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Exploring individuals' socioeconomic characteristics and digital infrastructure determinants of digital payment adoption in Ethiopia

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ABSTRACT

The COVID-19 pandemic has spurred a surge in digital payments, with over 40 % of adults in low- and middle-income countries making their first merchant payments using cards, phones, or the internet since the pandemic began. This study examines the determinants of adopting digital payments during the COVID-19 pandemic in Ethiopia. To achieve this objective, the study utilized secondary data from the World Bank's most recent dataset, collected as part of the Global Findex Database 2021. A Covariance Based-Structural Equation Modeling (CB-SEM) was applied to analyze the data and explore the intricate pathways between variables. The mediation role of the use of technological tools on the relationship between socio-economic factors and digital payment adoption was also examined. Accordingly, mobile ownership, having an ATM/Debit card, and internet access were the technological tools significantly determining digital payment adoption. Age, education, income quantile, receiving wage payment, and engagement in formal financial transactions (as a proxy for financial inclusion) were among the socio-economic characteristics influencing digital payment adoption. Engagement in formal financial inclusion, mobile ownership, having an ATM/Debit card, and internet access were also influenced by individuals' socio-economic characteristics. Mobile ownership, having an ATM/Debit card, internet access, and engagement in formal financial transactions were significant mediating factors in the relationship between digital payment and socio-economic predictors.

1. Introduction

The global spread and use of the internet and mobile phones have contributed to the development of digital payments (Sahi, Khalid, Abbas, & Khatib, 2021). With the growing advancement in technology, the application of information communication technology (ICT) in facilitating financial transactions (also called digital finance) is dramatically increasing around the globe. Digital finance involves all electronic financial services and products, including financing, investment, payment, insurance, and financial information delivered through digital channels (Gomber, Koch, & Siering, 2017; Ozili, 2018). Digital finance is considered as a response to technological development in the financial sector (Al-Smadi, 2023).

The internet has sparked an IT-based revolution in the financial services sector, radically altering the delivery of banking services

(Hanafizadeh, Keating, & Khedmatgozar, 2014). This development of internet-based financial services has led to the adoption of digital finance solutions such as internet banking, mobile banking and payment systems, and electronic payments (Shaikh, Hanafizadeh, & Karjaluoto, 2017). Digital finance has several benefits for the government, individuals, enterprises, and the economy. First, it offers a platform for the government to increase its total expenditure and tax revenue that results from the growth of financial transactions (Manyika, Lund, Singer, White, & Berry, 2016; Ozili, 2018). Second, it boosts the gross domestic product (GDP) by expanding access to credit facilities for individuals and enterprises. For example, Manyika et al. (2016) reported that digital finance could increase GDP by \$3.7 trillion across all economies in 2025. Third, digital finance significantly enhances the performance of financial institutions (Scott, Van Reenen, & Zachariadis, 2017). According to some estimates, financial institutions can save \$400 billion in direct

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costs by turning to digital services (Manyika et al., 2016). Finally, digital finance could enhance financial inclusion by serving people who have been traditionally excluded from the financial system (Bourreau & Valletti, 2015; Li, Wu, & Xiao, 2020); for example, by enabling them to use their electronic devices (e.g., cell phones) to perform financial transactions and to access social protection funds from rural areas (Gomber et al., 2017; Pearce, 2011). For enterprises, digital finance can help to reduce the information asymmetry between lenders and borrowers, ultimately decreasing transaction costs (Banna & Alam, 2021; Li et al., 2020; Ren, Li, Zhao, & Zhou, 2018; Xu, 2017). Digital finance also offers new opportunities for delivering a range of financial services to otherwise financially excluded groups (Demirguc-Kunt, Klapper, Singer, & Ansar, 2018).

Digital finance and related technologies are not growing uniformly across global economies. Advanced economies have more sophisticated digital financial technologies, with higher rates of digital financial transactions compared to low and middle-income countries. For instance, in the US, a report by McKinsey & Company indicates that 82 % of the population used digital payments in 2021, up from 78 % in 2020 and 72 % five years prior (Goel, Mahajan, Nadeau, Sperling, & Yeh, 2021). However, the rise in digital finance adoption is not only limited to developed nations. For example, in India, 33 % of people reported using digital payments during COVID-19 more frequently than before the COVID-19 pandemic (Mate & Kapdi, 2021). Similarly, Indonesia has seen a significant increase in digital payment usage, with a 300 % rise from 2018 to 2019 (Kasri, Indrastomo, Hendranastiti, & Prasetyo, 2022). This trend continued in 2021, with 150 million transactions, marking a 24 % increase from 2020. Africa has shown promise in the growth of digital payments. In 2020, Africa's domestic and cross-border digital payments generated approximately \$24 billion in revenues, of which about \$15 billion was domestic payments generated from 47 billion individual transactions (McKinsey & Company, 2022).

In the context of developing countries, a growing number of studies, including Sahi et al. (2021), Patil, Tamilmani, Rana, and Raghavan (2020), Alalwan, Dwivedi, and Rana (2017), Chitimira and Torerai (2023), Danladi, Prasad, Modibbo, Ahmadi, and Ghasemi (2023), Koomson, Martey, and Etwire (2023), Tut (2023), and Khera, Ng, Ogawa, and Sahay (2022), have explored the complexities in and the factors influencing the use and adoption of digital payments and highlighted the status and prospects of digital financial technology adoption. These studies explored the determinants and recommended ways to adapt and improve financial inclusion in developing countries. Yet, the use of digital payments is not as widely practiced as expected. For example, in most of sub-Saharan Africa, only a small percentage of upper-income households enjoy the convenience of digital payments. According to Gallup's survey that consisted of 11 countries in sub-Saharan Africa, more than 80 % of adults paid their bills or made remittances with cash. As a result, institutions incur high costs, including the processing of financial transactions, storage, security, and transportation of cash (McKinsey & Company, 2014). The use of digital payments can transform the financial lives of individuals and communities in Africa (Batista & Vicente, 2020; World Bank, 2014), where most people in urban areas maintain connections with their relatives and friends in rural areas. The adoption of digital payments can significantly improve financial transactions, such as remittances, and household welfare by reducing poverty and vulnerability in rural areas (Balasubramanian, Drake, & Urrea, 2023; Munyegera & Matsumoto, 2016; N'dri & Kakinaka, 2020).

The present study focuses on Ethiopia, a country with one of the fastest-growing economies in Africa that has been significantly pushing towards digital transformation. Yet economic transactions in the country are largely cash-based, with low levels of financial transactions and limited access to formal financial services. In the Ethiopian context, various studies have examined the adoption of financial technologies, such as the adoption of electronic banking systems in the Ethiopian banking industry (Bultum, 2014; Kifle, 2022), factors affecting

consumers' intention to use e-payment services (Kebede & Bonge, 2023), and the effect of financial technology on financial inclusion (Menza, Jerene, & Oumer, 2024). While many of these studies have provided valuable insights into digital payment adoption in Ethiopia, they often focus on specific groups of the population and particular digital infrastructure and thus do not fully capture the diverse digital payments infrastructure and its various uses. Additional insights are needed to identify major constraints and suggest interventions that can enhance the uptake of digital payments in Ethiopia, which is very slow (Jerene & Sharma, 2020). For example, almost all (99 %) adults in Ethiopia pay utility bills with cash, compared to 12 % of people in Kenya and 59 % in the region; only 0.3 % of adults in Ethiopia have a mobile money account, according to Findex (Menza et al., 2024). Additionally, a study conducted by the Ethiopian Policy Studies Institute (PSI) (2024) showed that Ethiopia stands behind many other African countries in terms of digital payments. Using the most often measure of digital payment competitiveness, penetration of digital payments in Ethiopia (i. e., the percentage of digital transactions to GDP) was about 7.4 % in 2019, while in Kenya, it was 43.4 % in 2020. The study further revealed that Ethiopia has low access to automated teller machines (ATMs), with only 5.29 ATMs per 100,000 people in 2021, compared to the Sub-Saharan Africa average of 6.94. Regarding money transactions using mobile phones, Ethiopia, despite being the second most populous country in Africa, falls far behind its neighbor, such as Kenya, whose mobile money transactions reached US\$ 109.9 billion compared to Ethiopia's US\$ 470 million. Although digital payment services are experiencing significant growth, in terms of value, volume, number of subscribers, and transactions per subscriber, with transactions reaching 1.6 trillion in 2022, the share of total assets transacted digitally remains relatively low compared to Kenya (Ethiopian Policy Studies Institute (PSI), 2024). Furthermore, only about 30.5 % of Ethiopians have a bank account (World Bank, NBE, & CSA, 2020). Notably, Ethiopia's rural areas are home to 81.4 % of the excluded adults.

Ethiopia is an ideal case study for exploring the socioeconomic and digital infrastructure determinants of digital payments in an emerging market context. First, as discussed above, the use of digital payments is very low, even compared to neighboring East African countries like Kenya, Uganda, and Tanzania (Mossie, 2022). The country's diverse socioeconomic landscape—characterized by significant income inequality, a large rural population, and varying levels of education—plays a crucial role in determining the adoption of new financial technologies, making Ethiopia a strong case for such research. Although Ethiopia's digital infrastructure is improving, its distribution remains uneven, with rural areas experiencing limited access to internet and mobile networks. These disparities provide a compelling setting for examining how socioeconomic and infrastructural challenges interact to influence digital payment adoption. Second, as part of a broader economic reform agenda, the government of Ethiopia prioritized the development of financial services which makes the country ideal for researching socioeconomic and technological infrastructure determinants of the adoption of digital payments. For example, Ethiopia's National Digital Payments Strategy (NDPS) 2021–2024 details an ambitious approach to how responsible digitization of payments in the country can drive greater efficiency in payment service delivery, transparency, financial inclusion, and inclusive growth. This study is particularly relevant for Ethiopia as the country continues to reform the telecommunication industry and expand access to mobile banking, encouraging financial inclusion. The findings of this study can have practical and theoretical applications for other developing economies with corresponding economic conditions, where the adoption of digital payment technologies is severely hampered by cash-based economies, poor banking penetration, and inadequate digital infrastructure. Also, achieving an inclusive digital payment system requires a holistic approach to understanding the barriers to the adoption and upscale of digital payments among the general population in the country. Thus, investigating how variations in socioeconomic characteristics and access

to digital infrastructure affect the use of digital payments is highly relevant and timely to realize NDPS in Ethiopia.

Our study builds on and expands prior research by targeting individuals from the general population, and thus offers a broader and more generalizable understanding of the factors influencing the uptake of digital payments in Ethiopia. Applying the Technology Acceptance Model (TAM) and the Covariance-Based Structural Equation Modeling (CB-SEM) framework, the study will provide empirical evidence on how the socioeconomic characteristics of individuals and access to digital infrastructure impact the adoption of digital payments by analyzing the direct and indirect interactions of socioeconomic characteristics and digital infrastructure with the adoption of digital payments. The application of CB-SEM allows us to investigate the direct and indirect effects of various factors on the adoption process. Practically, the findings of this study offer critical insights for evidence-based managerial decisions aimed at expanding digital infrastructure and the adoption of digital payments in Ethiopia. Specifically, this study provides valuable evidence for key stakeholders to enhance digital infrastructure addressing disparities in socioeconomic conditions and access to digital infrastructure in the country and tailor their marketing and educational campaigns to address specific barriers for adoption.

The remaining part of the paper is structured as follows. Section two presents the literature review. The third section outlines the methods and materials. Section four presents the results of the study. The discussion section is presented in section five. The final sections present the implications, limitations of the study, and directions for future research of the study.

2. Literature review

2.1. Theoretical literature

The technology adoption literature provides several theories, such as the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Diffusion of Innovation Theory (DIT), Theory of Planned Behavior (TPB), and Social Cognitive Theory. We opted for TAM primarily for two reasons. Firstly, our primary focus is on socioeconomic determinants and access to digital infrastructure rather than the characteristics of the technology itself, which is the primary focus of DIT. Moreover, our interest lies in the actual uptake of digital payments rather than the intentions behind their use, which is the primary focus of TPB. Although UTAUT and SCT are the other relevant theories that consider a broader array of factors, our scope is specifically limited to socioeconomic factors and digital infrastructure, making TAM more pertinent for our study purpose. Secondly, the practical relevance of TAM has also influenced our choice. This study leverages unique secondary data collected by the World Bank. Although the data collected by the World Bank only contains socioeconomic and technological infrastructure variables in categorical forms, the variables are reclassified to make them suitable for TAM. TAM offers a robust framework that contextualizes the digital payment adoption process in Ethiopia and adds to the understanding of how socioeconomic factors influence technology adoption in developing countries. TAM has been used to explore the acceptance of adoption of digital financial services and technologies (Almajali, Al-Okaily, Al-Daoud, Weshah, & Shaikh, 2022; Chawla & Joshi, 2019; Fajar & Fanuel, 2024; Igamo et al., 2024; Ogunmola & Das, 2024; Srivastava, Mohta, & Shunmugasundaram, 2024; Wong & Kwok, 2022; Yang, Yang, & Chang, 2023).

TAM proposes two major criteria that drive technology adoption: perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the degree to which an individual believes that using a specific system will enhance their job performance, while PEOU relates to the degree to which an individual believes that using a specific system will be effortless (Davis, 1989). Essentially, the decision to use an information system is made by weighing its perceived usefulness against the perceived difficulty of using it. These perceptions subsequently

influence the user's attitude towards using the technology, which then affects their behavioral intention to use the system and, ultimately, their actual usage behavior. Behavioral intention refers to a user's intention to use technology in the future, whereas actual use refers to the real-world application of technology. If an application is regarded as simple to use, the user is more likely to value it, increasing the likelihood of technological acceptance (Davis, 1989, 1993).

TAM's primary constructs, such as perceived usefulness and perceived ease of use, are typically measured in categorical scales but can also be adapted to binary outcomes. In this study, the goal is to understand factors influencing digital payment adoption, with binary outcomes (yes or no). The categorical variables, perceived usefulness, perceived ease of use, attitude to use, behavioral intention to use, and actual use, are used in the TAM framework. Specifically, ATM/debit card ownership was treated as part of the perceived usefulness construct, as these factors enhance the perceived benefits of digital payments. Internet access and mobile ownership were assigned to the perceived ease of use construct, given that access to the internet and owning a mobile phone simplifies the use of digital payments. However, the study did not include a separate attitude to use and behavioral intention construct as it focused on the actual adoption of digital payments, representing the actual use construct. The reason for this omission is that, due to the nature of the chosen variables, there were no variables available to measure the attitude to use and the intention to use. We assume that these constructs are implicit within the framework, and we developed the framework explicitly from the perceived ease of use and perceived usefulness constructs to the actual usage construct, as these are central to understanding how users engage with technology. This approach aligns with TAM's emphasis on actual system usage as a key outcome. Digital payment adoption, therefore, served as the actual use construct, capturing whether individuals had adopted digital payments. By integrating these categorical variables into TAM, a conceptual framework was developed as presented in Fig. 1.

2.2. Empirical literature and hypotheses

In this subsection, we provide a review of key empirical findings of primary interest – socioeconomic factors and access to digital infrastructure and draw some hypotheses based on the findings of these studies and knowledge of the digital finance landscape in Ethiopia. While previous studies provide valuable insights, they are less generalizable as they are limited in their scope and context as well as the dynamic nature of the digital landscape and the significance of socioeconomic factors in accessing digital infrastructure and adopting digital payments, particularly in developing countries like Ethiopia. In this study, the adoption of digital payments is defined as individuals' use of digital technologies to make payments, purchase items, send and receive money, and check their account balances within the past 12 months of the interview.

2.2.1. Socioeconomic characteristics and adoption of digital payments

Studies have shown that socioeconomic factors affect individuals' adoption of digital payments. According to a study by Ghosh and Hom Chaudhury (2022), income class, education, and gender are the most important variables influencing the use of digital financial services in India. Individuals in the high-income category and with high education levels and males tended to favor the use of digital financial services compared to their counterparts. Another study by Banerjee and Pradhan (2022) showed gender and education as the main factors determining the adoption of digital payment systems. Dzogbenuku, Amoako, Kumi, and Bonsu (2022) reported a significant difference between female and male users in digital payment usage, and across age groups regarding the use of digital payments. Age and income are also considered proxies for technology readiness (Abegao Neto & Figueiredo, 2023) and risk perceptions (Caldeira, Ferreira, Freitas, & Falcão, 2021) of individuals. In a study on determinants of digital payment adoption, Alnemer (2022)

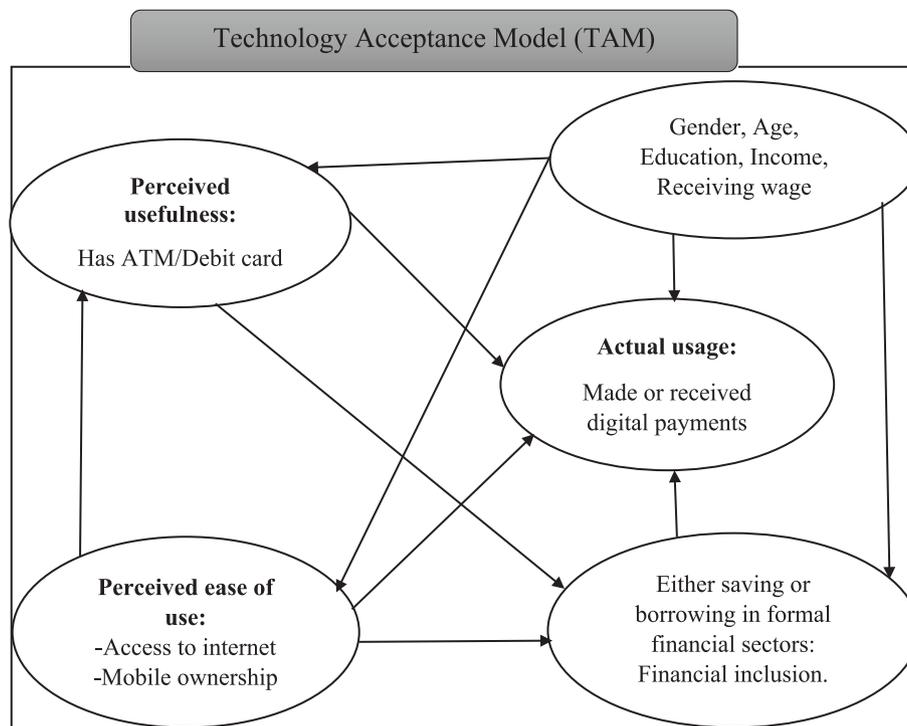


Fig. 1. Conceptual framework of the study.

found that the rate of digital banking adoption is higher among males compared to females. Customers aged 25–49 years are more likely to adopt digital banking. The analysis of educational profiles shows that adoption rates are highest among individuals with tertiary education, followed by those with secondary education. Additionally, the likelihood of adopting digital banking increases with the respondents' income levels. Furthermore, [Nokulunga and Klara \(2023\)](#) reported that wage income plays a significant positive role in participating in digital financial services and adopting digital payments.

Based on the above review and our understanding of the study context, we formulated the following hypotheses:

- H1.** The gender of an individual influences the decision to adopt digital payments.
- H2.** The age of an individual influences the decision to adopt digital payments.
- H3.** The educational level of an individual influences the decision to adopt digital payments.
- H4.** The income of an individual influences the decision to adopt digital payments.
- H5.** Receiving a wage payment influences the decision to adopt digital payments.

2.2.2. Engagement in formal financial transactions and adoption of digital payments

Engaging in formal financial transactions drives digital payment adoption, as digital financial services are provided by the formal financial sector and could be influenced by socioeconomic characteristics. A study by [Allen, Demircuc-Kunt, Klapper, and Peria \(2016\)](#) showed strong relationships between account ownership and income, education, age, and residential and marital status. On the other hand, [Desalegn and Yemataw \(2017\)](#) reported a non-linear relationship between age account ownership in formal financial institutions. In China, a study by [Fungáčová and Weill \(2015\)](#) showed a strong positive correlation between income and education, gender (being men) and age, and

account ownership and access to formal credits. In Ethiopia, a study based on data from a single region conducted by [Abdu and Adem \(2021\)](#) showed strong relationships between age, financial literacy, income and having a mobile banking account and participation in the formal financial services. Several other studies in Ethiopia and other African countries have also showed similar strong relationships between socioeconomic factors and participation in formal financial transactions ([Asuming, Osei-Agyei, & Mohammed, 2019](#); [Bekele, 2023](#); [Chinoda & Kwenda, 2019](#); [Mossie, 2022](#); [Prete, 2022](#)). However, the direction of relationships, the geographical scope of the study, and the variables of interest significantly vary among the studies.

Accordingly, based on our understanding of the study context and some empirical findings in various contexts, we constructed the following hypotheses.

- H6.** The gender of an individual influences engagement in formal financial transactions.
- H7.** The age of an individual influences engagement in formal financial transactions.
- H8.** The educational level of an individual influences engagement in formal financial transactions.
- H9.** The income of an individual influences the engagement in formal financial transactions.
- H10.** Receiving wage payments influence an individual's engagement in formal financial transactions.
- H11.** Engaging in formal financial transactions influences an individual's decision to adopt digital payments.

In addition to the potential direct effect, our study also analyzed the indirect effects (i.e., the mediating role of engagement in formal financial transactions) of socioeconomic characteristics on the adoption of digital payments. This relationship is rarely explored in prior studies. Accordingly, the following hypotheses were formulated:

- H12.** The impact of gender on the adoption of digital payments is mediated by engagement in formal financial transactions.

H13. The influence of age on the adoption of digital payments is mediated by engagement in formal financial transactions.

H14. The impact of education on the adoption of digital payments is mediated by engagement in formal financial transactions.

H15. The impact of income on the adoption of digital payments is mediated by engagement in formal financial transactions.

H16. The impact of receiving wages on the adoption of digital payments is mediated by engagement in formal financial transactions.

2.2.3. Mobile ownership and digital payments

Access to digital infrastructure such as mobile phones can cater to the needs of individuals at affordable cost, while also helping them reduce processing time and make more accurate and faster transactions. In this section, we review empirical studies that focused on the relationship between socioeconomic characteristics and mobile phone ownership, between mobile ownership and engagement in formal financial transactions, and in (direct) effect of access to mobile ownership on the adoption of digital payments to formulate our hypotheses.

Several studies have shown strong relationships between socioeconomic characteristics and mobile phone ownership; however, the direction of the relationships varies. Song, Wu, and Zou (2023) found a strong relationship between age, education, income, smarter phone ownership, and the adoption of a mobile payment system, with age having the largest marginal effect. A study by Warsame and Ileri (2018) showed how age and gender affect the use of M-Shwari loan services (i. e., mobile microfinance services) in Kenya. Similarly, Shaikh, Glavee-Geo, Karjaluoto, and Hinson (2023) showed how the use of mobile money services played a role in transforming traditional services to digital mobile money services in Ghana. A study by Nandru, Chendragiri, and Arulmurugan (2024) showed strong relationships between gender (being female), education (being in tertiary education), income (being in the third- and fourth-income quintile), wage income, and age (across age groups) and access to mobile money accounts in India.

Regarding relationships between mobile ownership and engagement in formal financial transactions, Ali and Ghildiyal (2023) found that individuals with mobile phone ownership and who had access to banks were more likely to engage in digital financial services. Likewise, some studies (e.g., Munikrishnan, Mamun, Xin, Chian, & Naznen, 2024; Nandru, Sa, & Chendragiri, 2023) have looked at the effect of access to mobile ownership on the adoption of digital payments directly or indirectly via engagement in formal financial transactions. Apparently, mobile phone ownership creates the opportunities to open bank accounts and obtain ATM/debit cards but does not guarantee the use of digital payment services as other factors discussed above and that follow are likely to play a critical role in individuals' decisions whether to adopt (or not) digital payments.

Based on the above review, we have formulated the following hypotheses to test them in the Ethiopian context.

H17. The gender of an individual influences mobile ownership.

H18. The educational status of an individual influences mobile ownership.

H19. The income of an individual influences mobile ownership.

H20. Receiving wages influences mobile ownership.

H21. Mobile ownership influences engagement in formal financial transactions.

H22. Mobile ownership influences the decision to adopt digital payments.

H23. The effect of mobile ownership on the adoption of digital payments is mediated by engagement in formal financial transactions.

2.2.4. Internet access and adoption of digital payments

Owning a mobile is not enough to engage in digital financial transactions and adopt digital payments, without access to internet services. However, individuals' access to the internet and the adoption of digital payments could also be influenced by several factors, including socioeconomic characteristics and level of engagement in formal financial transactions.

Several studies in various contexts have attempted to shed light on some of these relationships but their results are not always in agreement. A study by Sakib, Akter, Sahabuddin, and Fahlevi (2024) and Dieu, Al Mamun, Nguyen, and Naznen (2023) reported that facilitating conditions such as internet access have a significant influence on the adoption of cashless transactions. Chaudhuri, Flamm, and Horrigan (2005) and Reddick, Enriquez, Harris, and Sharma (2020) showed how socioeconomic characteristics play a vital role in determining an individual's access to the internet, either directly or indirectly. However, access to the internet may not lead to the use of digital financial services unless individuals engage in the formal financial transaction or adoption of digital payments. In this regard, some studies documented a strong and positive relationship between access to the internet and engagement in digital financial services (Mothobi & Kebotsamang, 2024), and between access to the internet and the uptake of digital payments (Niankara & Traoret, 2023). Thus, based on the above empirical evidence, the following main hypotheses were developed.

H24. Gender influences an individual's access to the internet.

H25. Educational status influences an individual's access to the internet.

H26. Income influences an individual's access to the internet.

H27. Receiving wage payments influences an individual's access to the internet.

H28. Internet access influences individuals' decision to engage in formal financial transactions.

H29. Internet access influences the decision to adopt digital payments.

H30. The effect of access to the internet on the adoption of digital payments is mediated by engagement in formal financial transactions.

2.2.5. Use of ATM/debit cards and adoption of digital payments

The use of digital payment cards such as ATM/Debit can be a key driver and determinant of digital payment adoption. As these variables represent the perceived usefulness variables in this study, adopting and using financial digital technologies could positively contribute to digital payment adoption. Previous studies have shown a positive relationship between the perceived usefulness of mobile banking on the adoption of mobile banking (Abdennebi, 2023) and digital banking adoption (Alnemer, 2022) or cashless transactions (Sakib et al., 2024).

Several studies, however, showed individuals' adoption and use of digital technologies such as ATM/Debit cards could be influenced by socioeconomic factors. A study conducted in India by Nandru et al. (2024) revealed that gender, tertiary education, third- and fourth-income quintile, and workforce have a significant association with ownership of payment cards. Similar findings were reported by Rahman, Ismail, and Bahri (2020), Menza et al. (2024), and Piotrowska (2024), highlighting the importance of sociodemographic characteristics of individuals in technology adoption.

In the Ethiopian context, the adoption and use of ATM/Debit cards are in the infancy stage (Adane, Wale, & Meried, 2021). These cards are primarily available to bank customers living in cities where major financial institutions operate (Worku, 2010). Despite the availability of ATM cards, not all customers adopt them for digital payments. This can be attributed to various factors, including demographic, social, economic, and institutional influences. Consequently, the adoption of ATM/Debit cards may have both direct and indirect effects on digital payment

adoption. Directly, these cards are digital payment technologies; indirectly, they may mediate the relationship between socioeconomic characteristics, formal financial transactions, mobile ownership, internet access, and the adoption of digital payments. Understanding these dynamics can help financial institutions and policymakers to develop targeted strategies to enhance digital payment adoption. In this sense using formal financial institutions to borrow or to save money, mobile ownership and internet access may influence digital payment through influencing access and adoption of ATM/Debit cards. According to Alkhwaldi et al. (2022), when the user of FinTech finds the technology to be beneficial, then they are expected to have better perceptions and intentions towards using it. Therefore, the following hypotheses were developed.

H32. The gender of an individual influences the adoption of ATM/Debit cards.

H33. The educational status of an individual influences the adoption of ATM/Debit cards.

H34. The income of an individual influences the adoption of ATM/Debit cards.

H35. Receiving wage payments influences the adoption of ATM/Debit cards.

H36. The use of ATM/Debit cards influences the adoption of digital payments.

H37. The effect of using formal financial transactions on the adoption of digital payments is mediated by individuals' use of ATM/Debit cards.

H38. The effect of mobile ownership on the adoption of digital payments is mediated by the use of ATM/Debit cards.

H39. The effect of internet access on the adoption of digital payments is mediated by the use of ATM/Debit cards.

Previous studies also examined the effect of receiving wage payments on both the use of formal financial institutions and the use and the adoption of digital financial technologies. A study by Nokulunga and Klara (2023) showed that receiving wage payments plays a significant positive role in participating in formal and informal financial transactions. Wages are important for saving and borrowing in the formal and informal sectors. Additionally, receiving wage may initiate an individual to own a mobile phone, to access internet services, and to adopt ATM/Debit cards because these instruments make wage receiving, and paying bills or taxes easy for the individual. Accordingly, the following hypotheses were developed.

H40. Educational level positively influences the receipt of wage payments.

H41. The effect of receiving wage payments on the adoption of digital payments is mediated by individuals' engagement in formal financial transactions.

H42. The effect of receiving wage payments on the adoption of digital payments is mediated by mobile ownership.

H43. The effect of receiving wage payments on the adoption of digital payments is mediated by access to the internet.

H44. The effect of receiving wage payments on digital payments is mediated by the adoption of ATM/Debit cards.

2.3. Summaries of empirical literature

In the digital finance adoption literature, numerous studies have examined the determinants of digital payment adoption in both developed and developing countries using various theoretical models of technology adoption. This study has reviewed and summarized these empirical studies in Table 1. The summary is organized by the core topic

covered by the study, the country where the study was conducted, the theoretical model employed, the main findings, the authors, and the publication year.

2.4. Conceptual framework

Based on the hypotheses developed above, the conceptual framework of this study, which will be analyzed using the SEM statistical technique, is presented below. The framework was developed in a simple manner, not in the way typically constructed in SEM analysis. When constructing the SEM structure, paths were established from one individual variable to another to identify the effect of each variable on the other. For example, each socioeconomic variable was linked to the dependent variables to analyze its individual impact (Fig. 1).

3. Methodology

3.1. Source of data

This study used cross-sectional data collected from the World Bank's 2021 Global Findex database. Based on nationally representative surveys of approximately 128,000 adults across 123 economies during the COVID-19 pandemic, the 2021 edition provides updated indicators on access to and usage of formal and informal financial services. This includes insights into the use of cards, mobile phones, and the internet for digital payments, encompassing the adoption of digital merchant and utility payments during the pandemic. The report also sheds light on behaviors that contribute to financial resilience. For the Ethiopian case, the data collection process involved face-to-face interviews. Primary sampling units were identified and stratified by population size, geography, or both. Sample selection was based on stratified random sampling, or simple random sampling where population information was unavailable to stratify the population. Random route procedures were used to select households. To increase the probability of contact, the interviewers would make up to three attempts at different times and days. A simple substitution method was employed if an interview could not be obtained. Detailed information on the data collection process can be found at [<https://www.worldbank.org/en/publication/globalfindex>].

The database contains survey data from 1000 randomly selected nationally representative samples in each country, gathered through a structured questionnaire. The targeted individuals are part of the adult population, based on the 2020 World Development Indicators (WDI). In addition to financial inclusion and digital payment indicators, the database offers information on the individual characteristics of the sampled individuals, including age, education, income, and gender. This provides an opportunity for econometric and descriptive analysis. Hence, we utilized these micro datasets to analyze digital payment adoption in a specific case—Ethiopia. Previous studies such as by Bekele (2023) and Mossie (2022) used the 2017 database of the Global Findex to study financial inclusion in Ethiopia.

3.2. Employed variables

3.2.1. Dependent variable

The main dependent variable of this study is defined as individuals' decision to adopt digital payments using digital technologies to make payments, purchase items, send and receive money, and check their account balances in the previous year. Therefore, a value of 1 was assigned if the respondent used mobile money, a debit or credit card, or a mobile phone to make a payment from an account or used the internet to pay bills or to buy something online or in a store, or paid bills or sent or received remittances directly from or into a financial institution account or through a mobile money account in the past year. It also includes respondents who received payments for agricultural products, government transfers, wages, or a public sector pension into a financial

Table 1
Summaries of empirical literature review.

Core topic	Theoretical model	Constructs/variables considered	Main findings	Author name & year
Digital banking adoption	TAM	PEOU, PU, Trust, demographics (gender, age, employment, education, income), adoption of mobile banking,	-Significant association between adoption of digital banking and demographic characteristics of customers -PEOU and PU positively and significantly influence digital banking adoption	Alnemer (2022)
Consumer adoption of cashless payment	UTAUT2	Performance expectancy (PE), Facilitating condition (FC), Social influence (SI), Innovativeness (IV), Perceived Technology security (PTS), and Hedonic motivation (HM).	-All the factors have a positive influence on the adoption of cashless payments	Rahman et al. (2020)
Determinants of ownership of payment cards, mobile money accounts, and government remittances of digital financial services	–	Gender, age, income, education, being in the workforce, and residential status of respondents	-Female, tertiary education, income for all quintiles, and workforce, are more likely to use DFSs	Nandru et al. (2024)
Adoption of cashless transactions	Extended UTAUT	PU, PEOU, facilitating conditions, perceived security/trust and social influence	-PU, facilitating conditions, perceived trust/security, and social influence have a significant influence on consumer intentions towards cashless transactions.	Sakib et al. (2024)
Intention and adoption of cashless payment	UTAUT	Perceived trust (PTR), lifestyle compatibility (LCM), performance expectancy, effort expectancy, and facilitating conditions	- Performance expectancy, effort expectancy, facilitating conditions, LCM and PTR have positive and significant effects on the intention to adopt cashless payment	Dieu et al. (2023)
M-banking adoption	TAM	PEOU, PU, perceived security, M-banking Adoption Intention	-PEOU and PU are significant in influencing M-banking adoption intention.	Abdennebi (2023)
Adoption intention of mobile QR code payment system	UTAUT	Digital financial literacy (DFL), personal innovativeness (PI), and perceived trust (PT)	- Performance expectancy, effort expectancy, facilitating conditions, PT, and customers' DFL are significant determinants of intention to use QR code m-payment services.	Nandru et al. (2023)
Intention and adoption of cashless payment	UTAUT	-Performance expectancy (PE), lifestyle compatibility (LC), Perceived security (PS), effort expectancy (EE), social influence, intention to adopt cashless payment, adoption of cashless payment (ACP)	- PE, LC and PS had a positive and substantial effect on ICP. -Experience had moderating effects on the associations between PE and ICP	Munikrishnan et al. (2024)
Adoption of mobile payments	UTAUT	-Age, gender, experience and voluntariness Effect of Age and Income	- Income positively moderates the performance expectation and negatively moderates the perceived cost and perceived risk. - Age positively moderates performance expectations and negatively moderates cost perception	Abegao Neto and Figueiredo (2023)
Adoption of mobile payment	Technology readiness (TR)	Perceived ease of use, perceived usefulness, perceived quality and trust, age and, income	- Age and income negatively affect costs and risk perceptions leading to the assumption that these audiences are more resistant to switching to emerging technology such as mobile payments.	Caldeira et al. (2021)
Adoption of digital financial services and digital financial inclusion	–	Socio-economic characteristics, mobile phone ownership, banking behavior,	- Male with higher age, education, working status, and higher income are more likely to adopt digital financial services. - Individuals with mobile phone ownership and utilizing banking in terms of borrowings and savings are more likely to adopt digital financial services.	Ali and Ghildiyal (2023)
Network coverage and adoption of fintech	–	Mobile network coverage, adoption of financial technologies, and financial inclusion	- A significant and positive relationship between network coverage and the adoption of digital financial services.	Mothobi and Kebotsamang (2024)
Digital finance	–	Wages, government transfers, remittances, borrowing and saving, digital transactions	- Electronic transfer of wages, government transfers, and remittances can motivate individuals to make use of digital modes of transactions and mobile - Women are lagging behind men, but the digital transfer of wages motivates them to make digital transactions.	Chatterjee (2024)
Digital payment-financial inclusion nexus and payment system innovation	–	Formal account, digital payment, mobile money account, debit card, credit card, emergency fund, wage, saving and borrowing, and socioeconomic variables	- Formal financial inclusion had a significantly positive impact on the likelihood that individuals use digital payment solutions (DPS) for in-store and online shopping experience - DPS uptake for online shopping highlighted a significant gender-based gradient in favor of males. - Higher education levels, labor market participation, rising income levels, reduced COVID-19 related financial worries, mobile phone ownership, and internet access, are all found to have positively contributed to individuals' DPS uptake likelihood	Niankara and Traoret (2023)

Note: TAM: Technology Acceptance Model; UTAUT: Unified Theory of Acceptance and Use of Technology; UTAUT2 an extension of the original Unified Theory of Acceptance and Use of Technology (UTAUT) with addition of hedonic motivation construct; DOI: Diffusion of Technology; TR: Technology Readiness.

institution account or through a mobile money account in the past year. A value of 0 was assigned if the respondent did not make or receive a digital payment. Other variables that are considered as dependent variables were an individual’s engagement in formal financial transactions (either saving or borrowing in formal financial institutions), mobile ownership, internet access, ATM/Debit card, and receiving wages.

3.2.2. Independent variables

Keeping the nature of the interdependence of the variables based on the assumption that engagement in formal financial transactions, mobile ownership, internet access, and ATM/debit card will affect one another, these variables are also considered as explanatory variables for one another. The other explanatory variables that were postulated to influence the dependent variables were socioeconomic variables such as gender, age, education, individual’s income quintiles, and receiving wages payments.

3.3. Description of employed explanatory variables

Based on the 2021 World Bank Findex database, the variables employed in this study are presented in Table 2. Engagement in formal financial transactions (FoFTR) variable is constructed from two variables from the database: saving in formal financial sectors and borrowing from formal financial sectors. If an individual either saves or borrows, or both from the formal financial sector, then he/she is said to be engaged in formal financial transactions. The other variables are described and defined based on the 2021 Global Findex Microdata Codebook labeling and definition.

3.4. Model specification

3.4.1. Covariance based (CB) - structural equation modeling (SEM)

To determine the factors influencing digital financial inclusion, probability models could provide the likelihood estimates to understand the effects of the explanatory variables on the dependent variable. However, this study hypothesized that the explanatory variables are interrelated to each other, which initiates us to estimate the direct and indirect effects of these explanatory variables on digital financial inclusion, and the other dependent variables. To do this, we conducted SEM (Path and mediation) analysis to understand the direct and indirect effects. SEM determines the dependence or independence of the variables through the integration of linear equations (Viloria, Lezama, & Mercado, 2019).

Covariance-based (CB)-SEM and Partial Least Squares (PLS)-SEM are the two widely used methods of SEM. The first approach is based on covariance, and the second approach is based on variance (least squares). Both methods are equally effective for developing and analyzing structural relationships (Dash & Paul, 2021). However, there are differences between the two. If the research objective is theory testing and confirmation, then the appropriate method is CB-SEM. In contrast, if the research objective is prediction and theory development, then PLS-SEM is more suitable.

The goal of our research is to examine the structural relationships between categorical variables that represent socioeconomic characteristics and digital infrastructures. Conceptually and practically, PLS-SEM is like multiple regression analysis, typically used for continuous or ordinal variables. However, the categorical variables in this study can be best analyzed using a logit model within the SEM framework, making CB-SEM more appropriate. Another advantage of CB-SEM is its suitability for complex models with multiple variables and pathways. It allows for testing and estimating direct and indirect effects among observed variables simultaneously. Since this study tests complex hypotheses about relationships between variables while considering

Table 2
Description of variables.

Name of the variable	Type	Description
Gender	Categorical	= 1 if the respondent is female; = 2 if the respondent is male
Age	Continuous	Age of the respondents
Education	Categorical	= 1 if the respondent has completed primary school or less; = 2 if the respondent has completed secondary school; = 3 if the respondent has completed tertiary education or more
Within-economy household income quintile (Income)*	Categorical	= 1 if individual income is in the first 20 % quintile (poorest1st); = 2 if individual income is in the second 20 % quintile (poorest2nd); = 3 if individual income is in the third 20 % quintile (middle); = 4 if individual income is in the fourth 20 % quintile (Richest2nd); = 5 if individual income is in the richest 20 % quintile (Richest1st)
Receive wages (ReWAGE)	Categorical	= 1 if the respondent receives a wage payment; = 0 if the respondent did not receive a wage payment
Owns a mobile phone (MoOWN)	Categorical	= 1 if the respondent owns a mobile phone = 2 if no = 3 if don’t know = 4 if refused to answer
Internet access (IntACC)	Categorical	= 1 if the respondent has access to the Internet = 2 if no = 3 if don’t know = 4 if refused to answer
Has a ATM/Debit card	Categorical	= 1 if the respondent has an ATM/debit card = 2 if no = 3 if don’t know = 4 if refused to answer
Engagement in formal financial transaction (FoFTR)	Categorical	= 1 if the respondent either save in or borrow from formal financial sectors = 0 if the respondent neither save nor borrow from formal financial sectors

* This variable assigns respondents to one of five income quintiles based on their self-reported household income compared to other households in the same economy. This may include inquiries about total household incomes from various sources, such as wages, business income, remittances, and other financial resources.

measurement error and model fit, CB-SEM is the more robust framework.

Additionally, CB-SEM is applicable when the existing theory needs to be tested and confirmed, whereas PLS-SEM is used for prediction purposes and theory development (Dash & Paul, 2021). Moreover, CB-SEM provides various fit indices that help assess how well the proposed model fits the data. These indices provide quantitative measures of model fit, allowing for the evaluation of the adequacy of the theoretical model. It also provides standardized coefficients that facilitate the interpretation of the strength and direction of relationships between variables, which is particularly useful for understanding the relative importance of different pathways and variables in the model.

CB-SEM is grounded in statistical theory, allowing for rigorous hypothesis testing. It provides p-values for individual parameters and overall model fit tests (e.g., LR test), which are crucial for making statistical inferences about relationships. Therefore, based on our analysis needs, data characteristics, and research objectives, CB-SEM was chosen for this analysis. This method provides robust statistical inference, fit

indices, and standardized coefficients that support rigorous hypothesis testing and interpretation of relationships within the SEM framework.

Based on the hypothesis, including the main dependent variable, we formed six equations for six dependent variables; digital payments, engagement in formal financial transactions, mobile ownership, ATM/Debit card, internet access, and receive wage. Accordingly, the structural equations were formulated as follows:

$$DiPAP(Y_1) = \beta_1 Gend + \beta_2 Age + \beta_3 Educ + \beta_4 Income + \beta_5 FoFTR + \beta_6 MoOWN + \beta_7 IntACC + \beta_8 AtmDEB + \beta_9 ReWAGE + \epsilon_i \tag{1}$$

$$FoFTR(Y_2) = \beta_1 Gend + \beta_2 Age + \beta_3 Educ + \beta_4 Income + \beta_5 MoOWN + \beta_6 IntACC + \beta_7 ReWAGE + \epsilon_i \tag{2}$$

$$MoOWN(Y_3) = \beta_1 Gend + \beta_2 Educ + \beta_3 Income + \beta_4 ReWAGE + \epsilon_i \tag{3}$$

$$IntACC(Y_4) = \beta_1 Gend + \beta_2 Educ + \beta_3 Income + \beta_4 MoOWN + \beta_5 ReWAGE + \epsilon_i \tag{4}$$

$$AtmDEB(Y_5) = \beta_1 Gend + \beta_2 Educ + \beta_3 Income + \beta_4 FoFTR + \beta_5 MoOWN + \beta_6 ReWAGE + \beta_7 IntACC + \epsilon_i \tag{5}$$

$$ReWAGE(Y_6) = \beta_1 Educ + \epsilon_i \tag{6}$$

To enhance the goodness of fit for the SEM model and considering the limited explanatory power of the effect of the five-income quantile on possessing an ATM/Debit card, we opted to remove the path from income to ATM/Debit card. Additionally, we excluded the variable ‘Age’ from all paths except those connecting the digital payment adoption’ and ‘Engagement in formal financial transactions’ variables. The estimation of the parameters in these equations was conducted using the SEM builder in STATA (version 14), allowing us to determine the direct, indirect, and total effects of each variable on the dependent variables.

3.4.2. Descriptive statistics

The survey results reveal a demographic distribution with 54 % of respondents identified as females and 46 % as males, with an average age of 32 years. In terms of educational attainment, approximately 65 % completed primary school or less. The remaining 30 % and 5 % of respondents have completed secondary school and tertiary education, respectively. Examining the income quantile, 25 % of respondents fall into the richest 20 % quintile (richest 1st), while 21 % fall into the fourth 20 % quantile (richest 2nd). The third 20 % quantile (middle), second 20 % quantile (poorest 2nd), and poorest 20 % quantile (poorest 1st) account for 19 %, 19 %, and 16 %, respectively (Table 3). Notably, the majority, comprising 85 % of respondents, do not receive wages, whereas the remaining 15 % receive wage payments.

Examining digital transactions, 74 % of respondents did not make or receive digital payments, while only 26 % engaged in such transactions. Mobile phones were owned by 60 % of the respondents, and the remaining 40 % did not own this technology. Additionally, only 20 % have internet access, and the majority (77 %) do not, with 3 % responding “I don’t know”. In terms of financial tools, 76 % lack an ATM/Debit card, while only 18 % possess one. Regarding formal financial transactions, encompassing savings or borrowing in formal financial institutions, only 27 % of respondents engaged in such activities, with the majority (73 %) did not use these formal transactions (Table 3).

4. Results

4.1. Diagrammatic structure and fit indices of the SEM model

Before diving into the effect analysis of the regression results, this

Table 3
Descriptive results of the chosen variables for the study.

Variable	Categories	Percentage/average
Gender	Female	54 %
	Male	46 %
Age	Year	32 years
	Education	Completed primary school or less
Education	Completed secondary school	30 %
	Completed tertiary education or more	5 %
	Income quantile	Richest
Income quantile	Richest2nd	21 %
	Middle	19 %
	Poorest2nd	19 %
	Poorest1st	16 %
	Receive wage payment	Yes
Receive wage payment	No	85 %
	Made or received a digital payment	Make or receive digital payment
Made or received a digital payment	Did not make or receive digital payments	74 %
	Owns a mobile phone	Yes
No		40 %
Internet access	Yes	20 %
	No	77 %
	Don’t know	3 %
Has ATM/Debit card	Yes	18 %
	No	76 %
	I don’t know	6 %
Using formal financial transaction	Yes	27 %
	No	73 %

section presents the diagrammatic structure of the SEM model and the fit indices. Fig. 2 shows the diagrammatic structure of the built SEM model, which reveals the connected paths between the explanatory variables and the dependent variable, and among the explanatory variables themselves that help to identify their interdependence and their effect on the dependent variable.

Based on the estimation of the fit statistics, the RMSEA value is 0.05 with 0.461 Probability of RMSEA (Pclose) ≤ 0.05. According to Blunch (2012), the model is regarded as a good fit where the RMSEA is 0.08 or less. Since the 0 ≤ RMSEA ≤ 0.08, the model is a perfect fit (Haagen, Moerbeek, Olde, Van Der Hart, & Kleber, 2015). The Comparative fit index (CFI) and Tucker-Lewis’s index (TLI) were 0.914 and 0.982, respectively. Since 0.90 ≤ CFI < 1.00 and 0.90 ≤ TLI < 1.00, the model has an acceptable fit (Haagen et al., 2015). The last index is the standardized root mean squared residual (SRMR) with a value of 0.020 which is 0 ≤ SRMR < 0.05 that shows a perfect fit of the model.

4.2. Standardized coefficient estimation

This section presents the standardized estimation results of the SEM analysis. As depicted in Table 4, on average a one-standard-deviation increase in using formal financial transactions is correlated with a 0.215 standard deviation increase in the likelihood of making or receiving digital payments. This relationship demonstrates statistical significance at the 1 % level. Similarly, a one-standard-deviation increase in mobile ownership is associated with a 0.096 standard deviation increase in the likelihood of digital payments, with the relationship achieving statistical significance at α = 0.01 (Table 4). Moreover, a one-standard-deviation increase in receiving wage payments is linked to a 0.128 standard deviation increase in the likelihood of making or receiving digital payments, reaching statistical significance at the 1 % level (Table 4). On average, a one-standard-deviation increase in access to the internet is associated with a 0.080 standard-deviation increase in the likelihood of making or receiving digital payments, and this relationship is statistically significant at the 1 % level (Table 4).

The possession of an ATM/Debit card demonstrates a significant relationship with the likelihood of making or receiving digital payments,

Table 4
Determinants of digital payment adoption.

Standardized	Coefficient	P-value
Made or received digital payments		
Using formal financial transaction (Yes dummy)	0.215	<0.001***
Mobile ownership (Yes dummy)	0.096	<0.001***
Receive wage (Yes dummy)	0.128	<0.001***
Internet access (Yes dummy)	0.080	0.010***
Has ATM/Debit card	0.282	<0.001***
Age (in years)	0.099	<0.001***
Education (Secondary)	0.102	<0.001***
Education (Tertiary dummy)	0.079	<0.001***
Gender (Female dummy)	0.021	0.409
Income (Richest1st)	0.013	0.729
Income (Richest2nd)	-0.059	0.088*
Income (middle quantile)	-0.013	0.709
Income (Poorest2nd)	-0.007	0.822
Constant	-0.193	0.055*

***, and * represent significance at the 1 % and 10 % levels, respectively.

Table 5
Determinants of using formal financial transaction.

Relationships	Coefficients	P-value
Using Formal Financial Transaction		
Mobile ownership (Yes dummy)	0.162	<0.001***
Receive wage (Yes dummy)	0.081	0.014**
Internet access (Yes dummy)	0.105	<0.001***
Age (in years)	0.018	0.560
Education (Secondary or less dummy)	0.023	0.502
Education (Tertiary dummy)	0.039	0.259
Gender (Female dummy)	-0.088	<0.001***
Income (Richest1st)	0.145	<0.001***
Income (Richest2nd)	0.123	<0.001***
Income (middle quantile)	0.102	0.011**
Income (Poorest2nd)	0.079	0.044**
Constant	0.124	0.309

***, and ** represent significance at the 1 % and 5 % levels, respectively.

Table 6
Determinants of mobile ownership and receiving wage payment.

Relationships	Coefficients	P-value
Mobile ownership (Yes dummy)		
Receive wage (Yes dummy)	0.123	<0.001***
Education (Secondary dummy)	0.216	<0.001***
Education (Tertiary dummy)	0.120	<0.001***
Gender (Female dummy)	-0.110	<0.001***
Income (Richest1st)	0.249	<0.001***
Income (Richest2nd)	0.238	<0.001***
Income (middle quantile)	0.200	<0.001***
Income (Poorest2nd)	0.119	<0.001***
Constant	0.719	<0.001***
Receive wage (Yes dummy)		
Education (Secondary dummy)	0.247	<0.001***
Education (Tertiary dummy)	0.322	<0.001***
Constant	0.197	<0.001***

*** Represents significance at the 1 % level.

education plays in an individual’s employment status, be it in the government or NGOs. As depicted in Table 6, receiving a wage, holding a secondary education, and possessing a tertiary education all significantly increase the likelihood of owning a mobile phone, with standard deviation increases of 0.123, 0.216, and 0.120, respectively. These effects are strongly significant at the 1 % level (Table 6).

The female gender (indicated by a dummy variable) exhibits a negative and significant ($p < 0.01$) impact on mobile ownership, correlating with a 0.110 standard deviation decrease in the likelihood of owning a mobile phone. Examining income quantiles, individuals in the

richest 20 % quantile (richest 1st), the fourth 20 % quantile (richest 2nd), the third 20 % quantile (middle), and the second 20 % quantile (poorest 2nd) all experience an increase in the likelihood of owning a mobile phone, with standard deviation increases of 0.249 ($p < 0.01$), 0.238 ($p < 0.01$), 0.200 ($p < 0.01$), and 0.119 ($p < 0.01$), respectively (Table 6). Furthermore, being a holder of secondary or tertiary education increases the likelihood of receiving wage payments by standard deviations of 0.247 and 0.322, respectively, and both influences are statistically significant at the 1 % level (Table 6).

The study also considered other variables, namely an individual’s access to the internet and whether an individual possesses an ATM/Debit card. As outlined in Table 7, mobile ownership, receiving wages, being a secondary education holder, and holding tertiary education credentials all positively and significantly influence the likelihood of an individual’s access to the internet, with statistical significance observed at the 1 % level in each case. However, being female is associated with a decrease in the likelihood of internet access by 0.045 standard deviation, and this effect is marginally significant at the 10 % level (Table 7). Additionally, individuals with an annual income in the richest 20 % quantile (Richest 1st) and the fourth 20 % quantile (Richest 2nd) experience an increase in the likelihood of internet access by standard deviations of 0.177 ($p < 0.01$) and 0.06 ($p < 0.1$), respectively (Table 7).

The possession of an ATM/Debit card is influenced by various factors, including the use of formal financial transactions, mobile ownership, receiving wages, internet access, education, and gender. As illustrated in Table 7, a one standard deviation increase in using formal financial transactions is associated with a 0.165 ($p < 0.01$) standard deviation increase in the likelihood of having an ATM/Debit card. Similarly, a one standard deviation increase in mobile ownership correlates with a 0.162 ($p < 0.01$) standard deviation increase in the likelihood of possessing an ATM/Debit card. Receiving wages sees a one standard deviation increase associated with a 0.129 ($p < 0.01$) standard deviation increase in the likelihood of having an ATM/Debit card. Furthermore, being a secondary or tertiary education holder increases the likelihood of having an ATM/Debit card by standard deviations of 0.148 ($p < 0.01$) and 0.227 ($p < 0.01$), respectively. Regarding gender, being female is associated with a decrease in the likelihood of having an ATM/Debit card by a standard deviation of 0.095, and this effect is significant at the 1 % level (Table 7).

4.3. Mediation analysis

This section delves into the mediation analysis of the determinants of

Table 7
Determinants of Internet access and having ATM/Debit card.

Relationships	Coefficients	P-value
Internet access (Yes dummy)		
Mobile ownership (Yes dummy)	0.162	<0.001***
Receive wage (Yes dummy)	0.129	<0.001***
Education (Secondary)	0.264	<0.001***
Education (Tertiary dummy)	0.293	<0.001***
Gender (Female dummy)	-0.045	0.090*
Income (Richest1st)	0.177	<0.001***
Income (Richest2nd)	0.060	0.064*
Income (middle quantile)	0.049	0.157
Income (Poorest2nd)	0.006	0.869
Constant	-0.113	0.132
Has ATM/Debit card		
Using formal financial transactions (Yes dummy)	0.165	<0.001***
Mobile ownership (Yes dummy)	0.102	<0.001***
Receive wage (Yes dummy)	0.125	<0.001***
Internet access (Yes dummy)	0.175	<0.001***
Education (Secondary or less dummy)	0.148	<0.001***
Education (Tertiary dummy)	0.227	<0.001***
Gender (Female dummy)	-0.095	<0.001***
Constant	0.056	0.313

***, and * represent significance at the 1 % and 10 % levels, respectively.

Table 8
The mediation effects of determinants on digital payment adoption.

Digital financial inclusion→	Indirect effects	RIT	RID	Mediation paths
Gender →formal financial transaction →	-0.019 [0.007]***	7.56	0.88	Complete
Gender →Mobile ownership→	-0.012 [0.009]***	1.16	0.54	Complete
Gender →Internet access →	-0.004 [0.157]	0.20	0.17	No
Gender →Has ATM/Debit card →	-0.027 [0.001]***	4.91	1.26	Complete
Age →Formal financial transaction →	0.004 [0.561]	0.04	0.04	No
Secondary education →Formal financial transaction →	0.005 [0.503]	0.05	0.05	No
Secondary education →mobile ownership →	0.022 [0.002]***	0.17	0.21	Partial
Secondary education → Internet access →	0.021 [0.013]**	0.17	0.21	Partial
Tertiary education → formal financial transaction→	0.008 [0.263]	0.09	0.10	No
Tertiary education → Mobile ownership →	0.012 [0.009]***	0.14	0.16	Partial
Tertiary education→ Internet access →	0.024 [0.013]**	0.23	0.29	Partial
Tertiary 00education → Has ATM/Debit card→	0.064 [0.000]***	0.45	0.45	Partial
Income (Richest1st) → Formal financial transaction→	0.031 [0.002]***	0.71	2.43	Complete
Income (Richest1st) → Mobile ownership→	0.025 [0.002]***	0.66	1.94	Complete
Income (Richest1st) → Internet access→	0.014 [0.024]**	0.52	1.11	Complete
Income (Richest2nd) → formal financial transaction→	0.026 [0.005]***	0.80	0.44	Complete
Income (Richest2nd) → mobile ownership→	0.024 [0.002]***	0.67	0.40	Complete
Income (Richest2nd) → Internet access→	0.005 [0.133]	0.09	0.09	No
Income (middle quantile) → formal financial transaction→	0.022 [0.015]**	2.36	1.74	Complete
Income (middle quantile) → Mobile ownership→	0.020 [0.004]***	2.70	1.58	Complete
Income (middle quantile) → Internet access→	0.004 [0.215]	0.46	0.31	No
Income (Poorest2nd) → Formal financial inclusion→	0.017 [0.051]*	1.78	2.28	Partial
Income (Poorest2nd) → Mobile ownership→	0.012 [0.020]**	2.72	1.58	Complete
Income (Poorest2nd) → Internet access →	0.000 [0.869]	0.07	0.06	No
Receive wage → Formal financial transaction →	0.017 [0.018]**	0.12	0.14	Partial
Receive wage → Mobile ownership →	0.012 [0.009]***	0.09	0.09	Partial
Receive wage → Internet access →	0.010 [0.025]**	0.08	0.08	Partial
Receive wage → Has ATM/Debit card →	0.035 [0.000]***	0.22	0.28	Partial
Mobile ownership → Formal financial transaction →	0.031 [0.000]***	0.258	0.348	Partial
Internet access → Formal financial transaction →	0.025 [0.007]***	0.220	0.281	Partial
Mobile ownership → Internet access →	0.012 [0.019]**	0.116	0.131	Partial
Formal financial transaction → Has ATM/Debit card →	0.046 [0.000]***	0.178	0.217	Partial
Mobile ownership → Has ATM/Debit card →	0.026 [0.001]***	0.224	0.289	Partial
Internet accesses → Has ATM/Debit card →	0.055 [0.000]***	0.381	0.616	Partial

***, and ** represent significance at the 1 % and 5 % levels, respectively. The values in parentheses are the p-values. RIT and RID represent the “ratio of indirect to total effect” and “ratio of indirect to direct effect”.

making or receiving digital payments, employing the Sobel test as a statistical measure for assessing mediating effects. As presented in Table 8, the indirect effect of gender on making or receiving digital payments operates through using formal financial transactions, and this effect is significantly ($p < 0.01$) negative. The indirect effect of gender on making or receiving digital payments through using formal financial transactions is 7.56 times larger than the total effect and 0.88 times larger than the direct effect. Additionally, the indirect effect of gender on making or receiving digital payments through mobile ownership and ATM/Debit card was negative, and the effect was statistically significant ($p < 0.01$). The indirect effect of gender on making or receiving digital payments through influencing mobile ownership is 1.16 times larger than the total effect and 0.54 times larger than the direct effect. Similarly, the indirect effect of gender on making or receiving digital payments through influencing the possession of an ATM/Debit card is 4.91 times larger than the total effect and 1.26 times larger than the direct effect (Table 8).

The impact of an individual’s education status on making or receiving digital payments undergoes mediation through various factors, including mobile ownership, internet access, possessing an ATM/Debit card, and the act of making or receiving digital payments itself. Examining the results in Table 8, the indirect effect of secondary education on making or receiving digital payments, mediated by mobile ownership, is 0.17 times larger than the total effect and 0.21 times larger than the direct effect. This mediation is statistically significant at the 1 % level (Table 8). Similarly, the indirect effect of individuals with secondary education on making or receiving digital payments, mediated by internet access, is 0.17 times larger than the total effect and 0.21 times larger than the direct effect, with statistical significance at the 1 % level (Table 8).

Moving on to tertiary education, its impact on making or receiving digital payments is significantly ($p < 0.01$) mediated by mobile ownership, with the indirect effect being 0.14 times larger than the total effect and 0.16 times larger than the direct effect (Table 8). Furthermore, possessing an ATM/Debit card acts as a mediator between tertiary education and digital payments, demonstrating statistical significance at the 1 % level. The indirect effect of being a tertiary education holder on making or receiving digital payments, through influencing the possession of an ATM/Debit card, is 0.45 times larger than the total effect and 0.45 times larger than the direct effect (Table 8). Additionally, access to the internet serves as a mediator in the relationship between tertiary education and making or receiving digital payments, with statistical significance at the 1 % level. The indirect effect of being a tertiary education holder on making or receiving digital payments, mediated by access to the internet, is 0.24 times larger than the total effect and 0.29 times larger than the direct effect (Table 8).

Individuals’ annual income status indirectly shapes the dynamics of making or receiving digital payments by exerting influence on several key variables. Specifically, being an individual with an annual income in the richest 20 % quantile (Richest 1st) significantly impacts making or receiving digital payments indirectly through its influence on formal financial transactions, mobile ownership, and internet access with $p < 0.01$, $p < 0.01$, and $p < 0.05$, respectively (Table 8). Delving into the details presented in Table 8, the indirect effect of being an individual whose income is in the richest 20 % on making or receiving digital payments through influencing formal financial transactions is notably substantial. This effect is 0.71 times larger than the total effect and a striking 2.43 times larger than the direct effect (Table 8). Similarly, the indirect effect of income status on making or receiving digital payments through influencing mobile ownership is 0.66 times larger than the total effect and 1.94 times larger than the direct effect. Additionally, the indirect effect of being in the richest 20 % income bracket on making or receiving digital payments through influencing access to the internet is 0.52 times larger than the total effect and 1.11 times larger than the direct effect (Table 8).

Being an individual, whose income is in the fourth 20 % quantile has

a noteworthy and significant indirect influence on making or receiving digital payments, primarily through shaping the dynamics of using formal financial transactions and mobile ownership, both at the 1 % level. Examining the details reveals that the indirect effect through influencing the likelihood of using formal financial transactions is striking. It is 0.80 times larger than the total effect and a substantial 0.44 times larger than the direct effect. Similarly, through influencing mobile ownership, the indirect effect of being an individual with annual income in the fourth 20 % quantile is 0.67 times larger than the total effect and 0.40 times larger than the direct effect in the context of making or receiving digital payments (Table 8).

Moreover, using formal financial transactions and mobile ownership play significant mediating roles in the relationship between individuals with annual income in the middle-income quantile. Both mediating effects are statistically significant at the 5 % and 1 % level, respectively. The mediating effect of using formal financial transactions between middle-income individuals and making or receiving digital payments is 2.36 times larger than the total effect and 1.74 times larger than the direct effect. Similarly, the mediating effect of mobile ownership on the relationship between individuals with annual income in the fourth 20 % quantile and making or receiving digital payments is 2.70 times larger than the total effect and 1.58 times larger than the direct effect (Table 8). Furthermore, the effect of being an individual with annual income in the second 20 % quantile (poorest 2nd) is significantly ($p < 0.1$) mediated by using formal financial transactions, with the effect being 1.78 times larger than the total effect and 2.28 times larger than the direct effect. Similarly, being an individual with annual income in the second 20 % quantile is completely mediated by mobile ownership, with its effect being 2.72 times larger than the total effect and 1.58 times larger than the direct effect (Table 8).

The impact of receiving wage payments on making or receiving digital payments undergoes partial mediation through various factors, including using formal financial transactions, mobile ownership, internet access, and possessing an ATM/Debit card. Examining the detailed results in Table 8, the indirect effect of receiving wage payments on making or receiving digital payments through influencing the use of formal financial transactions is 0.12 times larger than the total effect and 0.14 times larger than the direct effect. Furthermore, the indirect effect through influencing mobile ownership is 0.09 times larger than the total effect and 0.09 times larger than the direct effect. The indirect effect through influencing access to the internet is 0.08 times larger than the total effect and 0.08 times larger than the direct effect. Lastly, the indirect effect through influencing the possession of an ATM/Debit card is 0.22 times larger than the total effect and 0.28 times larger than the direct effect (Table 8).

The interdependence between the variables other than the main dependent variable (digital payment) and their mediation effects are presented in Table 9. The indirect effect of gender on formal financial transactions was negative and significant at the 1 % significance level suggesting gender influences formal financial transactions through its impact on mobile ownership. Specifically, lower mobile ownership among males leads to a decrease in formal financial transactions (such as borrowing or saving money in formal institutions), as indicated by the significant indirect effect. The indirect effect of gender on formal financial transactions through ownership of mobile phones is 0.175 times larger than the total effect and 0.212 times larger than the direct effect. Partial mediation implies that while mobile ownership is a crucial factor, other variables also contribute to the relationship between gender and formal financial transactions (Table 9).

There is a significant and negative indirect effect of gender on internet access through mobile ownership at the 1 % level of significance, which indicates that gender differences in mobile ownership fully explain disparities in internet access. The negative coefficient suggests that males have lower rates of mobile phone ownership, leading to reduced internet connectivity. The indirect effect of gender on internet access through influencing mobile ownership is 0.296 times larger than

Table 9
Interdependence between explanatory variables, and their mediation paths.

Relationships	Indirect	RIT [RID]	Mediation paths
Gender →mobile ownership→ formal financial transaction	-0.019 [0.002]***	0.175 [0.212]	Partial
Gender →mobile ownership→ Internet access	-0.019 [0.001]***	0.296 [0.421]	Complete
Gender →mobile ownership → Has ATM/Debit card	-0.012 [0.008]***	0.110 [0.124]	Partial
Gender →Internet access → Formal financial transaction	-0.005 [0.144]	0.050 [0.053]*	No
Gender →Internet access → Has ATM/Debit card	-0.008 [0.105]	0.076 [0.082]*	No
Age →formal financial transaction →Has ATM/Debit card	0.003 [0.562]	-	-
Secondary education →formal financial transaction →Has ATM/Debit card	0.004 [0.504]	0.025 [0.026]**	No
Secondary education →mobile ownership →Formal financial transaction	0.035 [0.000]***	0.603 [1.518]	Partial
Secondary education →mobile ownership →Internet access	0.035 [0.000]***	0.117 [0.133]	Partial
Secondary education →mobile ownership →Has ATM/Debit card	0.022 [0.001]***	0.129 [0.149]	Partial
Secondary education → Internet access→ formal financial transaction	0.028 [0.006]***	0.547 [1.205]	Complete
Secondary education → Internet access → Has ATM/Debit card	0.046 [0.000]***	0.237 [0.311]	Partial
Tertiary education → Formal financial transaction → Has ATM/Debit card	0.006 [0.267]	0.027 [0.028]**	No
Tertiary education → mobile ownership→ formal financial transaction	0.020 [0.002]***	0.342 [0.520]	Complete
Tertiary education → mobile ownership → Internet access	0.020 [0.001]***	0.064 [0.069]*	Partial
Tertiary education→ mobile ownership → Has ATM/Debit card	0.013 [0.008]***	0.053 [0.056]*	Partial
Tertiary education→ Internet access → formal financial transaction	0.031 [0.005]***	0.444 [0.799]	Complete
Tertiary education → Internet access → Has ATM/Debit card	0.051 [0.000]***	0.185 [0.226]	Partial
Income (Richest1st) → Formal financial transaction→ Has ATM/Debit card	0.003 [0.562]	-	-
Income (Richest1st) → Mobile ownership→ formal financial transaction	0.040 [0.000]***	0.217 [0.277]	Partial
Income (Richest1st) → Mobile ownership→ Internet access	0.040 [0.000]***	0.185 [0.228]	Partial
Income (Richest1st) → Internet access→ formal financial transaction	0.019 [0.014]**	0.114 [0.129]	Partial
Income (Richest1st) → Internet access→ Has ATM/Debit card	0.031 [0.000]***	-	No path
Income (Richest2nd) → mobile ownership→ formal financial transaction	0.038 [0.000]***	0.239 [0.314]	Partial
Income (Richest2nd) → mobile ownership→ Internet access	0.039 [0.000]***	0.369 [0.584]	Complete
Income (Richest2nd) → mobile ownership→ Has ATM/Debit card	0.024 [0.002]***	-	-
Income (Richest2nd) → Internet access→ Formal financial transaction	0.007 [0.119]	0.054 [0.057]*	No
Income (Richest2nd) → Internet access→ Has ATM/Debit card	0.012 [0.079]*	-	-
Income (middle quantile) → formal financial transaction→ Has ATM/Debit card	0.017 [0.019]**	-	-
Income (middle quantile) → Mobile ownership → formal financial inclusion	0.032 [0.000]***	0.241 [0.317]	Partial

(continued on next page)

Table 9 (continued)

Relationships	Indirect	RIT [RID]	Mediation paths
Income (middle quantile) → mobile ownership → Internet access	0.032 [0.000]***	0.398 [0.661]	Complete
Income (middle quantile) → mobile ownership → Has ATM/Debit card	0.020 [0.003]***	–	–
Income (middle quantile) → Internet access → Formal financial inclusion	0.005 [0.204]	0.048 [0.051]*	No
Income (middle quantile) → Internet access → Has ATM/Debit card	0.009 [0.170]	–	–
Income (Poorest2nd) → Formal financial inclusion → Has ATM/Debit card	0.013 [0.057]*	–	–
Income (Poorest2nd) → Mobile ownership → Formal financial inclusion	0.019 [0.009]***	0.194 [0.241]	Partial
Income (Poorest2nd) → Mobile ownership → Internet access	0.019 [0.006]***	0.771 [3.376]	Complete
Income (Poorest2nd) → Mobile ownership → Has ATM/Debit card	0.012 [0.019]**	–	–
Income (Poorest2nd) → Internet access → Formal financial transaction	0.001 [0.869]	0.007 [0.008]***	No
Income (Poorest2nd) → Internet access → Has ATM/Debit card	0.001 [0.869]	–	–
Receive wage → Formal financial transaction → Has ATM/Debit card	0.013 [0.022]**	0.097 [0.107]	Partial
Receive wage → Mobile ownership → Formal financial transaction	0.020 [0.002]***	0.195 [0.243]	Partial
Receive wage → Mobile ownership → Internet access	0.020 [0.001]***	0.132 [0.152]	Partial
Receive wage → Mobile ownership → Has ATM/Debit card	0.012 [0.009]***	0.091 [0.100]	Partial
Receive wage → Internet access → Formal financial transaction	0.014 [0.014]**	0.144 [0.168]	Partial
Receive wage → Internet access → Has ATM/Debit card	0.023 [0.000]***	0.154 [0.182]	Partial

***, **, and * represent significance at the 1 %, 5 %, and 10 % levels, respectively. The values in parentheses are the *p*-values.

the total effect and 0.421 times larger than the direct effect. The complete mediation suggests that mobile ownership is the primary determinant of gender disparities in internet access, with minimal influence from other factors (Table 9). Additionally, the indirect effect of gender on ATM/debit card ownership was negative and significant at 1 % level which indicates gender influences ATM/debit card ownership through its impact on mobile ownership. Males, who are less likely to own mobile phones, consequently, face barriers to accessing banking services like ATM/debit cards. The indirect effect of gender on ATM/debit card ownership is 0.110 times larger than the total effect and 0.124 times larger than the direct effect. Partial mediation implies that while mobile ownership plays a significant role, other factors also contribute to gender disparities in ATM/debit card ownership (Table 9).

There is a significant and positive indirect effect of secondary education on formal financial transactions through mobile ownership at the 1 % level of significance. This indicates that individuals with secondary education are more likely to engage in formal financial transactions due to mobile phone ownership. The indirect effect was 0.603 times larger than the total effect and 1.518 times larger than the direct effect. Partial mediation implies that while mobile ownership is a significant factor, other variables also influence the relationship between secondary education and formal financial transactions (Table 9).

The indirect effect of secondary education on access to the internet through mobile ownership was positive and significant at the 1 % level of significance. This indicates that individuals with secondary education are more likely to have internet access due to higher rates of mobile phone ownership. The indirect effect of secondary education on internet access through influencing mobile ownership was 0.117 times larger than the total effect and 0.133 times larger than the direct effect. The partial mediation suggests that while mobile ownership plays a

significant role, other factors also influence the relationship between secondary education and internet access (Table 9). Secondary education indirectly and positively influences owning ATM/debit cards through mobile ownership at the 1 % level of significance. This indicates that individuals with secondary education are more likely to have ATM/debit cards due to mobile phone ownership. The indirect effect was 0.129 times larger than the total effect and 0.149 times larger than the direct effect. Partial mediation suggests that while mobile ownership is important, other factors also contribute to the relationship between secondary education and ATM/debit card ownership (Table 9).

The indirect effect of secondary education on formal financial transactions through internet access indicates significant and positive at the 1 % level of significance. This indicates that individuals with secondary education are more likely to engage in formal financial transactions due to internet access. The indirect effect was 0.547 times larger than the total effect and 1.205 times larger than the direct effect. The complete mediation indicates that internet access is the primary determinant of the relationship between secondary education and formal financial transactions, with minimal influence from other factors (Table 9). The relationship between secondary education and owning ATM/Debit cards through internet access was positive and significant at the 1 % level of significance. This indicates that individuals with secondary education are more likely to have ATM/debit cards due internet access. The indirect effect was 0.311 times larger than the total effect and 0.237 times larger than the direct effect, and the mediation was partial suggesting that while internet access plays a significant role, other factors also contribute to the relationship between secondary education and ATM/debit card ownership (Table 9).

Regarding the indirect effect of tertiary education, there is a significant and positive indirect effect of tertiary education on formal financial transactions through mobile ownership at the 1 % level of significance. This indicates that individuals with tertiary education are more likely to engage in formal financial transactions due to mobile phone ownership. The indirect effect was 0.520 times larger than the total effect and 0.342 times larger than the direct effect, and the mediation was complete mediation, which implies that mobile ownership fully explains the relationship between tertiary education and formal financial transactions, with no additional direct effect observed. Similarly, the indirect effect of tertiary education on internet access through mobile ownership was significant and positive at the 1 % level, indicating individuals with tertiary education are more likely to have internet access due to mobile phone ownership. The indirect effect is 0.064 times higher than the total effect and 0.069 times higher than the direct effect. The mediation is partial suggesting that while mobile ownership plays a significant role, other factors also contribute to the relationship between tertiary education and internet access (Table 9).

Additionally, the effect of tertiary education on owning ATM/debit cards through mobile ownership was positive and significant at 1 % level indicating that individuals with tertiary education are more likely to have ATM/debit cards due to mobile phone ownership. The indirect effect is 0.053 times larger than the total effect and 0.056 times larger than the direct effect. The partial mediation suggests that while mobile ownership is important, other factors also contribute to the relationship between tertiary education and ATM/debit card ownership. Moreover, there is positive and significant effect of tertiary education on formal financial transactions through internet access at 1 % level of significance, indicating individuals with tertiary education are more likely to engage in formal financial transactions due to higher rates of internet access. The indirect effect is 0.444 times larger than the total effect and 0.799 times larger than the direct effect, and the mediation is complete indicating internet access fully explains the relationship between tertiary education and formal financial transactions, with no additional direct effect observed (Table 9). Furthermore, tertiary education has an indirect positive and significant effect on owning ATM/debit cards through internet access at the 1 % level of significance indicating that individuals with tertiary education are more likely to have ATM/debit

cards due to higher rates of internet access. The indirect effect of tertiary education on owning ATM/debit cards is 0.185 times larger than the total effect and 0.226 times larger than the direct effect, and the mediation was partial suggesting that while internet access plays a significant role, other factors also contribute to the relationship between tertiary education and ATM/debit card ownership (Table 9).

Individuals' income status has also an indirect effect on some of the variables through influencing some of the other variables. As shown in Table 9, there is a significant and positive indirect effect of income (richest 1st) on formal financial transactions through mobile ownership at the 1 % level of significance. This indicates that individuals in the wealthiest income bracket are more likely to engage in formal financial transactions due to mobile phone ownership. The indirect effect is 0.217 times larger than the total effect and 0.277 times larger than the direct effect, and the mediation is partial suggesting while mobile ownership plays a significant role, other factors also contribute to the relationship between income and formal financial transactions. Similarly, there is a significant and positive indirect effect of income (richest 1st) on internet access through mobile ownership at the 1 % level of significance, indicating that individuals in the wealthiest income bracket are more likely to have internet access due to higher rates of mobile phone ownership. The indirect effect is 0.185 times larger than the total effect and 0.228 times larger than the direct effect, and the mediation is partial suggesting while mobile ownership is a significant factor, other variables also influence the relationship between income and internet access (Table 9). Finally, the relationship between income (richest 1st) and formal financial transactions was significantly mediated by access to the internet, at the 5 % level of significance. This indicates that individuals in the wealthiest income bracket are more likely to engage in formal financial transactions if they have internet access. The indirect effect is 0.114 times larger than the total effect and 0.129 times larger than the direct effect, and the mediation is partial suggesting while internet access plays a significant role, other factors also contribute to the relationship between income and formal financial transactions (Table 9).

The indirect effect of income (richest 2nd) on formal financial transactions through mobile ownership was positive and significant at the 1 % level of significance, indicating that individuals in the second richest income bracket are more likely to engage in formal financial transactions with mobile phone ownership. The indirect effect is 0.239 times larger than the total effect and 0.314 times larger than the direct effect, and the mediation is partial indicating that mobile ownership plays a significant role, other factors also contribute to the relationship between income and formal financial transactions. Similarly, the indirect effect of income (richest 2nd) on internet access through mobile ownership was positive and significant at the 1 % level of significance. This indicates that individuals in the second richest income bracket are more likely to have internet access due to mobile phone ownership. The indirect effect was 0.369 times larger than the total effect and 0.584 times larger than the direct effect, and the mediation is complete suggesting that mobile ownership fully explains the relationship between income and internet access, with no additional direct effect observed (Table 9).

Mobile ownership mediates the relationship between income (middle quantile) and formal financial transactions, and the effect was significant and positive at the 1 % level of significance. This indicates that individuals in the middle-income quantile are more likely to engage in formal financial transactions with mobile phone ownership. The indirect effect was 0.241 times larger than the total effect and 0.317 times larger than the direct effect, and the mediation was partial indicating that while mobile ownership plays a significant role, other factors also contribute to the relationship between income and formal financial transaction. Similarly, mobile ownership mediated the relationship between income (middle quantile) and access to the internet and the effect was significant at 1 % level. This indicates that individuals in the middle-income quantile are more likely to have internet access due to higher rates of mobile phone ownership. The indirect effect was 0.398 times

larger than the total effect and 0.661 times larger than the direct effect, and the mediation is complete suggesting that mobile ownership fully explains the relationship between income and internet access, with no additional direct effect observed (Table 9).

Mobile ownership variable positively and significantly mediates the relationship between an individual's income (poorest 2nd), and formal financial transaction and internet access at the 1 % level of significance. The result indicates that individuals in the second poorest income bracket are more likely to engage in formal financial transactions and have access to the internet if they have mobile phone ownership. The indirect effect of income (poorest 2nd) on formal financial transactions through mobile phone ownership was 0.194 times larger than the total effect and 0.241 times larger than the direct effect, and the mediation was partial suggesting while mobile ownership plays a significant role, other factors also contribute to the relationship between income and formal financial inclusion. The indirect effect of income (poorest 2nd) on internet access through mobile ownership was 0.771 times larger than the total effect and 3.376 times larger than the direct effect, and the mediation is complete suggesting that mobile ownership fully explains the relationship between income and internet access, with no additional direct effect observed (Table 9).

Engaging in formal financial transactions-either borrowing or saving in formal financial institutions mediates the relationship between receiving wage payment and owning ATM/debit cards through formal financial transactions at the 5 % level of significance. This indicates that individuals who receive wages are more likely to own ATM/debit cards due to their engagement in formal financial transactions. The indirect effect was 0.097 times larger than the total effect and 0.107 times larger than the direct effect, and the mediation is partial suggesting that while formal financial transactions play a significant role, other factors also contribute to the relationship between receiving wages and owning ATM/debit cards (Table 9).

Owning a mobile phone positively and significantly mediates the relationship between receiving wage and engaging in formal financial transactions, and receiving wage and access to internet, at 1 % and 1 % level of significance, respectively. The result indicates that individuals who receive wages are more likely to engage in formal financial transactions and can access internet connectivity due to mobile phone ownership. The indirect effect of receiving wage payments on formal financial transactions through mobile ownership was 0.195 times larger than the total effect and 0.243 times larger than the direct effect, and the mediation is partial suggesting that while mobile ownership plays a significant role, other factors also contribute to the relationship between receiving wages and engaging in formal financial transactions. The indirect effect of receiving wage payment on access to the internet through mobile phone ownership was 0.132 times larger than the total effect and 0.152 times larger than the direct effect, and the mediation is partial suggesting that while mobile ownership is a significant factor, other variables also influence the relationship between receiving wages and internet access (Table 9).

Mobile phone ownership positively and partially mediates the relationship between receiving wage payments and owning ATM/debit card ownership at the 1 % level of significance. The result indicates that individuals who received wage payments are more likely to own ATM/debit cards due to mobile phone ownership. The indirect effect is 0.091 times larger than the total effect and 0.100 times larger than the direct effect, and the mediation is partial indicating while mobile ownership plays a significant role, other factors also contribute to the relationship between receiving wages and owning ATM/debit cards (Table 9). The relationship between receiving wage payments and using formal financial institutions for borrowing and saving was significantly and positively mediated by the individual's access to the internet, at the 5 % level of significance. This implies that individuals who receive wages are more likely to engage in formal financial transactions partially due to internet access. The indirect effect was 0.144 times larger than the total effect and 0.168 times larger than the direct effect, and the mediation

was partial suggesting while internet access plays a significant role, other factors also contribute to the relationship between receiving wages and formal financial transactions (Table 9). Finally, internet access partially mediates the relationship between receiving wage payments and owning ATM/debit cards, at the 1 % level of significance. This implies that individuals who receive wages are more likely to own ATM/debit cards partially due to internet access. The indirect effect was 0.154 times larger than the total effect and 0.182 times larger than the direct effect. The partial mediation suggests that while internet access is a significant factor, other variables also influence the relationship between receiving wages and owning ATM/debit cards (Table 9).

Based on the standardized coefficient estimates of predictors for each dependent variable, and the mediation analysis, the hypotheses formulated, and the test of hypotheses results are summarized in Table 10.

5. Discussion

In this section, we discuss how socioeconomic disparities and digital access shape digital payment adoption in Ethiopia, contextualizing these findings within the broader landscape of existing studies, specifically within the developing economies.

Age was found to be one of the main determinants of digital payment adoption, and the likelihood of adopting digital payment methods increases with age. This positive correlation between age and digital payments may relate to several factors. From the perspective of economic participation and noting the sample average age of 32, individuals older than 32 are still in their prime working years and are more likely to be employed in jobs that necessitate the use of formal banking services, leading to greater reliance on digital payments. Even among those older people, many tend to rely on digital payments to receive social benefits from the government or remittances from family members abroad. Digital payment options allow this money to be received and used more conveniently and securely. Previous studies have also shown that age plays a role in influencing technology adoption. For example, a study by Riskinanto, Kelana, and Hilmawan (2017) showed that age influences the strength and direction of the relationship between perceived ease of use and perceived usefulness in E-payment adoption in Indonesia. Another study by Olson, O'Brien, Rogers, and Charness (2011) found that older age groups frequently used digital technology, and their frequent usage was related to their experience. Likewise, Ali and Ghildiyal (2023) reported that older males have a higher likelihood of adopting digital financial services. Conversely, Aduba (2021), in a study on determinants of electronic banking adoption found that the odds of adopting internet/mobile banking decreases with older users.

Educational status determines digital payment adoption with highly educated individuals being more likely to adopt digital payment. This positive relationship could be associated with better financial literacy, access to technology, or awareness of the benefits and security features of digital payments among more educated individuals. Also, people with higher education have increased employment incomes that would allow them to purchase mobile phones and internet data plans—both essential for making digital payments. Moreover, educated individuals tend to have greater trust in the security and dependability of digital payment systems. Financial literacy could be vital to exploring the availability of information about the functions and benefits of digital payments and adopting digital payment systems. Several studies have also documented a positive relationship between education and adoption of digital payments, such as Akinyemi and Mushunje (2020) and (Elena-Bucea, Cruz-Jesus, Oliveira, & Coelho, 2021). For example, a study by Tiwari, Srivastava, and Kumar (2019) revealed that education is one of the major reasons behind lower penetration of digital payments in India. According to a study by Bakhshi et al. (2024) building trust and awareness of financial services through education and out-reach programs can promote the adoption of digital payment systems. In China, Wang, Niu,

Table 10
Decision on the hypotheses tested.

Hypothesis	Decision
H ₁ : The gender of an individual influences their ability to make or receive digital payments	Rejected
H ₂ : The age of an individual influences their capacity to make or receive digital payments	Accepted
H ₃ : The educational status of an individual influences their ability to make or receive digital payments	Accepted
H ₄ : The income of an individual influences their ability to make or receive digital payments	Accepted
H ₅ : Receiving a wage payment influences an individual's ability to make or receive digital payments	Accepted
H ₆ : The gender of an individual influences their engagement in formal financial transactions	Accepted
H ₇ : The age of an individual influences their engagement in formal financial transactions	Rejected
H ₈ : The educational status of an individual influences their engagement in formal financial transactions	Rejected
H ₉ : The income of an individual influences their engagement in formal financial transactions	Accepted
H ₁₀ : Receiving wage payments influences an individual's engagement in formal financial transactions	Accepted
H ₁₁ : Engaging in formal financial transactions influences an individual's ability to make or receive digital payments	Accepted
H ₁₂ : The impact of gender on digital payments is mediated by engagement in formal financial transactions	Accepted
H ₁₃ : The influence of age on digital payments is mediated by engagement in formal financial transactions	Rejected
H ₁₄ : The impact of education on digital payments is mediated by engagement in formal financial transactions	Rejected
H ₁₅ : The impact of income on digital payments is mediated by engagement in formal financial transactions	Accepted
H ₁₆ : The impact of receiving wage on digital payments is mediated by engagement in formal financial transactions	Accepted
H ₁₇ : The gender of an individual influence's mobile ownership	Accepted
H ₁₈ : The educational status of an individual influence's mobile ownership	Accepted
H ₁₉ : The income of an individual influence's mobile ownership	Accepted
H ₂₀ : Receiving wages influences mobile ownership	Accepted
H ₂₁ : Mobile ownership influences engagement in formal financial transactions	Accepted
H ₂₂ : Mobile ownership influences the ability to make or receive digital payments	Accepted
H ₂₃ : The impact of mobile ownership on digital payments is mediated by engagement in formal financial transactions	Accepted
H ₂₄ : Gender influences an individual's access to the internet	Accepted
H ₂₅ : Educational status influences an individual's access to the internet	Accepted
H ₂₆ : Income influences an individual's access to the internet	Accepted
H ₂₇ : Income influences an individual's access to the internet	Accepted
H ₂₈ : Internet access influences the utilization of formal financial transactions	Accepted
H ₂₉ : Internet access influences the ability to make or receive digital payments	Accepted
H ₃₀ : The impact of access to the internet on digital payments is mediated by engagement in formal financial transactions	Accepted
H ₃₁ : The impact of mobile ownership on digital payments is mediated by access to the internet	Accepted
H ₃₂ : The gender of an individual influences the adoption of ATM/Debit cards	Accepted
H ₃₃ : The educational status of an individual influences the adoption of ATM/Debit cards	Accepted
H ₃₄ : The income of an individual influences the adoption of ATM/Debit cards	Accepted
H ₃₅ : Receiving wage payments influences the adoption of ATM/Debit cards	Accepted
H ₃₆ : The adoption of ATM/Debit cards influences digital payments	Accepted
H ₃₇ : The impact of using formal financial transactions on digital payments is mediated by the adoption of ATM/Debit cards	Accepted
H ₃₈ : The impact of mobile ownership on digital payments is mediated by the adoption of ATM/Debit cards	Accepted
H ₃₉ : The impact of internet access on digital payments is mediated by the adoption of ATM/Debit cards	Accepted
H ₄₀ : Educational attainment positively influences the receipt of wage payments	Accepted
H ₄₁ : The impact of wage receipt on digital payments is mediated by engaging in formal financial transactions	Accepted

(continued on next page)

Table 10 (continued)

Hypothesis	Decision
H_{42} : The impact of wage receipt on digital payments is mediated by mobile ownership	Accepted
H_{43} : The impact of wage receipt on digital payments is mediated by internet access	Accepted
H_{44} : The impact of wage receipt on digital payments is mediated by the adoption of ATM/Debit cards	Accepted

Zhou, and Gan (2024) found education as a significant factor on the use of various digital payment systems, including digital banking, mobile payment, digital wealth management and digital consumer credit. Moreover, in Pakistan, Ali, Raza, Hakim, Puah, and Chaw (2024) showed how raising awareness (financial literacy) influenced customers decision to use mobile payments. A study by Wang et al. (2024) also highlighted the importance of financial literacy for household decision-making and technology adoption. In India, Afzal, Ansari, Ahmad, Shahid, and Shoeb (2024) showed how individuals' knowledge and awareness of electronic banking cybersecurity positively influenced their electronic banking usage intention.

The findings show engagement in formal financial transactions (financial inclusion) as one of the determinants of digital payment adoption in Ethiopia during the COVID-19 pandemic. This result is consistent with the findings of Frączek and Urbanek (2021) that showed a positive relationship between financial inclusion and digital payment in passenger transport. Other studies have also shown that the availability of digital payment systems has a positive effect on financial exclusion. For example, a study by Jamil, Hamid, Alam, and Ahmad (2024) found how the development of digital finance promotes financial inclusion through digital payment, credit, and insurance.

Borrowing or saving in formal financial institutions was also influenced by gender, income, receiving wage payments, and mobile ownership. This is consistent with studies elsewhere. According to Mossie (2022), women and poor population groups are less likely to be financially included compared to their counterparts. Valera, Lei, and Fong (2024) and Trung and Quynh (2022) found a positive association between income level and financial inclusion in Asia. Regarding gender, female-headed households are less inclined to access formal finance (Ghosh & Vinod, 2017). A study by Allen et al. (2016) showed that financial inclusion is also influenced by ownership and use of formal accounts. Similarly, Ghosh and Vinod (2017) revealed wage discrimination affecting access to finance for Indian women. Mobile ownership also plays a role in facilitating formal financial transactions. Bekele (2023) showed that owning a mobile phone has a significant and positive effect on financial inclusion in Kenya and in Ethiopia. Murshed et al. (2023) further showed how improvement in mobile accessibility stimulated financial inclusion in South Asia. Finally, Ali and Ghildiyal (2023) documented a strong relationship between mobile phone ownership and digital financial services for banking (borrowings and savings).

The findings revealed that mobile ownership increases the likelihood of digital payment adoption. This is not surprising as owning a mobile phone can provide quick access and encourage individuals to make digital payments, such as bill payments, money transfers, and purchases. This is especially important in areas with limited banking options but with access to a mobile network. This result is consistent with the findings of several studies including those by Niankara and Traoret (2023), Song et al. (2023), Valera et al. (2024), (Shaikh et al., 2023), and (Ali et al., 2024).

Mobile phone ownership is also determined by the individual's characteristics such as gender, education, wage payment, and income. In terms of gender, females tend to have less access to mobile phones compared to their male counterparts in the context of developing countries (Pénard, Poussing, Zomo Yebe, & Ella, 2012; Sekabira & Qaim, 2017). This might be associated with the fact that women have lower

incomes than men, giving them less autonomy in financial decisions. In addition, a study by Saxena, Gera, and Taneja (2023) found that gender plays a significant moderating role in the relationship between effort expectancy and behavioral intention, as well as the relationship between optimism and behavioral intention. Individuals who receive regular wage payments and are in a better income quantile have better financial means to afford and purchase mobile phones and better data plans. Wage payments, particularly if made through formal banking channels, also necessitate the use of mobile phones for accessing banking services. This result is consistent with the findings of Forenbacher, Husnjak, Cvitić, and Jovović (2019) that showed employment status being one of the strongest factors affecting mobile ownership in Nigeria. A study by Zhang (2017) revealed that average income had a positive correlation with mobile phone penetration. Others associated the adoption of mobile money in rural areas of Africa with net monthly income (Akinyemi & Mushunje, 2020; Honoré, 2019; Pénard et al., 2012; Sekabira & Qaim, 2017). Education is another factor associated with the adoption of mobile phones. Grzybowski (2015), in the context of South Africa, revealed education (literacy) level as a significant determinant of mobile phone adoption. Educational (literacy) level is also a significant factor that affects mobile phone ownership and adoption (Pénard et al., 2012).

Unsurprisingly, internet access influenced digital payment adoption, consistent with several other studies. For example, Niankara and Traoret (2023) showed the importance of internet access to individuals' digital payment system uptake. Material access and internet access also contribute to all uses and outcomes (Van Deursen, 2020). Individual access to the internet was also influenced by gender, education, income, receiving wage payments, and mobile ownership. Gender was an important factor in determining access to broadband internet (Reddick et al., 2020). The influence of income and education on access to internet seem to be particularly strong (Chaudhuri et al., 2005). A study by Korkmaz, Erer, and Erer (2022) showed that improvements in income levels can increase internet access. Reddick et al. (2020) highlighted income as an important factor in assessing the digital divide between upper and lower-income households.

Individuals who have ATM/Debit cards have a higher likelihood of making or receiving digital payments. ATM/Debit cards are fundamental tools for accessing digital payment systems and a gateway for individuals to engage in electronic transactions. However, having an ATM/Debit card was influenced by gender, education, receiving wage payment, internet access, and mobile ownership. In the study, females have a lower likelihood of having ATM/Debit cards than their male counterparts signifying gender gaps in accessing digital payment tools. In developing countries context, women may face barriers such as lower income levels, limited financial literacy, access to financial institutions, and sociocultural norms that hinder their ability to obtain and use ATM/Debit cards. In contrast, Nandru et al. (2024), in India, found females being the main users of digital financial services during the COVID-19 pandemic. Higher levels of education are associated with the ownership of ATM/debit cards, as educated individuals are more likely to grasp the benefits of digital payment systems and possess the requisite skills to utilize them efficiently. Regular wage payments increase the likelihood of owning ATM/debit cards because people with regular incomes are more likely to have bank accounts and use related financial services, such as ATM/debit cards. According to a study by Nandru et al. (2024), individuals with better education and in the fourth-income quantile have better access to digital financial services. A study by Aurazo and Vega (2021) showed that formal employment has a significant positive role in the ownership of payment cards. Additionally, tertiary education holders are more likely to use digital financial services and own payment cards (Aurazo & Vega, 2021; Nandru et al., 2024). Internet connectivity and mobile phone ownership are critical drivers of digital payment uptake. Individuals with these resources are more likely to use digital banking services and obtain ATM/debit cards. Digital financial technologies such as mobile money, mobile banking, and e-wallet, that do not necessarily require consumers to be connected

to the internet are found to have a greater impact on financial inclusion in East African countries (Mothobi & Kebotsamang, 2024).

Mediation analysis was also conducted to show the interdependence between the chosen explanatory variables. Based on the mediation analysis, gender has an indirect effect on an individual's engagement in formal financial transactions, access to the internet, and owning ATM/debit card through mobile ownership. The relationship between gender and formal financial transactions was mediated by mobile phone ownership. Women's engagement in formal financial institutions may be impeded by gender differences in mobile ownership. Due to social norms, lower income, and less financial independence, women may have less access to mobile phones, which reduces their participation in formal financial transactions. The limited decision-making power of women, due to the patriarchal norms that men are the primary decision-makers in households, women's autonomy in purchasing and owning mobile phones or participating in financial decisions such as digital payment adoption may be restricted. In addition, women are often expected to focus on domestic responsibilities limiting their engagement with technology or financial systems which can discourage their access to mobile technology and digital payments. Moreover, women's financial dependency on men, a higher level of rural poverty, low literacy rates of women compared to men, and limited exposure to technology may restrict women from owning technological tools. Gender was one of the significant determinants of mobile phone adoption in rural India (Gupta & Jain, 2015). Since adopting mobile banking requires owning a mobile phone, differences in mobile ownership across genders may hinder the adoption of mobile banking. For example, a study by Chetioui, Lebdaoui, and Hafid (2023) showed that the relationship between mobile banking and actual usage and its antecedents is significantly mediated by gender highlighting the mediation role of gender as well. In contrast to our results, the finding of another study by Shehadeh, Dawood, and Hussainey (2024) revealed that adoption of cashless payment systems is different across gender and there was a strong association between digital financial experience and cashless payment usage for women compared to men. Furthermore, the association between gender and internet access is mediated by mobile phone ownership. This may be because gender differences in mobile phone ownership translate directly into differences in internet access, as mobile phones are the main device used to access the internet. Women may encounter obstacles to owning smartphones, such as concerns about pricing or cultural norms that impose restrictions on their ability to connect to the internet, thus limiting their access to digital services and information. Women in Africa often do not have digital assets such as smartphones, or internet services and lack digital literacy to perform digital transactions (Nghargbu & Jumare, 2024). According to a study by Chatterjee (2024), women are lagging behind men, but a digital transfer of wages motivates them to make digital transactions. Finally, because mobile ownership often facilitates access to digital banking and financial services, including ATM/debit card ownership, there is an indirect influence of gender on ATM/debit card ownership through mobile ownership. Women with limited access to mobile phones are less likely to use these digital financial services, resulting in a lower rate of ATM and debit card ownership. This could exacerbate financial marginalization for women. In Africa, although digital finance is fast growing, many women do not have access to digital financial services, especially those living in poor and marginalized communities (Nghargbu & Jumare, 2024). As traditional microfinance institutions and operators of table banking in ECOWAS strive to compete with specialized digital finance services operators amidst a competitive market, women are left behind as they fail to conform to technological advancement (Akeju, 2024). To facilitate gender-inclusive digital and financial inclusion, digital payments, supported by an appropriate consumer financial protection framework, enable confidential and convenient financial services, which can be especially important for women (Klapper & Singer, 2017).

Secondary and tertiary education have an indirect impact on individuals' use of formal financial institutions for savings or borrowings,

internet access, and ATM/debit card ownership through mobile ownership. Secondary and tertiary education, mediated by access to the internet, indirectly influences how individuals use formal financial institutions for savings, borrowing, or owning ATM/debit cards. Tertiary education is associated with better economic opportunities and financial literacy, enabling individuals to own mobile phones. This relationship likely explains why secondary and tertiary education indirectly influences people's use of formal financial institutions for borrowing or saving money through mobile ownership. Owning a mobile phone facilitates the use of formal financial institutions by providing access to resources for digital banking and money management. The use of formal financial institutions for borrowing or saving money through internet access is also influenced by secondary and tertiary education. Educated individuals are more likely to utilize the internet for banking, money management, and making informed financial decisions. Access to the internet simplifies these activities, thereby increasing interactions with official financial institutions. In a developing country setting, a study conducted in Nigeria by Aduba (2021) showed that the odds of adopting internet/mobile banking increases with higher educational attainment. Another study conducted by Chetioui et al. (2023) revealed a significant mediation role of education on the relationship between mobile banking actual usage and its antecedents. Observability, which is an easy understanding of a complex system or structure is one of the main determinants of the adoption of a unified payment interface (UPI) (Shahid, 2022).

The ownership of a mobile phone increases an individual's likelihood of understanding the benefits of internet access and having the funds to purchase mobile devices and data plans. This is another way that secondary and tertiary education indirectly influences internet access. This internet access enhances their ability to conduct various online activities, such as financial transactions and information retrieval. Furthermore, tertiary education levels indirectly impact ATM/debit card ownership through mobile ownership. People with higher education levels are more likely to use mobile phones and other forms of technology (Nandru et al., 2024). These devices can be used to access digital financial services like online banking and the use of debit and credit cards (Ali & Ghildiyal, 2023; Vatsa, Ma, & Zheng, 2024). This promotes overall financial inclusion and facilitates digital payments. A study by Wang et al. (2024) found that education has statistically significant and economically important effects on the use of various Digital payment systems, including digital banking, mobile payment, digital wealth management and digital consumer credit.

Income also plays a role in indirectly influencing formal financial transactions, internet access and ATM/debit card ownership. The role depends on the income quantile of individuals. Being an individual in the wealthiest income quantile indirectly influences the individual's usage of formal financial institutions for either borrowing or saving money and access to the internet through mobile ownership. This shows individuals in the richest 1st, richest 2nd, middle, and poorest 2nd quantile have better access to mobile phones compared to those in the poorest 1st quantile. Higher-income levels provide individuals with the financial capability to purchase and maintain mobile devices, which are essential tools for accessing formal financial services and the internet (Ali & Ghildiyal, 2023; Vatsa et al., 2024). This improved access facilitates financial transactions and digital connectivity (Siddika & Sarwar, 2023). Additionally, higher income quantiles indirectly influence the use of formal financial institutions for savings or borrowing through mobile phone ownership. The practice of formal saving and borrowings are the prerequisites for using digital mode of transactions and mobile (Chatterjee, 2024). Higher earners are more likely to possess mobile phones, which serve as a conduit to formal financial services (Ali & Ghildiyal, 2023). Wealthier individuals can conduct official financial transactions more easily since mobile banking and related services lower obstacles to traditional banking infrastructure (Panda, Patnaik, Pawar, & Birari, 2023). Moreover, those in higher income quantiles have better access to the internet because they can afford data plans and

smartphones—devices essential for internet access. This connectivity is crucial for leveraging digital financial technology and accessing a wider variety of online financial services and information. A study on the determinants of electronic banking adoption in Nigeria by [Aduba \(2021\)](#) revealed that the odds of adopting internet/mobile banking increases with higher income. Furthermore, those with higher incomes are more likely to be financially literate and have the means to use official banking services, which increases the number of ATM/debit card holders. These cards are essential for using a variety of financial services, including digital payments.

Regular wage receiving plays an indirect positive role in accessing digital tools such as mobile phones, ATM/debit cards, access to the internet, and using formal financial institutions for either borrowing or saving, which may facilitate the adoption of digital financial technologies and digital payments. This study found that receiving wage payments indirectly influences an individual's ownership of ATM/Debit card through a variable of whether an individual uses formal financial institutions for borrowing or saving money. Having a regular income such as receiving wage payments can drive individuals towards formal financial systems. Formal financial transactions are essential for adopting digital payment systems, as they provide a foundation for financial security and trust in digital financial technologies. Additionally, the study highlights that wage payments indirectly influence ATM/debit card ownership through both the use of formal financial institutions and internet access. An individual can acquire ATM/debit cards through engagement in formal financial services and these tools are critical for accessing digital payments and broader financial services, thereby promoting financial inclusion. These findings are consistent with the findings of [Niankara and Traoret \(2023\)](#) who reported that increased income levels, reduced COVID-19 related financial worries, mobile phone ownership, and internet access have positive contributions to individuals' digital payment uptake during the COVID-19 crisis. A study by [Siddika, Sarwar, and Bakar \(2023\)](#) revealed that the receipt of public and private wages and payment of utilities through digital platforms had a positive effect on digital financial inclusion.

Another study by [Chatterjee \(2024\)](#) revealed that electronic transfer of wages, government transfers, and remittances can motivate individuals to make use of digital modes of transactions, where the practices of formal saving and borrowing are the prerequisites to use digital modes of transaction. However, this mechanism holds good for East Asia Pacific, but not for South Asia and Sub-Saharan Africa, which are poor in information and communication technology (ICT) infrastructure ([Chatterjee, 2024](#)). A study by [Klapper and Singer \(2017\)](#) indicates that digital wage and social transfer payments can provide an on-ramp to financial inclusion. This emphasizes the importance of receiving wages through digital financial services in facilitating digital and financial inclusion. Conversely, the relationship between receiving wage payments and adopting digital financial services may not be unidirectional. A study conducted in China by [Li and Liu \(2023\)](#) revealed that digital financial inclusion increases wage income by enhancing residents' household employment levels, business income by promoting residents' entrepreneurship, and property income by improving financial market participation. It has a more significant effect on increasing the income of higher-income groups as well as rural residents.

6. Implications of the study

The findings of the study have practical and theoretical implications. Practically, the findings provide evidence for designing policies and programs to create inclusive and equitable digital infrastructures for individuals by expanding digital literacy and financial skills for easy adoption and use of digital payments. Additionally, the study can provide evidence-based knowledge for financial institutions, such as commercial banks, the National Bank of Ethiopia, and telecommunication companies (such as Ethio Telecom and Safaricom), for formulating strategies to expand and provide access to technological infrastructures

that could enable more people to participate in the digital economy, thereby increasing financial inclusion and economic opportunities. Theoretically, the study employed the existing TAM framework and demonstrated how digital infrastructure and socioeconomic factors impact digital payment adoption, in a developing country context such as Ethiopia. The study emphasizes the need to modify current models to accurately explain the challenges in emerging markets, where uneven digital infrastructure and the impact of social and cultural variables are apparent. This study provides empirical evidence to fill some of these gaps and thereby advances our knowledge of the factors directly or indirectly influencing individual's decisions to adopt digital payments.

7. Limitations and future research directions

The study complements existing research on individual-level digital payment adoption in the context of the COVID-19 pandemic. It primarily focuses on exploring the relationship between socio-economic factors, accessibility of digital tools, and digital payment adoption. Moreover, this study serves as a foundational point for future research endeavors aimed at gaining a deeper understanding of the interdependence among socio-economic factors, usage of technological tools, digital payment adoption, and financial inclusion, particularly within the Ethiopian context.

Although precautions were taken, this study is not without limitations, which opens new avenues for research. First, some important variables, such as the effect of rural-urban differences, were not investigated in the study. Future research could empirically verify the influence of these factors on digital payment adoption. Also, other important variables such as merchant digital payments, remittances, bill payments, receiving pension payments, mobile money account ownership, government transfers, and other important variables were not considered in this study. This decision was made partly to avoid the complexity of the model and partly due to the large number of missing observations for some of these datasets. Furthermore, 'behavioral intention to use' and 'attitude towards use' of the TAM constructs were removed from the study framework due to the lack of precise measurement for these constructs. Future research opportunities exist for analyzing variables with complete observations. In addition, further research can be conducted by adopting a technological framework model that considers the behavioral factors affecting Fintech adoption in the Ethiopian context.

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CRedit authorship contribution statement

Adino Andaregie: Writing – original draft, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Gumataw Kifle Abebe:** Writing – review & editing. **Prashant Gupta:** Writing – review & editing. **Gardachew Worku:** Writing – review & editing. **Hideyuki Matsumoto:** Writing – review & editing, Visualization, Validation. **Tessema Astatkie:** Writing – review & editing, Validation. **Isao Takagi:** Writing – review & editing, Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available upon a reasonable request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.digbus.2024.100092>.

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