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Article

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Empowering women in the digital age: can digital financial services fulfil the promise of financial autonomy and gender equality in the attainment of Sustainable Development Goal 5?

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ABSTRACT

Digital financial services play a crucial role in breaking down traditional barriers to financial access, promoting greater financial inclusion, and providing marginalized groups with equal access. These services offer innovative strategies designed to address the unique financial barriers and empower women to achieve financial access and independence. This study aims to examine the influence of the adoption of digital financial services on enhancing women's financial independence. This study examines the responses of 426 women in North India using Partial Least Squares Structural Equation Modelling (PLS-SEM) as its research approach. This study also employs the PLS Predict technique to evaluate the ability of the model to predict women's financial autonomy. The findings demonstrate a significant and favourable relationship between the utilization of digital financial services and the improvement of women's ability to make financial decisions. This study contributes to the discussion on promoting gender equality and economic empowerment, aligning with United Nations Sustainable Development Goal 5; showcasing the potential of information and communication technology (ICT) in advancing women's economic and social empowerment. The results offer vital perspectives for policymakers, financial service providers, and development agencies, emphasizing the substantial influence of digital financial services in promoting gender parity and enhancing women's socio-economic circumstances.

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1. Introduction

Sustainable Development Goal 5 underscores that women and girls constitute 50% of the global population, embodying equal parts of its potential. Despite this, gender disparities remain a ubiquitous barrier to societal advancement. A key objective of this goal is to amplify the deployment of empowering technologies, especially within the domain of ICT (information and communication technology), to foster women's empowerment (Eden & Wagstaff, 2021). This goal highlights the critical need to address and eliminate the persistent issues of gender inequality that hinder social progress. By leveraging technology, particularly ICT, there is a significant opportunity to empower women, enhancing their access to information, resources, and opportunities, which are essential for achieving gender equality and catalysing comprehensive societal development (Pradhan et al., 2017). This viewpoint is reinforced by the worldwide agreement among governments regarding the crucial role of digitalization in advancing financial inclusion and fostering economic growth. According to Velden (2018), digital technologies play a vital role in advancing sustainable development in sectors such as healthcare and energy, rather than just being helpful. The growing availability of digital financial tools can have a crucial impact on the

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inclusion of women in the official financial system, thus advancing gender equality and contributing to broader sustainable development objectives (Kulkarni & Ghosh, 2021). The 2016 report from the McKinsey Global Institute highlights the transformative potential of digital finance, suggesting it could extend financial services to an estimated 1.6 billion people across developing countries, with women making up more than half of this group. Research by Demirgüç-Kunt et al. (2018) reveals a gender gap in financial inclusion, showing that women are less likely than men to have a formal bank account, attributing this to persistent gender inequalities in account ownership. Between 2014 and 2017, there was a notable increase in the number of Indian women acquiring formal bank accounts. However, by 2017, a gender gap of 6% in the ownership of formal accounts still existed. Furthermore, the on-going utilisation of these accounts continues to be a cause for concern. According to Ghosh (2022), Indian women exhibit a 12% lower likelihood than men in using mobile phones to open accounts and a 9% lower likelihood of actively managing these accounts. Governmental initiatives to achieve comprehensive financial inclusion have not successfully addressed the issue of women's limited access to financial products and services due to their lack of formal account ownership, thus hindering their empowerment (Bhatia & Singh, 2019). Although there are still obstacles to overcome in achieving financial inclusion, India demonstrates significant potential for digital engagement. The country has more than one billion mobile subscribers, with a mobile penetration rate of 72%. This includes over 250 million smartphone users, and there is a growing trend in monthly data consumption (Omidyar Network, 2016). Access to digital banking services for women promotes economic development by mitigating inequality, enhancing social well-being, and optimising resource allocation (Kaur & Kaur, 2021). FinTech has the potential to greatly enhance digital financial inclusion for marginalised groups, such as women and girls, by reducing the financial gender disparity and promoting sustainable growth in India (Bala & Singhal, 2022).

Despite the recognized potential of digital financial services in enhancing financial inclusion and promoting gender equality, the persistent gender gap in financial access remains a significant barrier to societal advancement (O'Donnell, 2019). Sustainable Development Goal 5 emphasizes the importance of leveraging information and communication technology (ICT) to empower women (United Nations, 2015), yet the practical application of these technologies in breaking down financial barriers for women has not been sufficiently explored (Jensen & Westley, 2020; Kim & Lee, 2021). This study is motivated by the critical need to understand how digital financial services can be effectively utilized to empower women financially, especially in regions where traditional barriers have kept them marginalized from the financial ecosystem (Patel & Raj, 2020; Smith & Reilly, 2019).

1.1. Need and significance of the study

Previous studies have documented the gender gap in financial inclusion and the potential of digital finance to address this divide. However, there remains a significant gap in empirical research specifically examining the impact of digital financial services on women's financial independence in the context of developing countries like India. Recommendations from works such as Kulkarni and Ghosh (2021) and Bala and Singhal (2022) underline the importance of targeted research to understand the barriers and opportunities presented by digital finance for women. This study responds to these calls by focusing on the adoption and utilization of digital financial services among women, a context that presents both unique challenges and opportunities for enhancing financial inclusion. Based on the need to further explore this area and the gaps identified in the literature, this study will address the following research questions: RQ1:How does the adoption of digital financial services influence women's financial independence?RQ2:What is the relationship between the utilization of digital financial services and women's ability to make autonomous financial decisions?RQ3:To what extent do digital financial services contribute to narrowing the gender gap in financial inclusion within the context of developing countries?RQ4:How can policymakers and financial service providers leverage the findings to promote gender parity in financial access and usage? This study's significance is rooted in its exploration of how digital financial services can boost women's financial independence, addressing a notable gap in current research. It aims to illuminate the path toward reducing the gender disparity in financial inclusion, especially in developing countries where women face significant barriers to financial access. The insights

gained will guide policymakers and financial providers in creating more inclusive financial environments, aligning with broader objectives of gender equality and economic empowerment.

The manuscript is organized into six key sections: The introduction, which sets the stage by offering an overview of digital financial services and underscoring the significance of the study along with the research questions it seeks to tackle. Next, the literature review section establishes the conceptual framework, pinpoints the gap in existing research, and develops hypotheses. This leads into the third section, which provides an exhaustive account of the research methodology employed. The analysis and interpretation of the gathered data are elaborated in the fourth section. The manuscript culminates with the final two sections, which are dedicated to discussing the study's findings, their broader implications, and concluding remarks. These sections also propose directions for future research and enumerate the limitations encountered during the study.

2. Literature review

2.1. Theoretical background

Access to financial services holds fundamental value for women, enhancing their well-being and independence significantly (Rastogi & E, 2018). Gender discrimination in financial sectors not only perpetuates existing disparities but also aggravates poverty levels (Peprah et al., 2019). Initiatives like microfinance have shown promising outcomes in bolstering women's agency, enabling them to generate income, own assets, and improve their societal engagement (Kelkar et al., 2004). Access to financial resources plays a pivotal role in empowering women, affecting decision-making processes, self-esteem, and social status (Cheston & Kuhn, 2002; Hendriks, 2019). Microfinance programs have significantly contributed to the empowerment of women, positively affecting their economic, social, and political status (Dash et al., 2016). These programs provide women with the necessary financial resources for activities such as infertility treatments, which have a profound impact on their life choices and treatment options (Staniec & Webb, 2007). By enabling access to financial services, especially in rural areas, microfinance supports women in enhancing their productive capacities and household empowerment (Fletschner & Kenney, 2014). Despite the recognized benefits, women face numerous barriers to financial inclusion, including a significant gender gap in financial literacy and access to financial services (Fletcher & Mesbah, 2011; RBI, 2015). Challenges such as limited negotiation leverage, insufficient collateral, and restricted mobility hinder women's financial participation (Holloway et al., 2017). Addressing these obstacles requires tailored financial products and policies that cater specifically to women's needs (Ghosh & Vinod, 2016). For financial service providers, understanding these theoretical insights is crucial for designing and implementing services that better meet the needs of women. This involves creating marketing strategies that address societal norms and barriers, developing more user-friendly interfaces for varying literacy levels, and offering products that cater specifically to women's financial needs and constraints (Demirgüç-Kunt et al., 2018).

2.2. Economic benefits and welfare advantages

The economic empowerment of women through financial access not only improves their financial and social status but also enhances family planning and mobility (Adera & Abdisa, 2023). Achieving gender parity in employment and representation in financial sectors can significantly boost economic resilience and growth (Norris & Kochhar, 2019; Pitt & Khandker, 1998). Financial resources allocated to women tend to be invested in family welfare and developmental goods, underscoring the broader societal benefits of female financial inclusion (Buvinic & Jaluka, 2018; Duflo, 2012). Research has shown that when women control more financial resources, there are positive outcomes for child health and education (Ozili et al., 2023). Women are more likely than men to invest in their children's well-being, including nutrition, health care, and education, leading to better future prospects for the next generation and a positive cycle of poverty reduction and economic growth (Doepke et al., 2012; Miller, 2008). This investment in human capital is crucial for sustainable economic development. Moreover, women's financial inclusion contributes to a more diversified and stable economy. By providing women entrepreneurs with

access to credit and financial services, economies can benefit from an increase in the number and variety of businesses. This diversification can lead to greater economic stability and resilience, reducing vulnerability to economic shocks (Amin & Islam, 2015; Seguino, 2017). However, to fully realize these benefits, it is essential to address the systemic barriers that women face in accessing financial services. These include legal and regulatory hurdles, lack of collateral, and cultural norms that restrict women's economic activities, leveraging technology to enhance financial inclusion through digital financial services can offer scalable solutions to some of these barriers. Mobile banking and fintech innovations have shown promise in reaching underserved populations, including women, and can be a powerful tool for economic empowerment if designed and implemented with gender inclusivity in mind (Demirgüç-Kunt et al., 2018).

2.3. Empowerment through digital financial services

The Technology Acceptance Model (TAM), proposed by Davis (1989), posits that perceived ease of use and perceived usefulness are fundamental determinants of users' acceptance and usage of technology (Davis, 1989). Gender and Technology Theory, as articulated by Wajcman (2004), examines the interplay between gender and technology, suggesting that technology is both shaped by and shapes gender relations, challenging the neutrality of technological designs and innovations (Wajcman, 2004). Digital financial services have emerged as a powerful tool for empowering women, granting them autonomy over their finances and facilitating decisions on expenditure, savings, and financial planning (Suri & Jack, 2016). The Kenyan mobile money system, M-PESA, is a prime example of how digital platforms can enhance household financial stability and assist women in poverty alleviation (Aker et al., 2016). These services have been instrumental in reducing transaction costs, improving negotiation capacities, and boosting household consumption. Digital empowerment offers a pathway to bridging the gender gap in financial inclusion. However, challenges such as lower internet use among women, high costs, and socio-cultural norms persist (Mariscal et al., 2019; World Wide Web Foundation, 2015). Enhancing women's digital literacy and access to digital tools is crucial for enabling their active participation in the economy and society (Herbert, 2017; Krieger-Boden & Sorgner, 2018). Digital financial services not only facilitate women's financial autonomy but also play a pivotal role in fostering entrepreneurial endeavors among women. Access to digital banking and financial tools enables women entrepreneurs to bypass traditional barriers to finance, such as gender bias in loan approvals and the requirement for physical collateral, which women may disproportionately lack. This access is crucial in supporting women-led businesses and start-ups, contributing to economic diversity and growth (Demirgüç-Kunt et al., 2018). Moreover, digital financial inclusion has been shown to encourage savings and investment among women, leading to improved financial resilience and security. Studies indicate that when women have access to digital savings accounts, they are more likely to save for future needs, invest in their children's education, and improve the overall financial well-being of their families (Manyika et al., 2016).

Despite the advancements in digital financial inclusion, women in India still face considerable barriers in accessing and utilizing digital financial services. These obstacles stem from a range of socio-economic, cultural, and technological factors that disproportionately affect women. For instance, the digital gender gap is a significant barrier, with women being less likely to own mobile phones or have access to the internet compared to men, which directly impacts their ability to engage with digital financial services. Furthermore, literacy and digital literacy rates among women are lower, which hinders their understanding and utilization of digital financial platforms (Jensen & Oster, 2009; World Bank, 2018). Socio-cultural norms and restrictions also play a critical role in limiting women's financial autonomy and their access to digital services. Women often require permission from male family members to use digital financial services or even to own a mobile phone, which can restrict their access to these empowering tools (Patel & Sengupta, 2018; Singh, 2019). Additionally, the design and delivery of digital financial services often do not take into account the specific needs and constraints of women, further exacerbating the gap in financial inclusion (Chen & Rutherford, 2020).

Building on the transformative potential of digital financial services to enhance female financial autonomy and entrepreneurship, it becomes evident that these technologies are not just tools for

economic transactions but are catalysts for societal change. This literature review transitions into exploring the hypothesis that:

H1: Digital financial services positively influence female financial autonomy

2.4. Research gap and purpose of the study

Even with the strides made towards digital financial inclusion in India, women continue to face barriers in accessing and leveraging digital financial services. Previous studies have primarily focused on qualitative analysis to discover the role of digital financial inclusion for women. However, these studies have not thoroughly examined the aspects of female financial independence within the context of digital financial services, particularly concerning control over income, savings, and decision-making that leads to achieving sustainable development Goal 5. While these prior studies provide valuable insights, there is a noticeable lack of quantitative study that rigorously examines the statistical correlation among digital financial services and female financial independence. This gap highlights the need for more detailed quantitative analysis to understand better the impact of digital financial services on empowering women financially. This research seeks to explore the impact of digital financial services adoption on advancing women's financial autonomy. It delves into how these digital platforms can dismantle conventional obstacles to financial accessibility, foster more inclusive financial ecosystems, and ensure equitable access for underserved populations. Additionally, it considers the potential of digital financial services to catalyze economic empowerment, enabling women to participate more fully in the economy and make informed decisions about their finances and futures.

2.5. Theoretical framework

Theoretical framework, meticulously structured around a comprehensive literature review, aims to dissect the nuanced dynamics between Digital Financial Services (DFS) and Female Financial Autonomy (FFA). This framework, as illustrated in Figure 1, employs a sophisticated approach to analyze the transformative impact of DFS on enhancing women's financial independence. This study is guided by two primary theoretical frameworks: the Technology Acceptance Model (TAM) and Gender and Technology Theory. These frameworks are instrumental in examining the factors influencing the adoption of digital financial services by women and the subsequent effects on their financial independence and empowerment.

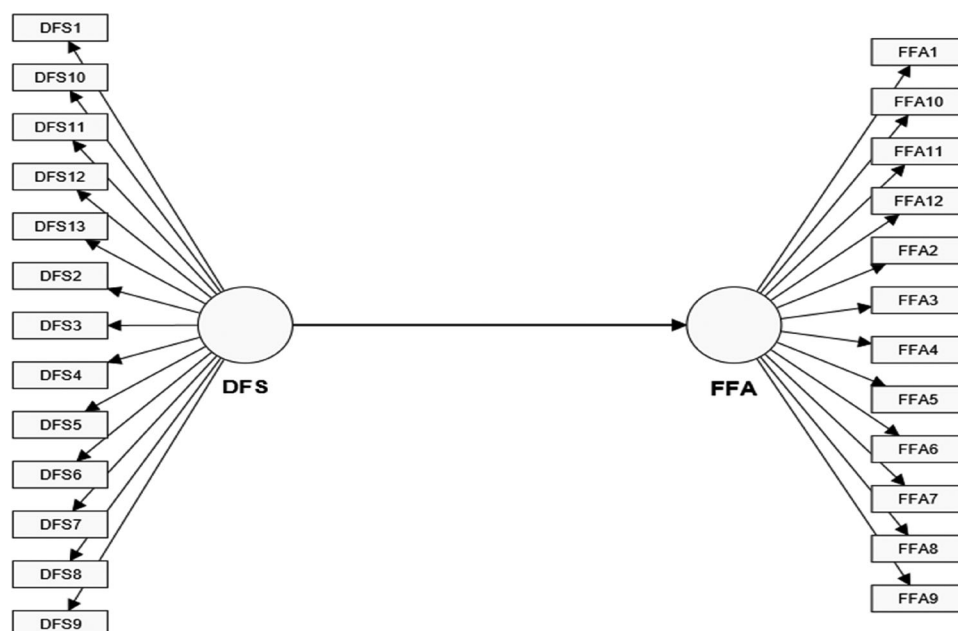


Figure 1. Conceptual Model.

2.6. Technology Acceptance model (TAM)

This study is anchored in the Technology Acceptance Model (TAM) originally proposed by Davis (1989), which posits that perceived ease of use and perceived usefulness are pivotal determinants of technology adoption. TAM provides a robust framework for examining the adoption and utilization of digital financial services among women, thereby offering insights into pathways for enhancing financial independence and decision-making autonomy among women in developing contexts like India. This model has been widely applied in various contexts to understand the adoption of new technologies, including digital financial services (Venkatesh & Davis, 2000). The integration of TAM into our analysis underscores the reliability of the variables under investigation and offers a theoretical lens through which the impact of digital financial services on gender parity can be discerned.

2.7. Gender and technology theory

Gender and Technology Theory offers a nuanced perspective on the intersection of gender and technology, arguing that technology is not gender-neutral and that its design, development, and deployment can reinforce or challenge existing gender inequalities (Wajcman, 1991). This theory underscores the importance of considering gender as a critical factor in the adoption and impact of technology, including digital financial services. Applying Gender and Technology Theory allows this study to explore how gendered norms and roles influence women's access to and use of digital financial services and how these services can be designed and implemented to promote gender equality and women's empowerment (Wajcman, 2004).

This study introduces a novel perspective to the literature on digital financial services (DFS) and women's financial independence by integrating the Technology Acceptance Model and Gender and Technology Theory. This dual theoretical framework enables an analysis of not only the cognitive factors influencing technology adoption (as outlined by TAM) but also the socio-cultural dimensions that shape women's experiences with technology (as highlighted by Gender and Technology Theory). Together, these theories provide a robust foundation for exploring how digital financial services can contribute to narrowing the gender gap in financial inclusion and advancing women's empowerment. It further distinguishes itself by proposing actionable, gender-sensitive policy recommendations with an international scope, aimed at enhancing digital financial literacy and access among women.

3. Research methodology

3.1. Data analysis

The main aim of this study is to investigate the influence of digital financial services (DFS) on female financial autonomy (FFA). To accomplish this, the research utilizes Smart PLS 4.0, effective software for structural equation modelling (SEM). This tool is particularly appropriate for analysing the model in question and the specific characteristics of the data, as noted by Wong (2013).

We begin by ensuring our dataset is properly cleaned and prepared, a foundational step for accurate analysis (Kline, 2015). To affirm the integrity of our constructs, we evaluate the measurement models for both convergent and discriminant validity as shown in Table 1 and 2, crucial steps for reliable PLS-SEM (Hair et al., 2017).

Convergent Validity: This is assessed to ensure items intended to measure the same construct indeed relate to each other (Fornell & Larcker, 1981).

Discriminant Validity: We then confirm that constructs are distinct from each other, a necessary condition for meaningful analysis (Henseler et al., 2015).

The analytical process begins with an evaluation of both first-order and structural measurement models. This step ensures that the constructs in the study are accurately measured and reflect the theoretical concepts they are intended to represent. After establishing the measurement models, the study advances to assess the structural model. This is done through the execution of 10,000 bootstrapping subsamples, employing a bias-corrected percentile method for a two-tailed test, as recommended by Hair et al. (2022). This method allows for a robust examination of the relationships between variables.

Table 1. Assessment of first-order constructs (Reliability and Validity).

Construct	Item code	Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Digital Financial Services	DFS1	0.962	0.994	0.994	0.994	0.929
	DFS2	0.959				
	DFS3	0.972				
	DFS4	0.956				
	DFS5	0.978				
	DFS6	0.948				
	DFS7	0.941				
	DFS8	0.969				
	DFS9	0.978				
	DFS10	0.98				
	DFS11	0.963				
	DFS12	0.969				
	DFS13	0.952				
Female Financial Autonomy	FFA1	0.894	0.975	0.976	0.978	0.788
	FFA2	0.894				
	FFA3	0.908				
	FFA4	0.872				
	FFA5	0.911				
	FFA6	0.888				
	FFA7	0.836				
	FFA8	0.916				
	FFA9	0.876				
	FFA10	0.822				
	FFA11	0.9				
	FFA12	0.931				

Source: Authors Calculation.

Table 2. Discriminant Validity HTMT.

Construct	Heterotrait-monotrait ratio (HTMT)
FFA <-> DFS	0.875

Source: Authors Calculation.

and helps in determining the significance and strength of the hypothesized paths in the structural model.

3.2. Instrument development and validation

This study implemented a cross-sectional survey approach, focusing on women who have bank accounts in the northern part of India, specifically within the union territory of Jammu and Kashmir. Utilizing a survey research methodology, primary data was gathered through a self-administered questionnaire. This questionnaire was crafted based on key dimensions identified from relevant prior research. The independent variable, Digital Financial Services (DFS), is operationalized through an expansive array of 13 items. These items are meticulously selected based on seminal works in the field, including the Global Findex Database 2014 by Demirgüç-Kunt et al. (2015), which provides a global benchmark for financial inclusion. Additionally, the model incorporates Venkatesh et al. (2003) comprehensive theory on user acceptance of information technology, enriching our understanding of the adoption of digital financial tools. Ozili's (2018) insights into the impact of digital finance on financial stability further complement this dimension, offering a holistic view of the operationalization of DFS within our model. On the dependent side of the model, Female Financial Autonomy (FFA) is assessed through a thoughtfully curated set of 12 items, drawing from a broad spectrum of research that spans gender and land rights by Agarwal (1994), to intrahousehold bargaining dynamics as explored by Doss (2013). The empowerment potential of loans to women, as critiqued by Kabeer (2001), alongside Malhotra et al. (2002) methodology for measuring women's empowerment, offer a robust foundation for evaluating FFA. Contributions from Stewart and Doss (2018) on gender and economic inequality provide further depth, ensuring a comprehensive assessment of FFA.

A thorough validation process was conducted before collecting data, which included consultations with 10 field experts. The Lawshe (1975) Content Validity Ratio (CVR) was employed to evaluate the validity of the questionnaire items, with a threshold of 0.62 for acceptance. This comprehensive validation procedure ensured the reliability and validity of the questionnaire, thus enhancing the credibility and strength of the research tool.

3.3. Sample size and data collection

The study conducted data collection through interviews, involving in-person visits to households. This method allowed for a personal and in-depth understanding of the participants' views on digital financial services and their impact on economic empowerment. To determine the sample size, the study applied Krejcie and Morgan (1970) sampling model. Based on this model and the population of 4,158,909 as per recent Census of India, 2011, the study required a sample size of 386 respondents. Additionally, a 10% contingency was included to compensate for potential missing data, leading to a total of 426 women being surveyed. Convenience sampling was used to gather data from 10 districts in Jammu and Kashmir. These districts were selected based on the demographic characteristics of having the highest female population, as recorded in the 2011 census. To ensure the accuracy and reliability of the data, all 426 responses were collected by enumerators. The questionnaire used in the study comprised 25 items. Data collection was carried out through convenience sampling as part of a cross-sectional survey. The responses to the questionnaire were measured using a five-point Likert scale, which ranged from 'strongly disagree' (scored 1) to 'strongly agree' (scored 5). Furthermore, the demographic details of respondents were also collected.

3.4. Consent

To ensure ethical compliance and respect for participant autonomy throughout the data collection process of our study, informed consent was duly obtained from all participants, aligning with the principles of voluntary participation and confidentiality. For literate participants, informed consent was facilitated through a written statement prominently displayed on the questionnaire. This statement clarified that the information provided by them would be utilized solely for research purposes, aiming to contribute valuable insights towards enhancing financial inclusion and economic empowerment initiatives. It emphasized the appreciation for their participation and the potential impact of their contributions on fostering better implementation strategies for these objectives. In the case of participants who were not literate, the same information conveyed in the written statement was verbally communicated to them by the enumerator. This ensured that all participants, regardless of their literacy status, were made fully aware of the study's goals, the confidentiality of their responses, and the significance of their input towards achieving the broader research aims. This approach to obtaining informed consent was designed to uphold the ethical standards of research, ensuring that all participants were informed in a manner accessible to them, thereby safeguarding their rights and fostering an environment of trust and mutual respect throughout the research process.

4. Results

Table 3 in the study presents the descriptive statistics of the women participants. The age range of the respondents was diverse, starting from 18 years old to those who are 55 years and above. Interestingly, each age group constituted about 20% of the respondents, providing a balanced representation across different age categories. Of the total 426 respondents, 205 were from rural areas, while the remaining were from

Table 3. Demographic features.

Age	Frequency	Per cent	Area	Frequency	Per cent
18–24	83	19.4			
25–34	85	20	Rural	205	47.9
35–44	86	20.2	Semi-Urban	45	10.6
45–54	85	20	Urban	176	41.3
55–Above	87	20.4			
Total	426	100	Total	426	100

Source: Authors Calculation.

urban and semi-urban areas. This distribution of respondents across various geographical locations allows for a comprehensive analysis of the responses, taking into consideration the varying perspectives and experiences of women from different areas. This diversity in the sample enhances the study's ability to draw more generalizable conclusions about the impact of digital financial services on female financial autonomy.

4.1. Assessing first-order constructs in measurement models

According to Hair et al. (2019, 2022), the assessment of a measurement model should prioritize confirming the model's reliability and validity. This study's analysis supports the validity of the indicators, establishing both convergent and discriminant validity for the constructs involved. To verify the reliability of each construct, the study evaluated the outer loadings of items linked to their respective constructs, ensuring they met or exceeded the benchmark loading value of 0.70 as advised by Hair et al. (2019). Additionally, the constructs' reliability was further confirmed through the Cronbach's alpha (α) and composite reliability (CR) scores presented in Table 1, all of which were above the accepted threshold of 0.70, indicating reliable constructs as per Henseler et al. (2015). The model's convergent validity was also affirmed through the average variance extracted (AVE) method, with all reflective constructs achieving the minimum requirement of 0.50, signifying adequate convergent validity as per Fornell and Larcker (1981). Our analysis confirmed that the square roots of AVEs for both constructs were indeed greater than their inter-construct correlation, satisfying the Fornell and Larcker (1981) criterion and ensuring discriminant validity within our study's constructs. This thorough evaluation of the measurement model's reliability and validity ensures its robustness and appropriateness for subsequent analysis within the research.

The HTMT criterion, proposed by Henseler et al. (2015), serves as a rigorous method for assessing discriminant validity, presenting benefits particularly in scenarios where conventional methods such as the Fornell-Larcker criterion and analysis of cross-loadings might not sufficiently detect problems with discriminant validity. The HTMT (Heterotrait-Monotrait) ratio of correlations method was utilized to assess the discriminant validity between the constructs of digital financial services and female financial autonomy, as shown in Table 2. The obtained HTMT value for these constructs was 0.875, which is below the critical threshold of 0.90, in line with the criteria set forth by Gold and Malhotra, Henseler et al. (2015), and Hair et al. (2022). A HTMT value less than 0.90 suggests that the constructs are adequately distinct, affirming strong discriminant validity.

4.2. Evaluating the structural model

Following the assessment of the measurement model, the research then proceeded to evaluate the structural model, adhering to the methodology recommended by Hair et al. (2019, 2022). The initial phase involved determining the coefficient of determination (R^2) for the dependent variable, as advised by Hair et al. (2017). The R^2 value for the construct about women's financial independence was calculated at 0.744, demonstrating considerable explanatory capability (Chin, 1998). This indicates that digital financial services account for 74.4% of the variation in women's financial autonomy, underscoring the significant influence of digital financial inclusion on improving women's financial independence. The analysis continued with an examination of multicollinearity through the Variance Inflation Factor (VIF), which revealed a result of 1.002. This figure is significantly lower than the accepted cut-off of 3.33 (Hair et al., 2019), indicating no concerns regarding multicollinearity. Following this, hypothesis testing was conducted using the bootstrap technique with 10,000 subsamples (Hair et al., 2022), which showed a beta (β) coefficient of 0.862 with a p -value of .00 and a 95% Confidence Interval extending from 0.816 to 0.899. This provides robust evidence in support of the first hypothesis. Additionally, the analysis evaluated the effect size (f^2) and T-statistics, uncovering an effect size of 41.374, pointing to a significant influence. The examination of the structural model was graphically depicted in Figure 2 and elaborated upon in Table 4, illustrating the interconnections among independent, dependent, and control variables. The study incorporated (Area) as a control variable, coded as a dummy variable (0 for urban areas and 1 for rural areas), revealing a tendency for urban women to exhibit greater financial autonomy. However, it's important to note that the sole effect of digital financial services on female financial autonomy was the primary focus of our investigation, and the specific effect of Area was not directly examined in this

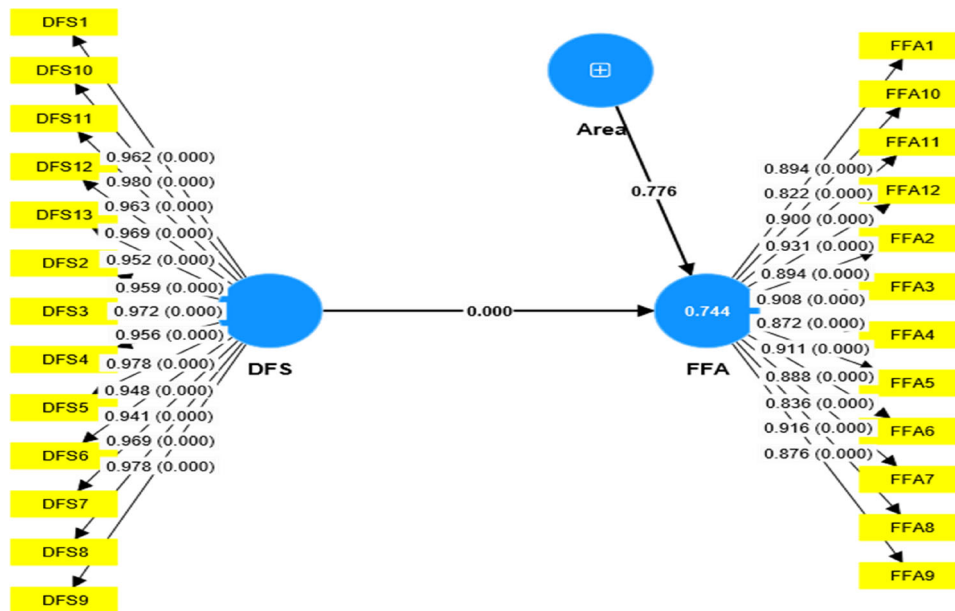


Figure 2. Structural Model. Source: Authors Calculation.

Table 4. Structural Model Assessment.

Hypothesis	path relation	(β)	T Statistics	CI0.95	VIF	f^2	R^2	p value	Significance
H1	DFS \rightarrow FFA	0.862	41.374	(0.816;0.899)	1.002	2.895	0.744	0	Yes
control variable	Area \rightarrow FFA	-0.014	0.284	(-0.11;0.082)	1.002	0			

Source: Authors Calculation.

Table 5. Predictive relevance.

Item	$Q^2_{predict}$	PLS-SEM_RMSE	LM_RMSE	PLS LM	Predictive Power
FFA1	0.554	0.638	0.660	-0.022	High Predictive power
FFA10	0.446	0.646	0.653	-0.007	
FFA11	0.607	0.615	0.702	-0.087	
FFA12	0.634	0.579	0.590	-0.011	
FFA2	0.601	0.582	0.605	-0.023	
FFA3	0.640	0.544	0.573	-0.029	
FFA4	0.525	0.659	0.658	0.001	
FFA5	0.626	0.591	0.611	-0.020	
FFA6	0.643	0.553	0.578	-0.025	
FFA7	0.538	0.679	0.704	-0.025	
FFA8	0.585	0.623	0.623	0.000	
FFA9	0.592	0.632	0.675	-0.043	

Source: Authors Calculation.

LM: Linear Model Benchmarks; PLS: Partial Least Squares; RMSE: Root Mean Squared Error.

context. Moreover, the model's goodness of fit was assessed via the Standardized Root Mean Square Residual (SRMR), which was found to be 0.029. This value falls comfortably below the preferred maximum of 0.08 (Henseler et al., 2015; Hair et al., 2019), signifying a well-fitting model that is apt for the research aims. These outcomes affirm the model's effectiveness in mirroring the collected data, emphasizing the pivotal role of digital financial services in fostering female financial autonomy and highlighting the necessity of advancing digital financial inclusion for women's economic empowerment.

4.3. Q2 predict: measurement of predictive relevance

Utilizing the PLS Predict methodology, the study probed into the predictive capability of Female Financial Autonomy in Digital Financial Services, aligning with the frameworks proposed by Danks and Ray (2018) and Shmueli et al. (2019). The assessment of predictive relevance was anchored on the criterion that a Q2 predict value exceeding zero signifies meaningful predictive utility. This approach was specifically applied to gauge the predictive accuracy for female financial autonomy, focusing on calculating

both the Root Mean Squared Error (RMSE) and the magnitude of the predictive error. The analysis revealed that the distribution of prediction errors was even, prompting a comparative evaluation of RMSE metrics derived from both the theorized PLS model and a non-theorized Linear Regression model, as outlined in Table 5 and discussed by Shmueli et al. (2019). This comparison underscored a high predictive efficacy concerning female autonomy, as highlighted by Hair et al. (2019).

DFS: Digital Financial Services; FFA: Female Financial Autonomy; CI: Confidence Interval at 95%; β : Standardized Beta; H1: Hypothesis 1.

5. Discussion and implications

The findings indicate a significant positive relationship between DFS and FFA, suggesting that increased access to and use of digital financial services can lead to enhanced financial autonomy for women. The positive correlation between DFS and FFA supports the assertions made by Demirgüç-Kunt et al. (2015) and Venkatesh et al. (2003) regarding the potential of digital financial tools to enhance financial inclusion and user acceptance. Similarly, our findings resonate with Ozili (2018), who highlighted the role of digital finance in fostering financial stability. By providing empirical evidence from India, this study adds to the body of knowledge by demonstrating how these global insights apply within the specific socio-economic and cultural context of India. Moreover, the research underscores the critical role of digital financial services in empowering women, echoing the sentiments of Agarwal (1994) and Kabeer (2001) regarding the empowerment potential of financial access. Our findings also contribute to the discourse on intrahousehold bargaining and resource allocation (Doss, 2013; Malhotra et al., 2002), by providing quantitative evidence that DFS can be a significant lever for enhancing women's financial decision-making power within households.

6. Practical implications

The findings from the study on the impact of digital financial services (DFS) on women's financial autonomy have several managerial and broader implications.

6.1. For financial service providers

Financial institutions should develop digital financial services (DFS) products that are tailored to the specific requirements of women. This encompasses functionalities that guarantee confidentiality, protection, and user-friendliness, taking into account the distinct obstacles women encounter when obtaining and utilizing financial services. Innovation should prioritize the development of user-friendly interfaces that cater to individuals with diverse levels of literacy and digital expertise. Marketing campaigns should target women in urban and rural areas, emphasizing the advantages of DFS in fostering financial independence. These strategies should target cultural and societal norms that might impede women's involvement in the financial system.

6.2. For policymakers and government agencies

6.2.1. Gender-Sensitive policy frameworks

Advocate for the development of gender-sensitive policy frameworks that explicitly recognize and address the unique financial needs and constraints of women. This involves conducting gender gap analyses to inform policy decisions and ensure that regulatory environments support the equitable provision and use of DFS by women.

6.2.2. Financial literacy and digital education

Promote policies that support financial literacy and digital education programs tailored for women, recognizing that education is a critical enabler of financial inclusion. Such initiatives can help women make informed decisions about using digital financial services, thereby enhancing their financial autonomy.

6.2.3. Partnerships for financial inclusion

Encourage public-private partnerships (PPPs) aimed at accelerating the deployment of digital financial infrastructure in underserved areas. Partnerships between government, financial service providers, and technology firms can lead to innovative solutions that bridge the digital divide and foster inclusive financial ecosystems.

6.2.4. For development organizations and NGOs:

Promote awareness among women regarding the advantages of digital financial services and their capacity to improve financial independence. This entails engaging in cooperation with local authorities and influencers to modify societal perspectives on women's involvement in the economy. Create support networks for women to exchange experiences and acquire knowledge from one another regarding the effective utilization of digital financial services for personal and entrepreneurial purposes. Allocate resources towards conducting research and gathering data to closely track the advancements of digital financial inclusion initiatives specifically targeting women.

7. Conclusion

This study establishes a new standard by introducing a creative framework that combines digital finance with women's financial autonomy a concept that has been previously examined separately but not integrated into a cohesive model. This investigation is notable for its innovative use of the PLS-SEM method to examine the relationship specifically in the context of a developing country such as India. The study incorporates geographical location area as a controlling variable. The goal is to provide practical and valuable information for financial service providers, policymakers, government bodies, and developmental agencies by highlighting the crucial role of digital financial services in promoting economic and social empowerment for women. This undertaking is in line with the aspiration to achieve UN Sustainable Development Goal 5, which specifically focuses on advancing women's empowerment by embracing empowering technologies, such as information and communication technology (ICT). The findings strongly confirm the direct relationship between adopting digital financial services and the empowerment of women in managing their personal and household finances. DFS serve as catalysts for change by breaking down conventional obstacles to financial accessibility, providing women in culturally and socially restricted settings with an alternative path to financial inclusion. Through the use of digital channels, DFS promotes women's engagement in financial transactions, savings, and investments. This not only enhances their understanding of financial matters but also fosters a sense of financial self-reliance and the ability to make independent decisions. This study illustrates that financial autonomy goes beyond simply having access to financial resources, encompassing the power to make decisions about how these resources are used. Enabling women to participate in financial decision-making is recognized as a vital component of their autonomy. The findings of this study demonstrate that DFS has a significant influence on women's financial autonomy, leading to a greater likelihood of them allocating resources towards the well-being of their families, including healthcare, education, and overall prosperity. Consequently, this contributes to the improvement of community welfare. Moreover, the research highlights the importance of digital literacy in maximizing the complete capabilities of digital financial services. For women to effectively utilize DFS, they must have the skills to navigate digital platforms. This emphasizes the need for targeted digital literacy programs that focus on women, to reduce the digital divide and promote financial inclusion and independence. Essentially, DFS can make a substantial contribution to eliminating gender-based economic disparities by empowering women with the resources and information necessary to make well-informed financial decisions. Collaboration among policymakers, financial institutions, and developmental agencies is crucial in ensuring that the benefits of digital financial inclusivity are available to women worldwide, thereby paving the way for a fairer and more prosperous society.

8. Limitations and direction for future research

Although this study offers valuable insights, it is not exempt from limits. The survey's cross-sectional nature constrains the capacity to deduce causality. Moreover, the study's emphasis on a particular region

could impact the applicability of the results to different settings. Subsequent investigations could employ longitudinal designs to gain a deeper understanding of the enduring effects of DFS on women's financial independence. Conducting comparative studies in various cultural and geographical contexts could enhance our comprehension of the factors that impact the efficacy of DFS in advancing women's economic empowerment.

Authors contribution

Mohsin Showkat: Conception, design, drafting-, data collection, and interpretation of the manuscript. Razia Nagina: Conception and drafting of the manuscript. Usha Nori: Design and review of the manuscript. Muzamil Ahmad Baba: Design and review of the manuscript. Mohd Asif Shah: Design, analysis, interpretation and review of the manuscript. The authors read and approved the final manuscript.

Informed consent

It was obtained from the participants in this study. Written consent was secured from literate respondents, and oral consent was obtained for illiterate respondents.

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Data availability statement

We hereby declare that the data supporting this study are available to the author and will be provided upon reasonable request for research purposes.

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