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Research Article

Digital Transformation and SME Growth: Understanding the Role of E-Commerce Awareness and Technology Adoption

Charles Momanyi[1, *], Maengwe Orwaru[1], Lameck Ondieki Agasa[2], Ronald Tombe[3]

[1]Department of Business Administration, Kisii University, Kisii, Kenya
[2]Department of Community Health and Behavioral Sciences, Kisii University, Kisii, Kenya
[3]Department of Computing, Kisii University, Kisii, Kenya

Abstract

Small and medium-sized enterprises (SMEs) are critical to Kenya's economy, representing 98% of all businesses and contributing 33.8% to GDP. Despite this, many rural SMEs face persistent challenges, including limited market access, inadequate financing, and slow adoption of digital technologies. This study examined the determinants of adopting multiple digital payment methods among SMEs in Kisii and Nyamira Counties, with a focus on digital transformation strategies and e-commerce awareness. A mixed-methods exploratory design was employed. In the qualitative phase, interviews and focus group discussions were conducted to inform the development of a digital platform prototype. In the quantitative phase, survey data were collected from 104 SMEs, and chi-square tests and logistic regression analyses were applied to identify factors influencing digital payment adoption. The findings revealed that type of business, business location, and e-commerce awareness were significantly associated with adoption of multiple digital payment systems, with e-commerce awareness emerging as the strongest predictor ($p < 0.001$). Demographic characteristics such as age, gender, and capital base were not statistically significant. The results highlight that SMEs with higher e-commerce awareness are more likely to embrace diversified payment methods, suggesting that digital market knowledge is a key enabler of broader technological adoption. The study concludes that targeted e-commerce literacy training, improved digital infrastructure, and affordable technology solutions are necessary to strengthen SME digital transformation in rural settings. These interventions can enhance financial inclusion, expand market opportunities, and contribute to sustainable SME growth. The findings provide insights for policymakers, development partners, and SME support organizations seeking to promote inclusive digital economies in Kenya and similar emerging market contexts.

Keywords

Digital Transformation, E-commerce Awareness, SME Sustainability, SME Growth, Rural Enterprises

*Corresponding author: charles.momanyi@kisiiuniversity.ac.ke (Charles Momanyi)

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1. Introduction

Small and medium-sized enterprises (SMEs) are globally acknowledged as engines of innovation, job creation, and economic growth, particularly in developing economies [1]. In Kenya, SMEs account for approximately 98% of all registered businesses and contribute about 33.8% to the national Gross Domestic Product (GDP) as well as nearly 30% to annual job creation [2]. Beyond their economic role, SMEs foster entrepreneurship, provide employment opportunities for individuals with diverse and specialized skills, and enhance income distribution, thereby improving livelihoods across communities [3]. Their strategic importance is further emphasized in Kenya's Vision 2030, which identifies SMEs as a critical pillar for economic growth, poverty reduction, and industrialization (Government of Kenya, 2007).

Despite their critical contributions, SMEs in Kenya, particularly in rural areas, face structural challenges that limit their growth and long-term sustainability. Major barriers include limited access to finance, restricted market opportunities, and inadequate adoption of modern business models [4]. These constraints are exacerbated by the slow uptake of digital transformation strategies, which hinders SMEs' integration into the rapidly evolving digital economy. Unlike in developed countries where SMEs have leveraged digitization to enhance competitiveness and operational efficiency, many SMEs in Kenya remain product-driven, focusing primarily on product availability rather than embracing comprehensive digital transformation approaches [5].

Kenya has, however, witnessed rapid growth in its digital landscape, spurred by increased internet penetration, widespread use of mobile technologies, and government-led initiatives aimed at promoting digital inclusion [2]. Digital transformation (DT) offers an opportunity for SMEs to streamline operations, enhance customer experiences, and expand their market reach through e-commerce platforms [6]. As Verhoef et al. [7] explain, digitization involves converting analog processes into digital operations, enabling SMEs to create more value and innovate within their activities.

In many developed economies, SMEs have realized substantial benefits from adopting digital transformation strategies. For instance, in China, SMEs contribute approximately 50% of tax revenue, 60% of GDP, 70% of technological innovations, 80% of employment, and 90% of the total number of enterprises [8]. These figures demonstrate the potential of digital integration to stimulate SME growth, promote innovation, and strengthen economic resilience. However, in Kenya, the digital transformation journey for SMEs remains constrained by infrastructural limitations, regulatory barriers, limited financial resources, and a lack of digital literacy, particularly in rural regions such as Kisii and Nyamira counties [5].

Existing studies have highlighted the inadequacy of traditional SME management practices in addressing the complexities of modern business environments. Manley [9] Rodrigues [10], and Abosede [11] argue that outdated management approaches restrict SMEs from scaling their operations and responding to market dynamics effectively. These limitations are particularly acute in rural areas, where SMEs lack access to digital platforms that support business management, market integration, and financial services [12]. As a result, rural SMEs are often excluded from e-commerce ecosystems and digital finance innovations, limiting their growth potential and competitiveness in both local and global markets [13].

To address these challenges, there is a critical need to promote digital transformation among SMEs in Kisii and Nyamira counties. Supporting SMEs to adopt digital technologies can enhance access to microloans, facilitate participation in e-commerce markets, and improve overall business management capabilities. Digital literacy programs are also essential to equip rural entrepreneurs with the skills necessary to navigate digital platforms, thus fostering innovation, improving service delivery, and enhancing competitiveness.

This study seeks to examine the impact of digital transformation strategies on the growth and sustainability of rural SMEs in Kisii and Nyamira counties. Specifically, the research aims to assess the relationship between digital literacy levels and SME development and to determine the extent of awareness and use of e-commerce marketplaces that connect rural SMEs with urban consumers. The findings are expected to inform policy interventions and capacity-building programs aimed at strengthening SME resilience and promoting financial inclusion.

The significance of this study is grounded in both economic necessity and national development priorities. According to the Central Bank of Kenya [14], SMEs are responsible for nearly a third of the country's GDP, making their growth essential for broader economic prosperity. Moreover, fostering SME digital transformation aligns with Kenya's Vision 2030 and Sustainable Development Goal 8, which emphasizes decent work and economic growth (Government of Kenya, 2007).

2. Theoretical Literature Review

This study is anchored on two complementary theories: the Resource-Based View (RBV) and the Diffusion of Innovation (DOI) theory. Together, these frameworks offer a robust lens for understanding how rural small and medium-sized enterprises (SMEs) can leverage digital technologies to enhance their growth, market integration, and long-term sustainability.

The Resource-Based View (RBV), initially conceptualized by Penrose [15] and later formalized by Wernerfelt [16], emphasizes that a firm's sustainable competitive advantage is derived from the unique combination of its resources and capabilities. Barney [17] further expanded this view, intro-

ducing the VRIN framework, which states that for resources to provide long-term advantage, they must be Valuable, Rare, Inimitable, and Non-substitutable. In the context of rural SMEs in Kisii and Nyamira counties, digital infrastructure, financial capital, digital literacy, and access to e-commerce platforms represent strategic resources that can catalyze growth and ensure sustainability if properly harnessed [18].

Digital transformation strategies such as the adoption of mobile banking, digital payment systems, e-commerce platforms, and business management software are not merely technological upgrades but strategic capabilities that SMEs can use to create market differentiation and competitive advantage. According to Mora [19], rural enterprises that develop digital competencies position themselves better to expand market access, reduce operational costs, and innovate in product delivery, thereby enhancing both growth and sustainability.

Complementing RBV, the Diffusion of Innovation (DOI) theory, introduced by Rogers [20] and refined in later editions Rogers, [20], explains how new technologies and innovations spread through social systems over time. The DOI framework is highly relevant to this study, as the successful uptake of digital transformation strategies by SMEs in Kisii and Nyamira depends on how these innovations are perceived, communicated, and adopted within the business ecosystem. Rogers [21] outlines five key attributes that determine the rate of innovation adoption: relative advantage, compatibility, complexity, trialability, and observability. These factors are critical in assessing why some SMEs readily embrace digital solutions while others remain hesitant.

The DOI model also categorizes adopters into five groups innovators, early adopters, early majority, late majority, and laggards reflecting different levels of readiness and capability to embrace new technologies [22]. In Kisii and Nyamira, contextual challenges such as infrastructure limitations, regulatory gaps, limited access to finance, and digital skills deficits influence where SMEs fall along this adoption curve [5]. Addressing these constraints is essential for fostering inclusive digital transformation that promotes SME growth and resilience.

The Diffusion of Innovation (DOI) framework guides the user-centric design of digital tools by ensuring they address the specific needs of SMEs, reduce operational barriers, and align with the unique business environments of enterprises in Kisii and Nyamira [23]. The Resource-Based View (RBV) complements this perspective by emphasizing that investing in digital capabilities does not merely facilitate technological adoption; it transforms access to technology into a sustainable competitive advantage. Through strategic integration, SMEs are empowered not only to adopt new digital tools but to leverage them effectively for long-term growth and sustainability [24].

3. Research Methodology

This study employed a mixed-methods research design, combining both quantitative and qualitative approaches to achieve comprehensive data collection and analysis. The use of mixed methods allowed for the collection of both numerical and descriptive data, facilitating richer insights and more robust conclusions [25]. A sequential exploratory design was adopted, where qualitative data collection preceded quantitative data collection. The initial qualitative phase informed the development of a digital platform tailored to the needs of rural SMEs, while the quantitative phase involved testing the platform's effectiveness and assessing digital transformation adoption during pilot implementation.

The study targeted rural small and medium-sized enterprises (SMEs) registered with the county governments of Kisii and Nyamira. According to the latest SME registry from the County Departments of Trade and Industry, there were 125 registered rural manufacturing SMEs across diverse sectors at the time of the study. This registry, developed from the county business census, formed the sampling frame for the study.

To ensure a representative sample, a stratified simple random sampling technique was applied. The SMEs were stratified based on sectoral classification and county of operation. From the target population of 125 SMEs, the research team conducted direct outreach and data collection efforts. Due to non-responses and attrition, the final number of respondents was 104 SMEs, resulting in a response rate of 83.2% (104/125). This high response rate was achieved through follow-up calls, field visits, and engagement with SME associations.

Multiple data collection instruments were employed, including structured questionnaires for SME owners, semi-structured interviews with key informants in the financial and technology sectors, and focus group discussions with selected urban consumers. Additionally, platform usage analytics were collected during the pilot phase to capture real-time digital engagement data.

For quantitative data analysis, both descriptive and inferential statistical methods were used. Descriptive analysis included frequency distributions and cross-tabulations to summarize SME characteristics and digital transformation behaviors. Inferential analysis involved chi-square tests to assess associations between categorical variables, and multiple regression analysis to examine the relationships between digital transformation strategies, e-commerce adoption, and SME growth outcomes [26]. Data analysis was performed using SPSS software.

Ethical considerations were rigorously upheld throughout the study. Participants provided informed consent, and data were handled with strict confidentiality and data protection protocols. The digital platform development followed an agile methodology, incorporating continuous feedback from SMEs and other stakeholders during the iterative design and testing phases. This approach ensured that the final solution was not only user-centered but also scalable and sustainable for broader application across similar rural contexts.

4. Results

The results provide insights into the demographic and operational characteristics of rural SMEs, their digital readiness, and current practices related to digital payments and business management. Understanding these background factors is critical for assessing the capacity and willingness of SMEs to adopt digital transformation tools. The analysis focuses on variables such as age, gender, business type, capital base, business location, and modes of payment accepted. These factors are key to identifying potential barriers and enablers of digital technology adoption among SMEs and informing the development of targeted interventions that can drive growth, improve efficiency, and support sustainable digital integration in the region.

Table 1. *Background Information Summary.*

Variable	Frequency	Percentage (%)
Age		
Above 35 years	66	63.46
26-35 years	30	28.85
18-25 years	7	6.73
Below 18 years	1	0.96
Gender		
Male	55	52.88
Female	49	47.12
Business Type:		
Manufacturing	60	57.69
Farming	34	32.69
Mining	10	9.62
Capital Base		
<10,000 KES	56	53.85
10,001-30,000 KES	36	34.62
30,001-50,000 KES	7	6.73
>50,000 KES	5	4.81
Business Location		
Semi-urban	91	87.5
Rural	13	12.5
Mode of Payment Accepted		
Mpesa	56	53.85
Cash	53	50.96
Mobile Banking	9	8.65
Payment: Accepts Bank Deposit	2	1.92
Accepts All Modes	49	47.12

Source: Field Data, 2025

The survey analyzed the background characteristics and digital readiness of SMEs operating in Kisii and Nyamira counties. The data sheds light on the background of SME owners and the structural environment in which digital trans-

formation strategies are expected to operate.

The age distribution of respondents shows that the majority of SME owners are in the older age brackets. Specifically, 66 /104 (63.46%) were above 35 years, followed by 30/104 (28.85%) in the 26-35 age group. The younger age brackets were less represented, with 7/104 (6.73%) aged 18-25 and only 1/104 (0.96%) below 18 years. This suggests that digital interventions may need to be designed with an older population in mind, potentially requiring more targeted support for digital literacy and confidence building.

The gender composition of the surveyed SMEs was nearly balanced. 55/104 (52.88%) of the respondents were male, while 49/104 (47.12%) were female. This near parity indicates that both genders are actively engaged in entrepreneurship, highlighting the need for gender-responsive digital strategies that accommodate diverse user needs and barriers.

Manufacturing businesses formed the largest segment of SMEs in the region, accounting for 60/104 (57.69%) of the sample. Farming followed with 34/104 (32.69%), while mining accounted for 10/104 (9.62%). These findings reflect a relatively traditional and production-oriented SME sector, which may benefit from digital tools such as inventory management, digital marketing platforms, and e-commerce to improve reach and productivity.

Most SMEs reported modest capital investments. Over half of the SMEs, 56/104 (53.85%), operated with a monthly capital base of less than KES 10,000. A further 36/104 (34.62%) had capital in the range of KES 10,001-30,000. Only 7/104 (6.73%) and 5/104 (4.81%) had capital between KES 30,001-50,000 and above KES 50,000, respectively. These figures illustrate the small-scale nature of the enterprises and the financial limitations that may hinder adoption of advanced digital solutions, thus emphasizing the need for low-cost, mobile-friendly technologies.

A significant proportion of SMEs were based in semi-urban settings, with 91/104 (87.50%) of the businesses located in semi-urban areas and only 13/104 (12.50%) operating in rural settings. This concentration in semi-urban areas presents an opportunity for deploying digital transformation tools where infrastructure like mobile networks is more accessible, while also identifying a gap in rural digital access that needs to be addressed through inclusive strategies.

In terms of digital readiness through payment systems, 56/104 (53.85%) SMEs accepted Mpesa, Kenya's leading mobile money service. 53/104 (50.96%) accepted cash, while only 9/104 (8.65%) accepted mobile banking options and a mere 2/104 (1.92%) accepted bank deposits. Interestingly, 49/104 (47.12%) of SMEs reported accepting all modes of payment. This mixed adoption reflects a transitional phase in payment digitization, indicating that while Mpesa is widely accepted, broader financial integration through banking and Fin-tech remains limited.

These findings on payment systems underscore the varying levels of digital adoption among SMEs, providing a foundation for further analysis of broader digital transformation indicators. Table 2 presents the frequency and percentage distribution of key digital transformation indicators assessed in the study.

Table 2. *Frequency and Percentage Distribution of Digital Transformation Indicators.*

Variable	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
E-commerce increased sales	7 (6.73%)	43 (41.35%)	50 (48.08%)	4 (3.85%)	-
Improved internet connectivity	25 (24.04%)	57 (54.81%)	10 (9.62%)	12 (11.54%)	-
Improved mobile device access	56 (53.85%)	38 (36.54%)	6 (5.77%)	4 (3.85%)	-
Showcase products online with ease	10 (9.62%)	57 (54.81%)	31 (29.81%)	6 (5.77%)	-
Tap into global consumers	5 (4.81%)	59 (56.73%)	36 (34.62%)	4 (3.85%)	-
Lack of training/knowledge	12 (11.54%)	81 (77.88%)	10 (9.62%)	1 (0.96%)	-
High cost of digital tools	12 (11.54%)	83 (79.81%)	9 (8.65%)	-	-
Poor internet access	3 (2.88%)	20 (19.23%)	14 (13.46%)	67 (64.42%)	-
Security concerns	1 (0.96%)	78 (75.00%)	15 (14.42%)	10 (9.62%)	-
Resistance to change	-	11 (10.58%)	8 (7.69%)	84 (80.77%)	1 (0.96%)
Customer preference for	-	15 (14.42%)	20 (19.23%)	67 (64.42%)	2 (1.92%)

Variable	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
traditional methods					
Barrier: High cost	14 (13.46%)	84 (80.77%)	6 (5.77%)	-	-
Barrier: Lack of knowledge	8 (7.69%)	84 (80.77%)	11 (10.58%)	1 (0.96%)	-
Barrier: Poor internet access	3 (2.88%)	12 (11.54%)	19 (18.27%)	70 (67.31%)	-
Barrier: Customer preference	-	35 (33.65%)	12 (11.54%)	54 (51.92%)	3 (2.88%)

The frequency and percentage distribution of digital transformation indicators among SMEs in Kisii and Nyamira Counties highlights both the opportunities and barriers that shape digital transformation efforts in rural business environments.

A majority of respondents acknowledged that digital platforms such as e-commerce have positively influenced business performance. For instance, 43/104 respondents (41.35%) agreed and 7/104 (6.73%) strongly agreed that e-commerce has increased sales, while a significant portion remained neutral 50/104 respondents (48.08%), and only a few disagreed 4/104 respondents (3.85%). This neutrality may suggest limited or indirect experience with e-commerce benefits among some SMEs.

A strong majority reported improvements in digital infrastructure. Notably, 25/104 (24.04%) strongly agreed and 57/104 (54.81%) agreed that internet connectivity had improved, with a small number disagreeing 12 /104 (11.54%). Similarly, 56/104 (53.85%) strongly agreed and 38/104 (36.54%) agreed that mobile device access had improved. These findings suggest growing access to foundational digital tools, which is crucial for scaling up e-commerce and digital services.

Respondents also indicated that digital platforms are beneficial in showcasing products: 10 (9.62%) strongly agreed and 57 (54.81%) agreed that showcasing products online is now easier. A majority (59 or 56.73%) also agreed and 5 (4.81%) strongly agreed that digital platforms enable SMEs to reach global consumers.

However, the findings also reveal major digital literacy and infrastructure-related challenges. For example, 81/104 (77.88%) agreed and 12/104 (11.54%) strongly agreed that lack of training and knowledge is a significant barrier. Cost remains a critical challenge as 83/104 (79.81%) agreed and 12/104 (11.54%) strongly agreed that high costs of digital tools hinder adoption. Poor internet access was cited as a limitation by 67/104 (64.42%) who disagreed that access is adequate.

Security concerns (78 or 75.00% agreed) and resistance to change (84 or 80.77% disagreed, 1 or 0.96% strongly disagreed with the idea that SMEs easily adopt new tools) also featured prominently as inhibitors. Similarly, a large number of respondents (67 or 64.42%) disagreed that customers are open to non-traditional methods, highlighting that user preferences remain a bottleneck.

From a government support lens, many SMEs see high cost (84 or 80.77% agreed), lack of knowledge (84 or 80.77% agreed), and poor internet (70 or 67.31% disagreed with access being sufficient) as barriers that require institutional intervention. Notably, 35 (33.65%) agreed that customer preference is also a government-addressable barrier.

Table 3. *Digital Transformation Indicators.*

Variable	Yes (n,%)	No (n,%)
Heard of e-commerce before?	77 (74.04%)	27 (25.96%)
Attended digital training	50 (48.08%)	54 (51.92%)
Uses Mobile Money	96 (92.31%)	8 (7.69%)
Uses Accounting Software	12 (11.54%)	92 (88.46%)
Uses Inventory Tools	12 (11.54%)	92 (88.46%)
Uses Digital Marketing Tools	60 (57.69%)	44 (42.31%)
Uses Online CRM Systems	5 (4.81%)	99 (95.19%)

Variable	Yes (n,%)	No (n,%)
Uses Point of Sale	15 (14.42%)	89 (85.58%)
Need support	40 (38.46%)	63 (60.58%)

The findings from the baseline survey on digital transformation among SMEs in Kisii and Nyamira counties reveal varying levels of engagement with key digital tools and capacities.

A significant proportion of SME owners reported having heard of e-commerce, with 77/ 104 respondents (74.04%) acknowledging prior awareness, while 27/104 (25.96%) had not. This indicates growing awareness, though a quarter of the population remains uninformed, highlighting a need for targeted sensitization efforts.

When it comes to capacity building, 50/104 (48.08%) of the respondents reported having attended digital literacy training, while slightly more 54/104 (51.92%) had not. This near-equal split suggests that while training opportunities exist, access or participation remains limited for a substantial number of SMEs.

In terms of practical adoption, the use of Mobile Money is almost universal, reported by 96/104 (92.31%) of SMEs, affirming its centrality in daily transactions. However, adoption drops sharply when it comes to more sophisticated business tools. Only 12/104 (11.54%) of SMEs use Accounting Software and Inventory Management Systems, indicating very limited integration of these systems into business operations.

Similarly, only 60/104 (57.69%) utilize Digital Marketing Tools, suggesting that just over half are leveraging online platforms to reach consumers. Even fewer respondents use Online CRM Systems 5/104 (4.81%) or Point of Sale systems 15/104 (14.42%), underscoring a major gap in technology-supported customer and inventory management practices.

Regarding institutional support, only 40/104 (38.46%) expressed a definite need for support, whereas 63/104 (60.58%) indicated that they would consider it only if accompanied by financial assistance. This points to a preference for conditional support, likely due to cost sensitivities or past experiences with insufficient backing.

Table 4. *Chi-Square Test Summary with Percentages.*

Variable	Category	No (n,%)	Yes (n,%)	Total (n=104)	Chi-square	P-value
Age_group	18-25 Years	5 (4.81%)	2 (1.92%)	7	2.32	0.5081
	26-35 years	14 (13.46%)	16 (15.38%)	30		
	Above 35 years	35 (33.65%)	31 (29.81%)	66		
	Below 18 years	1 (0.96%)	0 (0.00%)	1		
Gender	Female	25 (24.04%)	24 (23.08%)	49	0.03	0.8707
	Male	30 (28.85%)	25 (24.04%)	55		
Type of Business	Farming	23 (22.12%)	11 (10.58%)	34	9.92	0.007
	Manufacturing	24 (23.08%)	36 (34.62%)	60		
	Mining	8 (7.69%)	2 (1.92%)	10		
Estimated Capital Base	30001-50000	2 (1.92%)	5 (4.81%)	7	6.37	0.0949
	Above 50,000	1 (0.96%)	4 (3.85%)	5		
	Between 10001-30,000	17 (16.35%)	19 (18.27%)	36		
	Less than 10,000	35 (33.65%)	21 (20.19%)	56		
Business Location	Rural area	12 (11.54%)	1 (0.96%)	13	7.55	0.006
	Semi -urban	43 (41.35%)	48 (46.15%)	91		
ecommerce_awareness	High	32 (30.77%)	46 (44.23%)	78	17.79	0.0001
	Low	3 (2.88%)	0 (0.00%)	3		

Variable	Category	No (n,%)	Yes (n,%)	Total (n=104)	Chi-square	P-value
	Medium	20 (19.23%)	3 (2.88%)	23		
digital_literacy	High	50 (48.08%)	45 (43.27%)	95	0.00	1.0000
	Medium	5 (4.81%)	4 (3.85%)	9		
Government support	High	10 (9.62%)	2 (1.92%)	12	3.76	0.0525
	Medium	45 (43.27%)	47 (45.19%)	92		

The chi-square test results highlight several socio-demographic and digital transformation indicators that are associated with the likelihood of SMEs accepting all modes of payment.

Age group was not significantly associated with payment mode adoption ($\chi^2 = 2.32$, $p = 0.5081$). Among respondents above 35 years, (33.65%) did not accept all modes of payment while (29.81%) did, indicating no strong differentiation across age categories. Similarly, the youngest group (below 18 years) had minimal representation, which may have affected the power of the test.

Gender also showed no significant relationship ($\chi^2 = 0.03$, $p = 0.8707$). Both males 28.85%and females 24.04% were evenly distributed between those who accepted all payment modes and those who did not.

In contrast, type of business was significantly associated with digital payment adoption ($\chi^2 = 9.92$, $p = 0.007$). A majority of manufacturing businesses (34.62%) accepted all payment modes compared to farming (10.58%) and mining (1.92%). This suggests that manufacturing SMEs are more likely to integrate diverse payment platforms, possibly due to larger transaction volumes or greater formalization.

Estimated capital base did not show a statistically significant relationship with payment adoption ($\chi^2 = 6.37$, $p = 0.0949$), although those with capital above KES 30,000 seemed more inclined to accept all modes of payment. For instance, 4.81% with KES 30,001-50,000 and 3.85% with above KES 50,000 accepted all modes.

Business location was significantly associated with payment mode adoption ($\chi^2 = 7.55$, $p = 0.006$). SMEs in semi-urban areas (46.15%) were far more likely to adopt multiple payment methods compared to those in rural areas (0.96%), highlighting the urban advantage in digital infrastructure and consumer demand for digital services.

Among digital transformation indicators, e-commerce awareness showed a strong significant association with payment mode acceptance ($\chi^2 = 17.79$, $p = 0.0001$). SMEs with high e-commerce awareness were more likely to accept all payment modes (44.23%), demonstrating the transformative role of digital market understanding.

Digital literacy, however, showed no significant association ($\chi^2 = 0.00$, $p = 1.0000$), with almost equal distribution of high scorers across both groups. This may indicate that general digital knowledge does not necessarily translate into diversified payment acceptance unless paired with targeted application.

Lastly, business tools (interpreted here from the "government support" variable) approached significance ($\chi^2 = 3.76$, $p = 0.0525$), with medium users (47/102; 45.19%) slightly more inclined to adopt all payment modes compared to high users (2/102; 1.92%). This borderline result may warrant further exploration with a larger sample.

The chi-square test results provided initial insights into the associations between socio-demographic factors, digital transformation indicators, and the adoption of all payment modes among SMEs. However, to control for potential confounding variables and assess the strength of these relationships simultaneously, a logistic regression analysis was conducted (see Table 5). The regression model builds upon the chi-square findings by adjusting for multiple predictors in a multivariate framework.

Table 5. *Logistic Regression Results Predicting Full Digital Payment Adoption (All Payment Modes Accepted).*

Predictor	Coefficient (β)	Std. Error	z-value	p-value	95% CI (Lower)	95% CI (Upper)
Intercept	-7.4137	6.366	-1.165	0.244	-19.891	5.064
Gender (Male)	-0.2657	0.573	-0.463	0.643	-1.389	0.858
Age Group (Ref: 18-25 years)						

Predictor	Coefficient (β)	Std. Error	z-value	p-value	95% CI (Lower)	95% CI (Upper)
─ 26-35 years	1.4587	1.133	1.288	0.198	-0.762	3.679
─ Above 35 years	2.1112	1.107	1.907	0.056	-0.058	4.281
─ Below 18 years	-4.1381	10.506	-0.394	0.694	-24.728	16.452
Type of Business (Ref: Farming)						
─ Manufacturing	0.7202	0.613	1.176	0.240	-0.480	1.921
─ Mining	-0.4283	1.041	-0.411	0.681	-2.469	1.612
Estimated Capital Base (Ref: 30,001-50,000 KES)						
─ Above 50,000 KES	-0.4620	1.899	-0.243	0.808	-4.185	3.261
─ 10,001-30,000 KES	-1.0948	1.284	-0.853	0.394	-3.611	1.422
─ Less than 10,000 KES	-1.5639	1.276	-1.225	0.221	-4.066	0.938
Business Location (Semi-urban)	0.2554	1.449	0.176	0.860	-2.585	3.096
E-commerce Awareness Score	0.6204	0.190	3.262	0.001	0.248	0.993
Digital Literacy Challenges Score	-0.3420	0.193	-1.776	0.076	-0.719	0.035
Business Tools Score	0.0481	0.252	0.191	0.849	-0.446	0.542

The full logistic regression model was developed to investigate the factors influencing the likelihood of small and medium enterprises (SMEs) adopting all available modes of payment. The analysis included 104 observations and incorporated a range of independent variables, including demographic characteristics (such as age and gender), business-related factors (type of business, estimated capital base, and location), and digital transformation dimensions (e-commerce awareness, digital literacy challenges, and usage of digital business tools).

Overall, the model demonstrated a good fit, with a pseudo R-squared value of 0.3757, indicating that approximately 37.6% of the variability in the adoption of all payment modes could be explained by the variables included. The likelihood ratio test was highly significant ($p < 0.001$), suggesting that the model provided a significantly better fit than a null model with no predictors.

Among all predictors, the e-commerce awareness score emerged as the most significant factor influencing payment behavior. The model indicated that for every unit increase in a business's e-commerce awareness score, the log-odds of adopting all modes of payment increased by approximately 0.62 ($p = 0.001$). This suggests that SMEs that are more knowledgeable about or engaged in e-commerce are substantially more likely to offer diverse payment options. This likely reflects the broader digital orientation and customer-driven responsiveness associated with e-commerce-savvy businesses.

The age group of the business owner also appeared to influence payment behavior. Owners aged above 35 years showed a positive association with payment diversification, with a coefficient of 2.11 and a marginal significance level ($p = 0.056$). This trend may indicate that older entrepreneurs, possibly due to more years of experience or greater access to capital and networks, are more inclined to integrate flexible payment systems into their operations.

Additionally, digital literacy challenges exhibited a negative relationship with the outcome, with a coefficient of -0.34 and a p-value of 0.076. While not statistically significant at the 5% level, this suggests that SMEs facing more difficulties with digital technologies are less likely to embrace multiple payment methods. This finding reinforces the importance of digital literacy as a foundational capacity for leveraging digital payment systems.

In contrast, other factors including gender, type of business, capital base, business location, and business tools score did not show significant associations when included in the full model. Their lack of statistical significance implies that

these variables, when considered alongside digital engagement indicators, may not independently drive decisions about payment method adoption.

Table 6. Logistic Regression Results for Predictors of Full Digital Payment Adoption.

Predictor	Coefficient (β)	Std. Error	z-value	p-value	95% CI (Lower)	95% CI (Upper)
Intercept	-12.7953	3.341	-3.830	0.000	-19.343	-6.248
Type of Business (Ref: Farming)						
─ Manufacturing	0.4056	0.541	0.750	0.454	-0.655	1.466
─ Mining	-0.4026	0.963	-0.418	0.676	-2.291	1.486
Business Location (Semi-urban)	2.2458	1.527	1.470	0.141	-0.748	5.240
E-commerce Awareness Score	0.5323	0.140	3.815	0.000	0.259	0.806

The reduced logistic regression model focused on three key predictors—type of business, business location, and e-commerce awareness score—to explain the likelihood of SMEs adopting all available modes of payment. The model was well-fitted and converged after seven iterations, with a pseudo R-squared value of 0.2657, indicating that approximately 26.6% of the variance in payment method adoption could be explained by these operational and digital factors. The model's log-likelihood ratio test was statistically significant (LLR p-value < 0.001), confirming that the model significantly improved over the null (intercept-only) model.

Among the predictors, e-commerce awareness score was a statistically significant and strong predictor of payment method adoption. Specifically, for every unit increase in the e-commerce awareness score, the odds of adopting all modes of payment increased substantially (coefficient = 0.5323, $p < 0.001$). This reinforces the notion that SMEs with greater awareness and understanding of e-commerce practices are much more likely to integrate diverse and potentially digital payment systems into their operations. This finding aligns with previous digital transformation research showing that firms engaged in online commerce tend to embrace technological innovations, including digital financial tools.

On the other hand, business location in semi-urban areas was positively associated with adoption (coefficient = 2.2458), though this relationship was not statistically significant ($p = 0.141$). This suggests a trend where businesses located in more developed or connected areas might be more inclined toward payment innovation, possibly due to better infrastructure, higher customer expectations, or proximity to digital service providers. However, the lack of statistical significance implies that this association needs further investigation or a larger sample to confirm its effect.

The type of business (manufacturing or mining compared to the reference category (farming) did not show a statistically significant relationship with payment method diversification. The coefficients for manufacturing (0.4056) and mining (-0.4026) had p-values well above 0.05, indicating that sectoral classification alone does not robustly predict payment adoption behavior when digital readiness is considered.

5. Discussion

The findings of this study provide critical insights into the digital transformation landscape of SMEs in Kisii and Nyamira counties, with a specific focus on the adoption of diverse digital payment systems. The results reveal a complex interplay between socio-demographic factors, digital readiness, and payment behavior among rural SMEs.

From the descriptive results, SMEs in Kisii and Nyamira counties exhibit varying levels of digital transformation, with a clear tendency toward incremental adoption. Mobile money usage, particularly Mpesa, is nearly universal at 92.31%, highlighting the dominance of basic mobile financial services in daily business operations. However, the uptake of advanced digital tools such as inventory management systems, customer relationship management (CRM) platforms, and accounting software remains critically low at below 15%, reflecting a limited transition beyond payment digitization. This pattern is consistent with findings by Marolt et al. [27], who identified "necessary" digital transformation paths where SMEs adopt basic technologies for survival but hesitate to engage in deeper structural digitalization due to resource and capability constraints. Similarly, Omowole et al. [28] note that SMEs often face barriers such as limited financial resources, inadequate digital skills, and resistance to technological change, which hinder their ability to integrate comprehensive digital solutions. The gap between mobile payment adoption and broader digital transformation mirrors findings from Mwangi et al. [29] in Kenya, where SMEs reported improved operational efficiency and customer satisfaction through mobile apps and cloud-based solutions but

continued to struggle with integrating advanced digital tools due to financing challenges and skill shortages. In the European context, Trenkle [30] and Eurostat [31] report similar trends, emphasizing that SMEs worldwide often approach digital transformation incrementally, prioritizing tools with immediate operational benefits while lagging behind large enterprises in adopting data-driven technologies like AI and advanced analytics.

The chi-square analysis revealed that type of business, business location, and e-commerce awareness were significantly associated with the adoption of all payment modes among SMEs in Kisii and Nyamira counties. Manufacturing businesses were notably more likely to integrate diverse digital payment systems compared to farming and mining enterprises, likely due to higher transaction volumes and the formalization of operations, a trend similarly observed by Montenegro [32] in the Philippines, who found that operational context significantly influences digital payment intentions among MSMEs. Additionally, semi-urban SMEs in the study demonstrated a higher propensity for digital payment integration compared to their rural counterparts, a finding consistent with global research highlighting the role of digital infrastructure availability and consumer demand as key enablers of digital transaction uptake [33, 34]. Most critically, e-commerce awareness emerged as the strongest factor influencing SMEs' likelihood of adopting multiple payment channels, aligning with findings from Al-Qudah et al. [35], who reported that perceived convenience, social influence, and innovativeness directly affect digital payment adoption intentions, especially in younger market segments. Conversely, socio-demographic factors such as gender, age group, capital base, and general digital literacy did not show significant associations with payment diversification at the bivariate level, suggesting that technological mindset and market exposure play a larger role than demographic or economic characteristics in driving digital transformation decisions. This pattern reflects broader trends in fintech adoption in Sub-Saharan Africa, where studies by Hornuf et al. [36] and Tiwasing et al. [37] emphasize that perceived ease of use, perceived usefulness, and customer trust are key drivers of mobile money and fintech service adoption, rather than firm size or owner demographics.

The full logistic regression model confirmed that e-commerce awareness is the most significant predictor of comprehensive digital payment adoption ($\beta = 0.6204$, $p = 0.001$). SMEs with higher levels of e-commerce awareness were substantially more likely to offer multiple payment options, suggesting that familiarity with online marketplaces fosters broader digital openness and innovation in business operations. This result is consistent with global evidence demonstrating that digital market engagement is a key driver of financial technology adoption. For instance, Montenegro [32] found that MSMEs' perceptions of digital transaction convenience and economic benefit significantly influence their intention to adopt electronic payment systems. Similarly, Al-Qudah et al. [35] reported that perceived convenience, social influence, and innovativeness directly enhance digital payment adoption intentions among younger demographics, a pattern that reflects broader market readiness for financial technology integration. Moreover, Paun et al. [33] identified e-commerce knowledge and digital infrastructure development as core accelerators of technology adoption in SMEs globally, while Hornuf et al. [36] confirmed through meta-analysis that perceived usefulness and ease of use are central drivers.

Other factors such as business type, location, and capital base did not achieve statistical significance in the full logistic regression model, indicating that these structural and demographic factors may not independently drive the decision to adopt comprehensive digital payment systems when controlling for other variables. However, the age of the SME owner approached significance ($p = 0.056$), suggesting a possible trend where older entrepreneurs might be more inclined to integrate diversified payment methods. This could be attributed to accumulated business experience, established customer relationships, or increased exposure to digital services over time. Nonetheless, this observation aligns with prior findings by Radipere and Dhliwayo [38], who reported that while age initially influences small business performance, it loses statistical significance beyond 20 years of operation, implying that age may reflect life-cycle effects rather than consistent performance drivers. Similarly, in the context of digital adoption, Faiz et al. [39] emphasize that organizational factors such as leadership support and digital culture play a more pivotal role than demographic characteristics in influencing SME technology uptake. Furthermore, the results echo Malesu and Syrovátka's [40] systematic review, which identified access to financial resources, strategic networking, and technology adoption—not age or business size—as the most consistent critical success factors for SME growth and performance. Studies on fintech adoption, such as Hornuf et al. [36] and Tiwasing et al. [37], further support this view, showing that perceived utility, ease of use, and market exposure often outweigh demographic variables in technology integration decisions. Additionally, research by Audretsch et al. [41] underscores the role of collaboration and knowledge transfer in driving SME innovation performance, suggesting that ongoing engagement with digital ecosystems and strategic partners may be more influential than age or business type alone.

The reduced logistic regression model (Table 6), which focused on business type, location, and e-commerce awareness, reaffirmed that e-commerce awareness is the most significant predictor of comprehensive digital payment adoption among SMEs ($\beta = 0.5323$, $p < 0.001$). This finding highlights the critical role of digital market knowledge and exposure in driving technological uptake in small businesses, supporting global evidence that emphasizes the link between e-commerce engagement and financial technology adoption [32, 33]. SMEs that are more familiar with online market-

places are more inclined to integrate multiple payment methods, suggesting that digital market participation is not merely a financial tool but a gateway to broader business innovation. While semi-urban location showed a positive association with payment adoption (β = 2.2458), this effect was not statistically significant, implying that although infrastructure availability and urban proximity may facilitate access to technology, they are insufficient on their own to drive digital transformation without accompanying digital engagement initiatives. This observation aligns with Makame et al. [34], who argue that while infrastructure is a necessary condition for e-commerce adoption, it must be complemented by organizational readiness and strategic vision. Similarly, the type of business lost significance in the multivariate context, indicating that sectoral characteristics are secondary to technological awareness and entrepreneurial mindset in determining digital payment uptake. This is consistent with findings by Hornuf et al. [36] and Al-Qudah et al. [35], who demonstrate that digital payment adoption decisions are increasingly driven by perceptions of convenience, perceived security, and social influence rather than by the specific industry or size of the enterprise. Furthermore, Malesu and Syrov átka [40] highlight in their systematic review that SME growth and transformation are most strongly influenced by digital capabilities, access to financial resources, and collaborative networks, rather than demographic or structural business attributes. Audretsch et al. [41] further support this by emphasizing the importance of knowledge transfer and collaboration for fostering innovation in SMEs, suggesting that partnerships and ecosystem engagement play a greater role in technology adoption than traditional business characteristics.

Abbreviations

AI	Artificial Intelligence
CBK	Central Bank of Kenya
CRM	Customer Relationship Management
DT	Digital Transformation
GDP	Gross Domestic Product
ICT	Information and Communication Technology
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
MSEs	Micro and Small Enterprises
MSMEs	Micro, Small, and Medium Enterprises
R&D	Research and Development
SMEs	Small and Medium-sized Enterprises
TOJET	The Turkish Online Journal of Educational Technology
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USD	United States Dollar
Vision 2030	Kenya's Development Blueprint

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Author Contributions

Charles Momanyi: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Maengwe Orwaru: Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Lameck Ondieki Agasa: Conceptualization, Data curation, Formal Analysis, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Ronald Tombe: Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Artificial Intelligence Use

In submitting this manuscript, we have used Open AI ChatGPT to help edit and refine the language in some sections.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Charles Momanyi is a senior Lecturer in the Department of Business and Economics at Kisii University, Kenya. His research interests include entrepreneurship development, SME sustainability, and business innovation strategies.

Maengwe Orwaru is a Lecturer in the Department of Business and Economics at Kisii University, Kenya. His research interests include entrepreneurship development, SME sustainability, and business innovation strategies.

Lameck Ondieki Agasa is a Staff in the Department of Community Health and Behavioral Sciences at Kisii University. He has expertise in statistics, digital health innovations, and data-driven policy research for socio-economic development.

Ronald Tombe is a lecturer at the Department of Computing and Information Technology at Kisii University. He focuses on digital transformation, e-commerce adoption, and technology diffusion in SMEs.