195	0.189
GMF	0.355	0.271

Model Fit

Smart PLS computes Standardized Root Mean Square Residual (SRMR) to evaluate model fit; a threshold of less than 0.080 is advised for an acceptable fit. The SRMR in this study was found to be 0.052, which is below the maximum criterion of 0.080 and indicates a good fit.

4.3. Discussion

The study findings indicate that WEE positively influences FL, aligning with previous research (Soegiono et al., 2019; OECD, 2013). Women's financial literacy is influenced by both formal education and local knowledge, especially in rural areas where bottom-up strategies that include traditional wisdom have been put into practice. WEE facilitates access to education, leading to better financial decision making (Junankar et al., 2016). Empowered women also play significant roles in household decision making and microfinance initiatives, relying on their involvement in income-generating activities and leveraging local wisdom (Barrios et al., 2020). Despite obstacles posed by the COVID-19 pandemic, women's organizations improved their financial capacities by organizing social events, saving money, taking out loans, and sharing profits while adhering to sustainability and equality principles (Soegiono et al., 2019). Marapu values, representing local wisdom, aid in financial management and access to informal financial resources. Marapu values serve as basic informal foundation for FL and GMF. These beliefs also link with green microfinance and women's economic empowerment by containing principles of responsible lending, community savings, and collective financial responsibility (Soegiono et al., 2019). In rural India, SHGs serve as informal education hubs, help women in acquiring saving, budgeting, and investment skills

before accessing formal MFI (Vasishta and Singla, 2025; Garikipati, 2012). We can create a sustainable financial education model by integrating these traditional beliefs and MFI, which will enhance women's self-efficacy and engagement with green financial products (Lee and Huruta, 2022).

Green microfinance initiatives have further empowered women, enabling them to make decisions independently and participate in income-generating activities. FL acts as a mediator between WEE and GMF, highlighting its importance in achieving Sustainable Development Goals (SDGs) (Lindahl and Mokvist, 2020; Nawaz et al., 2012). The result of the study also aligns with the results obtained by Lee and Huruta (2022), but the path coefficients in this study are lower than those in their study, a difference that may be due to the larger sample size used in the present study, and the demographic and contextual background of the study may be a reason for the lower effect size. After considering the difference in path coefficients, all relationships are statistically significant. Leveraging indigenous wisdom, such as Marapu beliefs, enhances the sustainability of green microfinance efforts. Prior studies focused on the impact of WEE on MF participation but overlooked the role of FL in the effective utilization of financial resources (Nawaz, 2015). This study extends the existing literature by demonstrating that WEE alone does not lead to engagement in GMF, but rather FL acts as a mediator, providing women with basic financial knowledge to access and manage green financial products (Lee and Huruta, 2022). FL plays a crucial role in understanding financial concepts, making informed decisions and accessing financial services, thus acting as a bridge between WEE and GMF (Lee and Huruta, 2022). Bangladesh's Solar Home System and local wisdom-based financial education programmes in Indonesia have shown that integrating WEE with FL improves women's ability to get sustainable financial services and renewable energy solutions (Atahau et al., 2021; Garikipati, 2012). These findings highlight the crucial mediating role of FL in sustainable financial inclusion (Moser et al., 2016). The study emphasized that MFI initiatives without FL intervention may not fully empower women to make sustainable financial choices, reinforcing the need for the integration of FL programmes with GMF framework (Garikipati, 2012).

This study contributes to existing literature by integrating FL, WE, and GMF, offering insights into strategies for achieving SDG targets. Collaboration among various stakeholders, including government, NGOs, universities, and corporations, is essential for accelerating progress towards SDGs. In India, social networks and community-based financial education also play an important role to empower women and give them the necessary financial education, especially in rural India, where formal financial training is limited. Several initiatives, such as SHGs, women's cooperatives, and traditional microfinance initiatives, help in fostering peer learning, navigating complex financial systems, sharing financial knowledge, collective decision making and risk sharing, which are important for building

financial confidence (Garikipati, 2012). These informal networks reduce the barrier posed by a low financial literacy level, allowing them to make financial choices confidently and engage with formal financial institutions (Lee and Huruta, 2022).

5. Conclusions

Our research suggests that women can enhance their FL and empower themselves in GMF endeavours by drawing on their indigenous knowledge. The overarching goal of our study is to align local government policies with Sustainable Development Goals (SDGs) related to WEE (SDG 5), climate action (SDG 13), and literacy (SDG 4). Strengthening financial literacy initiatives within women's inclusion programmes for climate-resilient microfinance institutions could help achieve these targets (Lindahl and Mokvist, 2020; Nawaz et al., 2012). FL strengthens the relationship between FL and GMF by empowering women to make sustainable financial choices. Women having an adequate financial literacy are more likely to invest in green financial solutions such as renewable energy, eco-friendly businesses, and green microfinance (Moser et al., 2016). Bangladesh's Solar Home System programme is an example that highlights the link between GMF and climate action. In this programme, microfinance institutions provided financially trained women with access to solar panel loans and reduced their dependence on non-renewable energy sources (Atahau et al., 2021). Thus, combining FL with GMF leads to long-term climate action and promotes environmental responsibility. Previous studies have highlighted the potential of microfinance combined with FL to empower women, especially in rural areas (Atahau et al., 2020). Collaborative efforts between women's farming groups, local educational institutions, government, and the wider community are essential to promote sustainable GMF. Policy implications include establishing locally relevant financial literacy programmes tailored to women's roles and allocating resources for gender-targeted financial inclusion initiatives. Additionally, there is a need for enhanced financial education, particularly in digital finance, to equip women in green microfinance activities with the necessary knowledge about financial products and services. By integrating FL into national policies, the government and MFI can enhance FL and microfinance programmes, ensuring wider access of MFI to underserved areas (Atahau et al., 2021). By promoting national financial literacy strategy, the government can enhance women's involvement in sustainable finance and can contribute to financial inclusion and climate resilience (Lee and Huruta, 2022). FL scalability depends on adopting digital financial solutions and culturally relevant training, as seen in Bangladesh and Indonesia, where local strategies enhanced women's access to green finance (Garikipati, 2012; Moser et al., 2016). Economically empowered women contribute to not only economic benefits but also to gender equality (Nawaz, 2015). MFI programmes contribute to

sustainability in green finance adoption by promoting collective decision making and rural development (Schäfer, 2017).

6. Limitations and Future Scope

Despite its strengths, this study has several limitations that should be acknowledged. Firstly, the use of purposive sampling may limit the generalizability of the findings. Future research could benefit from employing alternative sampling methods, for instance, probability sampling techniques, to enhance the study's generalizability. Additionally, expanding the geographical scope beyond the states selected for this study, such as including all the states of India, would further enhance the generalizability of the findings. Furthermore, this study's research scope was limited to a cross-sectional analysis at a single point in time. To better assess the sustainability of green microfinance institutions (MFIs), it would be beneficial to conduct longitudinal studies that consider the impact of seasonality and encompass a broader time frame. Expanding the geographical scope to explore cross-cultural or cross-national comparisons could provide a more comprehensive understanding of how indigenous knowledge and women's empowerment influence financial literacy and green microfinance. Including a longitudinal study would help assess the sustainability of green microfinance initiatives over time. Given the relevance of digital finance, exploring how digital financial tools could complement green microfinance in rural areas would be valuable for future research (Fernandez, 2025).

Compliance with Ethical Standards

Firstly, we disclose that there are no potential conflicts of interest related to this research. Secondly, this study involving human participants adheres to ethical guidelines, and an informed consent was obtained from all individual participants included in the study.

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