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Effect of Emerging Technologies on Operational Efficiency of Commercial Banks in Kenya

Stephen Githaiga Ngware
Department of Accounting, Finance, Economics and HR, USIU Africa
P. O. Box 14634 - 00800, Nairobi, Kenya
Email: sngithaiga@gmail.com

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Abstract

This paper examines how emerging technologies impact operational efficiency and long-term sustainability in Kenyan commercial banks. It utilizes Schumpeter's innovation theory, the Diffusion of Innovation theory, and the Technology Acceptance Model to assess the implementation of integrated payment technologies, predictive data analytics, generative artificial intelligence, and cryptocurrency in banking. While some banks have modernized their systems, many Tier II and III banks still face operational inefficiencies and rising non-performing loans. The study, involving 190 participants from 38 banks. Purposive sampling identified five respondents from each bank, specifically targeting individuals with pertinent knowledge in technology adoption and operational practices and found that adopting these technologies is crucial for enhancing operational performance. Inferential analysis revealed a strong positive relationship between emerging financial technologies and operational efficiency in Kenyan commercial banks ($R = 0.836$, $R^2 = 0.699$, Adj. $R^2 = 0.683$, SE = 0.3271). The model was statistically significant ($F = 9.684$, $p < 0.05$), indicating that the predictors jointly explain 69.9% of the variation in operational efficiency. All variables had significant positive effects: Integrated Payment Technology ($B = 0.5294$, $p = 0.000$), Predictive Data Analytics ($B = 0.4447$, $p = 0.001$), Generative AI ($B = 0.3816$, $p = 0.004$), and Crypto Assets Technology ($B = 0.2951$, $p = 0.009$). It concludes that the efficiency of Kenyan banks increasingly relies on effective technology integration and recommends investing in staff training, improving customer awareness, and establishing strong governance frameworks to adapt to the evolving financial landscape.

Key Words: Integrated Payment Technology, Predictive Data Analytics, Artificial intelligence, Crypto Assets, Operational Efficiency

Introduction

Emerging technologies are essential for improving commercial bank efficiency, replacing traditional banking with digital services that enhance customer satisfaction and reduce costs (Agarwal, 2010). Key innovations include FinTech, AI, big data, and blockchain, which enable online banking, ATMs, and electronic payments (Zhang et al., 2021). The COVID-19 pandemic accelerated digital adoption, with mobile banking transactions up 121% globally from 2019 to 2022 (McKinsey & Company, 2023). Digital-only banks and mobile money, such as Kenya's M-Pesa, have increased financial inclusion, providing services to previously unbanked populations (GSMA, 2022).

Banks face rapid technological change, globalization, and evolving consumer preferences, especially among youth, pushing them to adopt digital solutions and customer-centric, virtual frameworks (Gumilar et al., 2024; Nor, 2024). Technologies like Internet of Things (IoT) and Artificial Intelligence (AI) are transforming financial markets, requiring institutions to invest in advanced solutions and highlighting the need for digital financial literacy (De'Ulizia et al., 2024; Gumilar et al., 2024). Artificial Intelligence and machine learning are improving financial forecasting and operational resilience (Verma & Pandiya, 2024; Kanupriya, 2024). However, these advancements bring challenges, including the need to address new cybersecurity threats while enhancing user experience (Familoni & Shoetan, 2024; Tapscott & Tapscott, 2017).

Technological progress and globalization require banks worldwide to innovate, with Zhao et al. (2019) emphasizing this need. In the US and Europe, maintaining competitiveness through technology is crucial (Oke & Goffin, 2019), and efficient resource use via technology is vital in such markets (Davila et al., 2010). Innovation in banking is often prompted by new products, services, or processes in response to technological change (Magotra et al., 2018).

In Africa, banks are adopting digital platforms like internet, agency, and mobile banking to improve efficiency and increase financial inclusion, even during global disruptions. The integration of AI and IoT is reshaping financial markets, compelling banks to adopt these technologies to remain competitive (Mamela et al., 2024). Consequently, digital financial literacy is becoming more important. AI and machine learning are enhancing forecasting accuracy and operational resilience (Verma & Pandiya, 2024; Kanupriya, 2024). However, these advances also increase cybersecurity risks, particularly in mobile banking, underscoring the need for strong risk management (Familoni & Shoetan, 2024; Tapscott & Tapscott, 2017).

Kenya leads Africa in digital financial innovation, with the success of platforms like M-Pesa and a strong focus on digital literacy playing a transformative role (Hezron & Mutua, 2024; Mugane & Ondigo, 2016; Gathara et al., 2023). The adoption of digital technologies by the youth is essential for continued innovation and stability in the financial sector (Muttai et al., 2023; Gumilar et al., 2024). Across Africa, strategic partnerships, new financial products, and technological integration are improving performance, asset quality, and financial stability in banks.

The banking industry is undergoing significant changes driven by blockchain, cloud computing, AI, and IoT (Khan & Javaid, 2022; Gatteschi et al., 2020; Kariuki et al., 2024). These technologies are crucial for increasing efficiency, security, and transparency in financial operations (Wang & Kogan, 2018; Garanina et al., 2022). Blockchain technology, initially developed for cryptocurrencies, now promises transformative impacts across industries (Shyshkova, 2018).

While blockchain has broad applications in developing economies such as Jordan, its complex effects on Accounting Information Systems (AIS) and bank performance require further research. There is a growing recognition of blockchain's revolutionary potential in financial services, but specific empirical evidence for its impact on Jordan's commercial banks is still developing (Schmitz & Leoni, 2019; Shyshkova, 2018). Similarly, limited research exists on how advanced technologies enhance operational efficiency in Kenyan commercial banks. This study addresses these gaps by exploring the influence of emerging technologies on operational metrics and long-term financial sustainability in Kenyan banks. The research also applies

Schumpeter's theory of innovation and the Technology Acceptance Model (TAM) to show how technology adoption drives performance improvement.

Operational efficiency refers to an organization's ability to manage resources to achieve goals with minimal waste, largely through enhancing processes and systems (Olumoh, 2025). Key performance indicators (KPIs) of operational performance include efficiency, productivity, quality, cost control, service delivery, and customer satisfaction. High operational performance signals optimal resource use and achievement of strategic objectives without major obstacles (Akanbi, 2023; Kelvin-Iloafu et al., 2023). In banking, operational performance involves effective daily management of operations, operational risks, and income generation, including handling customer deposits, loans, investments, and strict regulatory compliance. Since banking is service-based, operational success depends on efficient customer service (Mbunji, 2024).

Achieving operational efficiency through new technologies is challenging due to high initial costs and cybersecurity demands, particularly for smaller banks (Alonge et al., 2024). Resistance to change from staff and customers, as well as regulatory complexities, further impedes digital transformation (Şişu et al. 2024). To address these, Kenyan banks should invest in employee training, customer digital literacy, and adopt scalable technologies like cloud computing and AI. Collaboration with fintechs can provide advanced solutions efficiently. Leveraging digital tools enables better service delivery, stronger customer relationships, and sustainable growth, helping banks stay competitive in a rapidly changing financial sector (Goel, & Kashiramka, 2025).

Theoretical Framework and Conceptual Model

This study is grounded in the Technology Acceptance Model (TAM) (Davis, 1989), which identifies perceived usefulness (PU) and perceived ease of use (PEU) as essential for users' acceptance of new technologies. In digital banking, PU reflects enhanced efficiency, while PEU denotes system simplicity. TAM's relevance is supported by research showing adoption is influenced by user perceptions, regulatory support, and trust. In Kenya, digital banking (e.g., mobile and internet banking) is on the rise but faces hurdles like infrastructure and cybersecurity issues. The study also employs the Diffusion of Innovations Theory (DoI) (Rogers, 1962), which explains how innovations spread, emphasizing factors such as relative advantage and compatibility. By combining TAM and DoI, the study formulates a thorough framework for examining digitalization in Kenyan banking. The framework draws on DOI, perceived risks, agent/service trust, and facilitating conditions. DoI identifies five innovation traits complexity, compatibility, observability, relative advantage, and trialability as crucial for adoption.

This study also applies Schumpeter's theory of innovation, which argues that businesses create new profit opportunities by introducing disruptive products, leading to economic renewal cycles (Schumpeter, 1954). Innovations attract imitators, triggering further innovation. Porter (1992) reinforces the need for continual improvement for sustained competitiveness and growth. While Solow (2007) critiques the theory's simplicity regarding socioeconomic complexities, it remains relevant for digital banking and fintech. Integrated payment services that enhance efficiency and reduce costs fit Schumpeter's model and are supported empirically by Berger (2003) and Columba (2009). However, Lambert (2019) questions banks' centrality in innovation, suggesting regulatory and market factors are more influential. Additionally, there are concerns about unintended effects, such as increased inequality and concentration of financial power among major banks.

The conceptual framework for this study examines how emerging technologies in the banking sector affect operational efficiency in commercial banks. Emerging technologies, exemplified by the shift to technology-driven services like internet of things, crypto and block chain technologies, AI, cloud computing, payment technologies, internet banking, electronic payments, and automated services, aims to improve customer experience, lower costs, and enhance service accessibility and in return improve operational efficiency of commercial banks. The dependent variable, operational efficiency, is measured primarily by increase in operational profit and decrease in operational expenses which gauges a bank's efficiency in generating earnings. The study also considers integrated payment technologies, predictive data analytics, generative AI and integration of crypto assets into banking operations as independent variables.

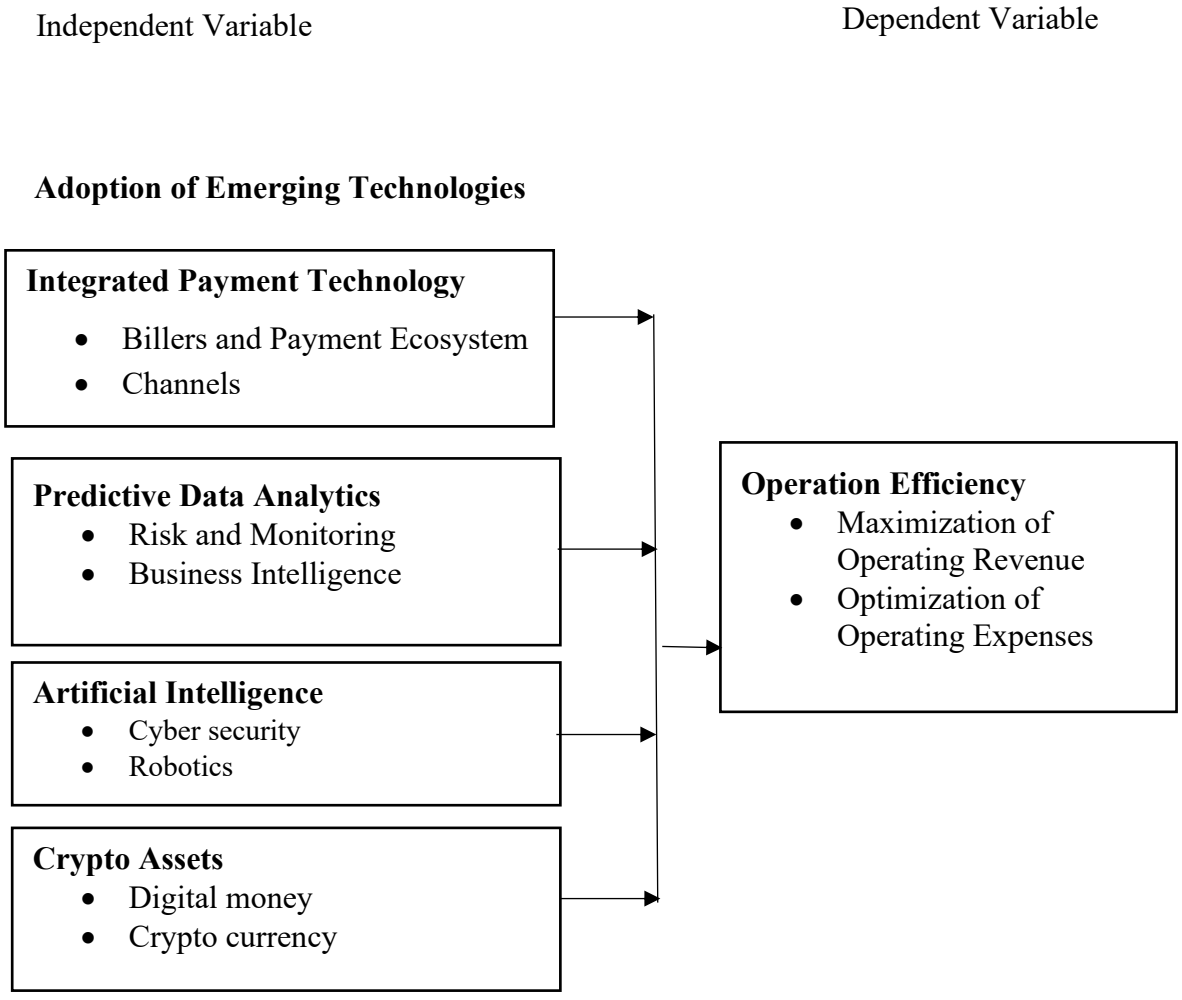

Figure 1. Conceptual Model

Literature Review

Integrated Payment Technology and Operational Efficiency of Commercial Banks in Kenya

Recent research highlights how advancements in payment technologies significantly impact the performance of commercial banks around the globe. For example, a study in Nigeria by Mohammed, Ibrahim, and Muritala (2022) found that payment methods like POS, internet, and mobile payments positively affected banks' return on assets. However, they noted that Real-Time Gross Settlement (RTGS) systems had a negative impact, pointing to the need for more widespread adoption and public understanding of these modern systems.

In China, Yao et al. (2018) revealed that third-party payment platforms not only facilitated better money circulation but also contributed to earnings growth. This showcases how technology can create beneficial synergies that enhance financial sector growth. Similarly, research from Kenya by Chelangat et al. (2022) indicated that adopting payment cards boosted revenue and customer engagement, further underscoring how integrated financial systems can positively affect bank performance.

On the flip side, a study by Quan et al. (2024) found that third-party payment platforms could reduce non-interest revenue across 38 banks, highlighting competitive pressures on traditional income sources. Meanwhile, in Malaysia, Kee et al. (2021) demonstrated that during the COVID-19 pandemic, cashless payment systems significantly improved transaction efficiency, safety, and customer satisfaction. They emphasized the importance of continuing to invest in integrated financial systems to enhance resilience. These studies paint a complex picture of how payment technology adoption presents both opportunities and challenges. They remind banks of the importance of balancing innovation with sustainable profitability to thrive in an ever-evolving financial landscape.

Predictive Data Analytics and Operational Efficiency of Commercial Banks in Kenya

The financial sector has become increasingly complex, and as a result, banks are turning to predictive analytics to help navigate this landscape. This technology is being used in various areas such as credit risk management, fraud detection, customer engagement, and improving operational efficiency. In credit risk evaluation, banks are leveraging machine learning techniques to get a better grip on default probabilities. By analyzing a wide range of data everything from financial histories to spending habits they can assess loan risks more accurately, which ultimately leads to healthier loan portfolios (Shaheen & Elfakharany, 2018). When it comes to fighting fraud, predictive analytics plays a key role here as well. With adaptive models that learn from new fraudulent activities, banks can maintain their accuracy even as digital threats evolve (Addy et al., 2019). On the customer service side, these models are enhancing the overall experience by anticipating individual needs and helping banks design tailored products that foster loyalty and satisfaction (Korns & May, 2019). Operationally, the automation of processes like credit scoring and marketing management helps banks save money, reduce the chance of human error, and boost efficiency (Nwafor et al., 2020).

In essence, the research highlights how predictive analytics is transforming the banking industry by improving decision-making, protecting institutions, and boosting competitiveness. Despite its numerous advantages, the application of predictive analytics in banking also presents certain drawbacks. A core concern is the privacy and data security. Financial institutions must handle customer information responsibly and adhere to regulatory requirements. Additionally, integrating predictive analytics into existing banking frameworks and workflows often requires a significant investment in technology and employee training.

Adoption of Generative AI and Operational Efficiency of Commercial Banks in Kenya

Recent research underscores the expanding influence of generative artificial intelligence (AI) within banking. Evidence suggests that this technology can significantly improve efficiency, risk management, and customer engagement. Al-Hchemi (2024) discusses how generative AI can enhance operational processes by providing tailored services, advancing fraud detection, and refining risk assessment. This leads to better decision-making and the development of personalized products, ultimately increasing customer satisfaction.

Similarly, contributions from Singh et al. (2025) reveal that AI integration in Europe has positively impacted loan processing and fraud detection. This not only minimizes errors but also enhances operational efficiency. However, they also note that the long-term effects of AI implementation require further investigation. Pattanayak (2023) emphasizes the transformative impact of generative AI on risk management. It allows for more precise threat predictions and strengthens compliance efforts. Moreover, he highlights the necessity for solid governance frameworks to mitigate data security and ethical issues.

Vučinić and Luburić (2024) extend this analysis beyond traditional banks, examining how AI and fintech advancements are reshaping the financial landscape. While these developments lead to efficiency improvements, they also pose regulatory challenges for central banks, particularly regarding neobanks and decentralized finance. These studies collectively affirm that generative AI has the potential to significantly enhance efficiency and resilience in the banking sector. Achieving its full promise requires addressing ethical, security, and stability concerns associated with its widespread adoption.

Integration of Crypto Assets Technology and Operational Efficiency of Commercial Banks in Kenya

The integration of blockchain technology has significantly transformed the banking sector, demonstrating its capacity to enhance efficiency, transparency, and security. Research by Khatri and Kaushik (2021) illustrates how blockchain streamlines operations by removing intermediaries, decreasing the need for paperwork, and supporting environmental sustainability. Guo and Liang (2025) further emphasize the technology's potential to meet customer expectations and drive innovation.

Practical examples, such as the implementation of blockchain infrastructure by NASDAQ, provide concrete evidence of its benefits, including reduced operational costs and optimized processes (Gatteschi et al., 2020). The findings of George et al. (2018) and ALSaqa et al. (2019) reinforce blockchain's effectiveness in mitigating inefficiencies through lowered paper usage, fraud prevention, and fewer errors. Additionally, Shyshkova (2018) along with Pal, Tiwari, and Behl (2021) highlight its significance in enhancing transparency and refining accounting practices. Wu and Duan (2019) point out the technology's capacity to improve bill processing, facilitate cross-border payments, and enable asset securitization within commercial banks, ultimately leading to decreased transaction costs for various stakeholders.

In emerging markets, the attention on blockchain adoption is escalating. Aketch, Mwambia, and Baimwera (2021) explored commercial banks in Kenya, revealing a strong positive correlation between blockchain utilization, reduced transaction costs, and a favorable policy environment. Recommendations for policy revisions aim to strengthen risk management and protect financial markets, alongside a call for further research into blockchain’s stability and its wider economic consequences. Meanwhile, Patel et al. (2021) warn that, despite the technology’s numerous advantages, high adoption costs and the necessity for specialized

infrastructure create obstacles, while dependence on qualitative evidence hinders a comprehensive understanding of its overall impact.

The collective findings underscore the considerable potential of blockchain in enhancing operational efficiency, preventing fraud, and lowering costs. However, achieving widespread adoption necessitates careful consideration of costs, infrastructure, and regulatory environments.

Methodology

The study uses a positivist research philosophy focused on objectivity, empirical measurement, and quantitative analysis to examine relationships between variables (Sileyew, 2019). This approach aligns with the goal of evaluating how digitalization impacts the operational performance of commercial banks in Kenya using statistical analysis and hypothesis testing. Employing a deductive research method, the study builds hypotheses from existing literature and empirical work (Creswell, 2024), then tests them with quantitative data from commercial banks. This method ensures the analysis is systematic, reliable, and generalizable, allowing for unbiased conclusions about the effect of emerging technologies on banking efficiency. Quantitative methods also provide statistical validation, minimize bias, and strengthen research rigor.

The study employed a descriptive correlational research method to investigate how adopting emerging technologies relates to banking operational efficiency. Descriptive research, as noted by Kumar and Praveenakumar (2025), provides detailed profiles of events, drawing insights from various perspectives. The correlational design enabled data collection from a broad participant base, analysing current circumstances without altering variables or influencing the environment. The approach was quantitative in nature. The multiple linear regression was obtained as below;

$$OE = f\,(IPT, PDA, GAI, CAT) \qquad (1)$$

$$OE=\beta_0 +\beta_1 IPT +\beta_2 PDA +\beta_3 GAI +\beta_4 CAT + \epsilon \qquad (2)$$

Where, OE = Operational Efficiency
IPT = Integrated Payment Technology
PDA = Predictive Data Analytics
GAI= Generative Artificial Intelligence
CAT = Crypto Assets Technology
β_0 = regression coefficients
$\beta 1 - \beta 4$ = Beta Co-efficient of Determination

Findings

Descriptive Statistics

The author employed purposive sampling and distributed a total of 190 questionnaires, targeting five employees from each of the 38 commercial banks selected for the study with 162 returned (85.3% response rate). Twenty-eight questionnaires were incomplete or unreturned. Respondents' ages: 19% (20-29), 46% (30-39), 25% (40-49), and 10% (50+), indicating most were in the 30-49 range, a group likely experienced with new technologies. Education levels showed 74% held undergraduate/postgraduate degrees, 24% had diplomas/certifications, and 2% had only secondary education, suggesting strong academic readiness. For work experience:

6% had <1 year, 42% had 1-5 years, 34% had 6-10 years, and 18% had over 10 years, showing most had significant operational exposure. Respondents largely agreed that technologies like Integrated Payment Technology, Predictive Data Analytics, Generative AI, and Crypto Asset Technology improved operational efficiency, with average scores between 3.7 and 4.0 and low standard deviations, indicating consensus.

Table 1. Descriptive Statistics Summary

Variables	Weighted Average	Standard Deviation
Operational Efficiency of Commercial Banks	3.7824	0.7216
Integrated Payment Technology Adoption	3.9132	0.6873
Predictive Data Analytics Usage	4.0196	0.6357
Generative Artificial Intelligence Adoption	3.9618	0.7145
Crypto Assets Technology Integration	3.8849	0.7632

Diagnostic tests

To assess the appropriateness of the dataset for multiple linear regression analysis, a series of diagnostic tests were conducted to evaluate the underlying assumptions of the classical linear regression model. These assumptions include normality of residuals, absence of multicollinearity, independence of errors, and homoscedasticity. Verifying these assumptions is essential for ensuring the reliability and validity of the regression estimates.

Normality of the data was tested using the Shapiro-Wilk test, which is recommended for moderate sample sizes due to its sensitivity in detecting departures from normality. As reported in Table 2 all variables yielded p-values greater than the 0.05 threshold (e.g., $p = 0.06$ for Integrated Payment Technology; $p = 0.08$ for Predictive Data Analytics), indicating that the null hypothesis of normal distribution could not be rejected. These results confirm that the data approximates normality, thereby satisfying this assumption for regression analysis.

Table 2. Normality test

Variable	Statistic	df	Sig.	Remark
Integrated Payment Technology	0.9742	162	0.06	Normally Distributed
Predictive Data Analytics	0.9765	162	0.08	Normally Distributed
Generative Artificial Intelligence	0.9718	162	0.06	Normally Distributed
Crypto Assets Technology	0.9751	162	0.07	Normally Distributed
Operational Efficiency	0.9703	162	0.05	Normally Distributed
a Lilliefors Significance Correction				

Multicollinearity was assessed using VIF and tolerance values. All independent variables had VIFs below 5, with the highest VIF being 3.464 for Crypto Assets Technology, and all tolerance values above 0.2. These results indicate that multicollinearity is not a concern, and the independent variables are sufficiently distinct for reliable regression analysis.

Table 3. Collinearity Statistics

Variable	Tolerance Limit	VIF	Remark
Integrated Payment Technology	0.412	2.426	No Multicollinearity
Predictive Data Analytics	0.368	2.717	No Multicollinearity
Generative Artificial Intelligence	0.351	2.85	No Multicollinearity
Crypto Assets Technology	0.289	3.464	No Multicollinearity

Dependent Variable: Operational Efficiency

Autocorrelation was measured using the Durbin-Watson test, which evaluates the independence of residuals. The test produced a statistic of 1.981 (see Table 4), which falls within the acceptable range of 1.5 to 2.5. This suggests no evidence of serial correlation in the residuals, thus supporting the assumption of error independence within the regression model.

Table 4. Autocorrelation test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.826[a]	0.682	0.597	0.56321	1.981

[a] *Predictors: (Constant), Integrated Payment Technology, Predictive Data Analytics, Generative AI, Crypto Assets Technology*

Dependent Variable: Operational Efficiency

The Breusch-Pagan test was used to assess homoscedasticity, yielding a Chi-square value of 1.284 and a p-value of 0.257. Since the p-value is greater than 0.05, the assumption of constant variance in the error terms (homoscedasticity) is supported. This result indicates that the variance of the residuals remains stable across the predictors, meeting a key regression requirement.

Table 5. Homoscedasticity test

Chi-Square	df	Sig.
1.284	1	0.257

Notes:

a. **Dependent Variable**: Operational Efficiency

b. This test evaluates the null hypothesis that the variance of the residuals is constant (homoscedastic) and not influenced by the independent variables.

c. **Model predictors**: Intercept + Integrated Payment Technology + Predictive Data Analytics + Generative Artificial Intelligence + Crypto Assets Technology

Where possible assumption violations were suspected, robust standard errors were applied to mitigate the impact of heteroscedasticity and ensure the accuracy of inferential statistics.

Overall, the diagnostic tests confirmed that the dataset met the necessary conditions for conducting multiple linear regression analysis.

Inferential Results

Model Summary

The model summary demonstrates that the coefficients of determination reflect the extent to which each predictor contributes to the dependent variable. The R-squared value, which in this case is 0.699, indicates that 69.9% of the operational efficiency of commercial banks in Kenya can be explained by the adoption of emerging technologies, specifically Integrated Payment Technology, Predictive Data Analytics, Generative Artificial Intelligence, and Crypto Assets Technology.

Table 6. Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.836	0.699	0.683	0.3271

The regression results show a strong positive correlation between the independent variables and operational efficiency (R = 0.836). The model explains about 69.9% of the variation in operational efficiency (R Square = 0.699), and this remains high after adjusting for predictors (Adjusted R Square = 0.683). The standard error of 0.3271 suggests residuals are closely clustered around the regression line.

Analysis of Variance

Dependent Variable: Operational Efficiency

Table 7. ANOVA (b)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	12.782	4	3.1955	9.684	.000(a)
Residual	10.560	32	0.3300		
Total	23.342	36			

The ANOVA results show the regression model is statistically significant ($F = 9.684$, $p < 0.001$), meaning the combined independent variables significantly explain the variance in operational efficiency. The model's high F-statistic and low p-value confirm its strong explanatory power.

Table 8. Multiple Linear Regression Analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	0.4728	0.1412		3.347	0.002
IPT	0.5294	0.1326	0.173	3.991	0.000
PDA	0.4447	0.1203	0.162	3.697	0.001
GAI	0.3816	0.1171	0.148	3.259	0.004
CAT	0.2951	0.1098	0.122	2.688	0.009

a. Dependent Variable: Operational Efficiency

Multiple linear regression analysis showed that emerging financial technologies significantly improve operational efficiency in banking. The regression model (OE = 0.4728 + 0.5294 IPT + 0.4447 PDA + 0.3816 GAI + 0.2951 CAT + ε) found all four variables to have statistically significant positive effects ($p < 0.05$). Integrated Payment Technology had the strongest effect ($B = 0.5294$, $p < 0.001$), followed by Predictive Data Analytics ($B = 0.4447$, $p = 0.001$), Generative AI ($B = 0.3816$, $p = 0.002$), and Crypto Assets Technology ($B = 0.2951$, $p = 0.009$). These results suggest that advanced technologies enhance operational efficiency. This supports findings by Barbosa and Graças Murici (2019) that technology adoption reduces costs and improves service by minimizing manual processes. The results also align with Goel & Kashiramka (2025), highlighting the role of digital tools in boosting efficiency, service quality, and sustainability in banking.

Discussion of Findings

The study demonstrates that the integration of emerging technologies, such as advanced payment systems, is fundamentally transforming banking operations. Drawing on Financial Intermediation Theory, the Technology Acceptance Model (TAM), and Schumpeter's Theory of Innovation, the findings reflect the critical impact of innovation and user perceptions on technological adoption in the financial sector (Schumpeter, 1954). Specifically, TAM highlights that perceived usefulness and ease of use are key drivers of crypto asset acceptance, emphasizing user-centric approaches in financial services.

Empirical evidence shows that payment technology integration enhances operational efficiency and competitiveness in commercial banks. For instance, Mohammed, Ibrahim, and Muritala (2022) found that internet and mobile payments improved Nigerian banks' performance by reducing costs and streamlining processes. Similarly, Yao et al. (2018) reported that third-party payment systems in China fostered money flow and earnings growth, underscoring the productivity benefits of modern payment solutions.

Further, Chelangat et al. (2022) observed that Kenyan banks adopting innovative payment card systems achieved revenue growth and increased consumer engagement. The shift to cashless payments during COVID-19, as documented by Kee et al. (2021), led to faster transactions and higher customer satisfaction. Although Quan et al. (2024) identified possible declines in non-interest income from third-party platforms, they reaffirmed that payment system innovation is vital for profitability. Collectively, these studies establish that integrated payment technologies are instrumental in improving the operational efficiency of commercial banks, with particular benefits observed in Kenya.

The research demonstrates that predictive analytics significantly enhances loan portfolio quality by enabling more informed lending decisions based on comprehensive behavioral and financial data (Shaheen & Elfakharany, 2018). It also boosts fraud detection and risk management (Andriosopoulos et al., 2019), and supports the personalization of financial products to increase customer engagement and satisfaction (Korns & May, 2019). Further, predictive analytics improves operational efficiency and reduces resource waste through automation (Nwafor et al., 2019). Importantly, the study notes that previous concerns about data privacy and implementation barriers (Shaheen & Elfakharany, 2018) have been addressed in Kenyan banks.

The findings align with existing literature on generative AI, indicating its positive impact on commercial banks' operational efficiency. Generative AI automates internal processes,

customizes client services, and enhances fraud detection and risk assessment, leading to quicker, more accurate service delivery, cost savings, and reduced manual effort (Al-Hchemi, 2024). It also supports proactive risk management, optimized compliance, and improved real-time decision-making, thus boosting operational agility and performance (Pattanayak, 2023).

Specifically, in Kenya, the adoption of generative AI in banking has led to improved fraud detection, streamlined loan approvals, and reduced human error, corroborating the findings of Singh et al. (2025) and Vučinić and Luburić (2024). While long-term outcomes in Europe remain uncertain (Singh et al., 2025), Kenyan banks have achieved short-term operational gains, indicating faster adaptation. The sector continues to advance despite ongoing regulatory and security concerns (Vučinić & Luburić, 2024). The integration of crypto assets also enhances efficiency by leveraging decentralized, secure, and real-time technologies, reducing transaction times, cutting costs, and increasing transparency (Guo & Liang, 2016; Dey & Shekhawa, 2021). Leading institutions like NASDAQ have successfully adopted these infrastructures.

In Kenya, favorable regulations and robust infrastructure have facilitated a strong relationship between operational performance and crypto technology use (Aketch et al., 2021). Both this study and prior research confirm that crypto adoption secures operations, improves service quality, and accelerates transactions, making it a strategic and technological upgrade for long-term sustainability.

Conclusion and Recommendations

The regression analysis indicates that emerging technologies such as predictive analytics, financial technology platforms, generative AI, and crypto assets substantially boost the operational efficiency of Kenyan commercial banks. Predictive analytics enhances resource allocation, risk control, and understanding of customer behavior. Financial technology platforms break down operational barriers, improve reporting, and streamline service delivery. Generative AI automates processes, aids in fraud detection, provides real-time insights, and enhances customer service. Crypto assets introduce innovations like smart contracts and faster, lower-cost cross-border transactions, fostering financial inclusion.

To benefit fully, banks must integrate these technologies into their core operations, which involves staff training, customer education, and strong governance to address risks such as algorithmic bias, data security, and cryptocurrency volatility. Collaborating with fintech firms, setting clear performance metrics, and adapting to regulatory changes are also vital. Further research should explore leadership roles, strategic alignment, and customer readiness for technological change. Ultimately, operational efficiency depends on effectively embedding these technologies in daily banking processes rather than relying only on traditional systems.

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