

AGILE VIRTUAL ICT SYSTEMS AND PROCESS OPTIMIZATION IN COMMERCIAL BANKS IN NAIROBI CITY COUNTY, KENYA

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ABSTRACT

Commercial banks play a critical role in the economic development of Kenya by providing essential financial services that foster economic growth and stability. The performance of commercial banks in Kenya is influenced by various challenges owing to the rapidly evolving financial landscape, they face growing pressure to enhance operational efficiency, deliver superior customer experiences to remain agile in responding to the market dynamics. The general objective of the study is to assess the effect of agile virtual ICT systems on process optimization of commercial banks in Nairobi City County, Kenya. Specifically, the study sought to examine the effect of adoption of ICT tools in process optimization in commercial banks in Nairobi City County, Kenya, and to assess the effect of DevSecOps systems in process optimization in commercial banks in Nairobi City County, Kenya. This study was guided by Technology Acceptance Model (TAM) and Socio-Technical Systems Theory. This study used descriptive research design. The target population was the 40 commercial banks in Nairobi City County, Kenya. The unit of observation was top, middle and lower-level management employees. The study used Krejcie and Morgan (1970) formula to arrive at the sample size. The study sample size was therefore 152 employees. Stratified random sampling was applied to get the respondents. Data was collected using a self-administered structured questionnaire. A pilot test was conducted to determine validity and reliability of the data collection instrument. Data obtained from the field was coded, cleaned, and entered into the computer for analysis using the SPSS version 25. Data analysis was done through use of descriptive and inferential statistics. Descriptive statistics included frequency, percentages, mean and standard deviation. Inferential statistical analysis used was multiple regression and correlation analysis. The study results were presented through use of tables and figures. The study concludes that ICT tools have a positive and significant effect on process optimization in commercial banks in Nairobi City County, Kenya. Further, the study concludes that DevSecOps systems have a positive and significant effect on process optimization in commercial banks in Nairobi City County, Kenya. The study recommends that the management of commercial banks in Kenya should invest in the integration of advanced ICT tools such as enterprise resource planning (ERP) systems to enhance process optimization.

Key Words: Agile Virtual ICT Systems, Process Optimization, Commercial Banks, Nairobi City County, ICT Tools, DevSecOps Systems

Background of the Study

The financial sector is a critical component of the global economy, encompassing a wide range of institutions and services including banks, investment firms, insurance companies, and real estate entities. It facilitates the flow of capital, manages risk, and provides the infrastructure for monetary transactions and economic growth (Amar & Haag, 2022). Key functions of the sector include lending, investing, asset management, and financial planning. Technological innovations like fintech, digital banking, and blockchain are rapidly transforming the landscape, increasing efficiency but also introducing new risks (Cunha & Putnik, 2023). Commercial banks are financial institutions that provide a wide range of banking services to individuals, businesses, and governments, primarily focused on accepting deposits, offering checking and savings accounts, and extending loans (Salehi, 2021). They play a central role in the economy by facilitating money circulation, providing credit for consumption and investment, and supporting business operations through services like cash management and trade finance (Somanathan, 2024).

Commercial banks play a vital role in the financial system by serving as intermediaries between savers and borrowers. They accept deposits from individuals, businesses, and institutions, providing a safe place to store money (Allahawiah, 2023). These deposits form the foundation for the bank's ability to issue loans, which are extended to households for personal needs like buying homes or cars, and to businesses for expansion, operations, or investment. This lending activity fuels consumption and economic growth, making commercial banks essential for development (Niyigena & Mbonigaba, 2021). In addition, commercial banks offer a range of financial services that support economic activity. These include issuing credit and debit cards, facilitating domestic and international money transfers, and providing online and mobile banking services (Godbless, 2022). Banks also offer investment products, financial advice, and safe deposit boxes. By offering these services, commercial banks help individuals manage their finances and enable businesses to operate efficiently (Mohamud, 2021).

Commercial banks also play a key role in implementing monetary policy. Central banks, such as the Federal Reserve or European Central Bank, influence interest rates and money supply through commercial banks by setting reserve requirements or adjusting policy rates (Tamanda, 2024). When commercial banks respond by increasing or decreasing their lending, they directly impact economic activity, inflation, and employment. Therefore, commercial banks act as a transmission mechanism for central bank policies. Furthermore, commercial banks contribute to financial stability and confidence in the economy (Omoruyi, Sobanke & Ijidakinro, 2023). Through risk assessment and credit evaluation, they help ensure that capital is allocated to productive and creditworthy borrowers (Obonyo & Muchelule, 2023). Regulatory oversight ensures they maintain sound financial practices, manage risks appropriately, and protect depositors' funds. Overall, the role of commercial banks is foundational to economic growth, financial stability, and the smooth functioning of modern economies (Nyang'au & Nyang'au, 2024).

In today's rapidly evolving financial landscape, the need for agility and technological innovation has become a critical priority for commercial banks globally. Agile virtual ICT (Information and Communication Technology) systems refer to flexible, adaptive, and collaborative digital infrastructures designed to support rapid development, deployment, and scaling of services or solutions in virtual environments (Mwania & Kyule, 2024). These systems leverage cloud computing, virtualization, and agile methodologies to enhance responsiveness to change, enable remote collaboration, and support continuous integration and delivery (Barno & Rotich, 2023). By emphasizing modularity, real-time communication, and iterative improvement, agile virtual ICT systems help organizations remain competitive in dynamic technological and business landscapes (Ndirangu, 2022). ICT tools encompass a broad range of technologies such as communication platforms (Slack, Microsoft Teams),

productivity software (Microsoft Office, Google Workspace), and collaborative environments (cloud storage and virtual meeting tools) that enable seamless interaction, data sharing, and workflow coordination across geographically dispersed teams (Amar & Haag, 2022).

DevSecOps integrates security practices into every phase of development, promoting a “shift-left” approach where potential vulnerabilities are addressed early rather than post-deployment. This is especially critical in today’s threat landscape, where rapid development must not compromise security (Salehi, 2021). This study sought to assess the effect of agile virtual ICT systems on process optimization of commercial banks in Nairobi City County, Kenya.

Statement of the Problem

Commercial banks in Kenya play a vital role in driving economic growth by providing essential financial services that support businesses, individuals, and the government. However, in today’s increasingly digital banking environment, their ability to optimize internal processes has become a major determinant of competitiveness and service quality. Although global banking institutions have embraced agile virtual ICT systems—such as cloud computing, agile software development, and real-time analytics—to enhance process efficiency, many commercial banks in Nairobi City County still rely on legacy systems and manual operations. These inefficiencies lead to delays in service delivery, poor data integration, and limited operational agility.

In addition, high operational costs continue to constrain the profitability and sustainability of commercial banks. Outdated ICT infrastructure, fragmented systems, and labor-intensive processes contribute to escalating administrative and maintenance expenses. While technologies like DevSecOps frameworks have the potential to minimize repetitive tasks and streamline workflows, their limited adoption among Kenyan banks means that cost-saving opportunities remain largely untapped. Consequently, financial institutions continue to experience high overheads that could be reduced through integrated and automated ICT-driven processes.

Customer experience has also become a key differentiator in the modern banking industry, yet many Kenyan commercial banks face persistent challenges in providing seamless digital services. Frequent system downtimes, delayed transactions, and a lack of personalized service offerings have led to customer dissatisfaction and migration to more agile FinTech alternatives. The absence of robust Continuous Integration/Continuous Deployment (CI/CD) practices and agile response systems undermines banks’ ability to offer real-time, reliable, and customer-centric services. Therefore, despite the potential of agile virtual ICT systems to enhance process efficiency, reduce operational costs, and improve customer experience, their implementation and effectiveness within commercial banks in Nairobi City County remain insufficiently explored.

Despite Kenya's position as a regional leader in fintech innovation, many banks continue to face significant process inefficiencies, such as delays in customer onboarding, loan processing, and interdepartmental communication. According to the Kenya Bankers Association (2023), 43% of commercial banks reported persistent workflow bottlenecks, largely attributed to poor integration of virtual ICT solutions. Furthermore, a 2023 Central Bank of Kenya (CBK) report indicated that only 52% of banks had implemented fully agile ICT environments, while 48% still rely on fragmented legacy systems that limit scalability and adaptability. Additionally, findings from a PwC Kenya Digital Banking Survey (2022) showed that while 85% of banking executives acknowledged the potential of agile ICT systems to transform operations, only 39% reported measurable improvements in process optimization after digital transformation efforts. These discrepancies raise concerns about whether current virtual ICT systems are designed and deployed in ways that truly support agile methodologies and end-to-end process improvement.

Despite the availability of these agile ICT tools, many banks lack a unified strategy to implement and integrate them effectively. There is also limited empirical research particularly within the Kenyan banking sector on how these technologies jointly influence process optimization. This study, therefore, seeks to investigate how the strategic adoption of Virtual ICT Systems, RPA, DevSecOps, and CI/CD systems affects process optimization, cost efficiency, customer experience and risk management in Commercial Banks in Nairobi City County, Kenya.

General Objective

The general objective of the study is to assess the effect of agile virtual ICT systems on process optimization of commercial banks in Nairobi City County, Kenya.

Specific Objectives

- i. To examine the effect of adoption of ICT tools in process optimization in commercial banks in Nairobi City County, Kenya
- ii. To assess the effect of DevSecOps systems in process optimization in commercial banks in Nairobi City County, Kenya

LITERATURE REVIEW

Theoretical Review

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a theoretical framework developed to understand and predict how users adopt and use new information technology. Initially proposed by Fred Davis (1986), TAM suggests that the adoption of technology is primarily driven by two main factors: perceived usefulness and perceived ease of use (Loh, Flicker & Horner, 2020). Perceived usefulness refers to the degree to which a person believes that using a particular technology will enhance their job performance or productivity. This perception hinges on whether the technology is perceived as valuable and beneficial in achieving specific goals or tasks (Nyakito, Amimo & Allida, 2021). For instance, if employees believe that adopting a new software system will streamline their workflow, increase efficiency, or improve decision-making, they are more likely to view it as useful and consequently more inclined to adopt it (Ojwang, Lee & Waruru, 2020).

Perceived ease of use, on the other hand, pertains to the extent to which a person believes that using the technology will be effortless and uncomplicated. It considers factors such as the simplicity of the interface, the ease of learning how to use the technology, and the clarity of its functions (Githinji, 2021). If potential users perceive that the technology is easy to understand and integrate into their work routines without requiring significant effort or training, they are more likely to perceive it as easy to use and thus more likely to adopt it. According to TAM, these two perceptions usefulness and ease of use directly influence users' attitudes towards adopting technology (Mokaya, 2020). These attitudes, in turn, shape their behavioral intentions to adopt the technology. In other words, if individuals believe that a technology is both useful and easy to use, they are more likely to develop a positive attitude towards using it and subsequently intend to adopt it. This intention then leads to actual adoption behavior (Loh, Flicker & Horner, 2020). This theory was used to examine the effect of adoption of ICT tools in process optimization in commercial banks in Nairobi City County, Kenya.

Socio-Technical Systems Theory

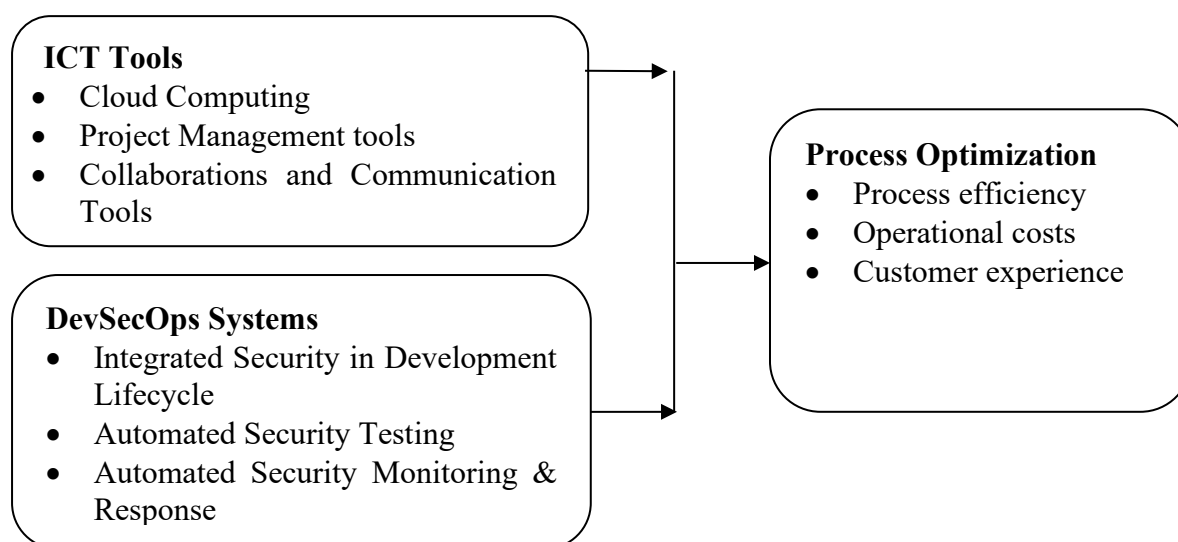
Socio-Technical Systems Theory (STS) is an interdisciplinary approach that examines the complex interplay between social and technical elements within organizations or work environments. Developed by Eric Trist and Ken Bamforth (1951), STS emphasizes that neither

social nor technical components alone determine organizational effectiveness (Ramaj, Sánchez-Gordón & Gkioulos, 2024). Instead, it highlights the need to jointly optimize both social systems such as people, culture, and organizational structures and technical systems, including tools, machines, and processes. The theory suggests that ignoring one side can lead to inefficiencies, dissatisfaction, or failure (Adewole, 2020). At its core, Socio-Technical Systems Theory argues that any work system consists of two interrelated subsystems: the social system, which involves human relationships, roles, and communication patterns; and the technical system, which encompasses the technologies, workflows, and physical tools used to accomplish tasks (Abiona, Oladapo & Modupe, 2024). Effective system design requires recognizing how changes in one subsystem impact the other. For example, introducing new technology may alter job roles or communication needs, while changes in social structures can influence how technology is adopted and used (Wanjeri & Ndikaru, 2024).

STS also promotes the idea of joint optimization, meaning that the best outcomes are achieved not by maximizing technical efficiency alone but by balancing it with human and social considerations (Onyuma & Kibet (2020). This approach values worker autonomy, participation, and well-being, recognizing that motivated and well-supported people are crucial to the success of technical innovations. It challenges traditional top-down management styles, advocating for participative design and collaboration between engineers, managers, and employees (Ramaj, Sánchez-Gordón & Gkioulos, 2024). This theory was used to assess the effect of DevSecOps systems in process optimization in commercial banks in Nairobi City County, Kenya.

Conceptual Framework

A conceptual framework is a structured system of ideas and theories that guides research by defining key concepts, relationships, and variables. It serves as a foundation for understanding and interpreting the phenomena under study, helping researchers to outline their hypotheses and design their methodology (Miles, Huberman & Saldana 2019). In this study the independent variables include; ICT Tools, DevSecOps Systems while the dependent variable is Process Optimization in Commercial



Independent variables

Dependent variable

Figure 2. 1: Conceptual framework

ICT Tools

ICT (Information and Communication Technology) tools are digital resources used to handle communication, information processing, and data sharing (Loh, Flicker & Horner, 2020). These tools include computers, smartphones, the internet, educational software, projectors,

interactive whiteboards, and cloud-based platforms. In education, ICT tools enhance teaching and learning by providing interactive content, online learning environments, and access to vast information sources. In business, they support communication, data analysis, project management, and remote work. Overall, ICT tools have transformed the way individuals learn, work, and connect by increasing efficiency, accessibility, and collaboration across various fields (Nyakito, Amimo & Allida, 2021).

Cloud computing is a technology that enables users to store, manage, and process data on remote servers hosted on the internet, rather than relying on local servers or personal computers (Ojwang, Lee & Waruru, 2020). This technology offers significant advantages such as flexibility, scalability, and cost efficiency. With cloud computing, individuals and businesses can access applications and data from anywhere in the world, as long as they have an internet connection. It eliminates the need for physical infrastructure and reduces the costs associated with hardware, maintenance, and IT staff (Githinji, 2021). Popular cloud service providers like Amazon Web Services (AWS), Microsoft Azure, and Google Cloud offer various models including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Cloud computing also enhances data security through advanced encryption and backup services, and it supports real-time collaboration by allowing multiple users to work on the same documents or applications simultaneously. This technology has become a cornerstone in modern business operations, education, healthcare, and more (Mokaya, 2020).

Project management tools are digital platforms or software applications designed to assist in planning, organizing, and managing resources to achieve specific goals within a project (Loh, Flicker & Horner, 2020). These tools help streamline workflows, improve time management, and ensure accountability across teams. Key features typically include task assignment, deadline tracking, progress visualization (e.g., Gantt charts or Kanban boards), and communication integration. Popular tools such as Asana, Azure Trello, Jira, and Monday.com enable team members to collaborate more effectively by providing a centralized platform for updates, file sharing, and feedback (Nyakito, Amimo & Allida, 2021). These tools are especially useful in complex projects involving multiple team members and departments, as they help prevent misunderstandings and delays by offering transparency and structure. In addition, many project management tools integrate with other software, such as Google Workspace or Microsoft Office, enhancing overall productivity. Whether for software development, marketing campaigns, or academic group projects, these tools are critical for successful project execution in today's fast-paced environments (Ojwang, Lee & Waruru, 2020).

Collaboration and communication tools are essential ICT solutions that support interaction, information sharing, and teamwork in both professional and educational settings (Githinji, 2021). These tools bridge geographical gaps and enable real-time or asynchronous communication among team members. Applications such as Slack, Microsoft Teams, Zoom, and Google Meet provide various communication channels, including text messaging, voice and video calls, and file sharing capabilities. These platforms promote efficient collaboration by integrating with cloud storage services and project management tools, allowing teams to work on shared documents, track progress, and hold virtual meetings all within a single interface (Mokaya, 2020). The rise of remote work and hybrid learning environments has made such tools indispensable for maintaining productivity and connectivity. Beyond communication, these platforms foster a collaborative culture where ideas and feedback can be exchanged quickly, leading to faster decision-making and stronger team cohesion. In sum, collaboration and communication tools have revolutionized how people work together, making teamwork more dynamic, flexible, and inclusive (Loh, Flicker & Horner, 2020).

DevSecOps Systems

DevSecOps systems represent the integration of security practices into the DevOps process, ensuring that security is considered at every stage of the software development lifecycle—from planning and development to deployment and operations (Ramaj, Sánchez-Gordón & Gkioulos, 2024). Traditionally, security was treated as a separate phase toward the end of the development cycle, which often led to vulnerabilities being discovered too late, causing delays and increased costs. DevSecOps addresses this challenge by embedding automated security checks, code analysis, and compliance validations directly into the CI/CD (Continuous Integration/Continuous Deployment) pipelines. Tools like Snyk, Aqua Security, Checkmarx, and GitLab's built-in security features allow developers to detect and fix security issues in real time as they write and deploy code. This shift-left approach ensures that vulnerabilities are identified early, reduces the attack surface, and fosters a shared responsibility for security among developers, operations, and security teams. DevSecOps systems also use infrastructure as code (IaC) and automated policy enforcement to secure cloud-native environments, containers, and micro services. Ultimately, DevSecOps enhances both the speed and security of software delivery, making it essential for modern, agile development teams that aim to innovate quickly without compromising on risk management or compliance (Adewole, 2020).

Integrated security in the development lifecycle ensures that security is embedded from the earliest stages of software creation, rather than being added on at the end (Abiona, Oladapo & Modupe, 2024). This proactive approach aligns with DevSecOps practices, where developers, operations, and security professionals collaborate to build secure applications from the ground up. Security activities such as threat modeling, secure coding standards, vulnerability assessments, and access control checks are incorporated into every phase planning, coding, testing, deployment, and maintenance. By addressing potential security risks early in the process, organizations can reduce vulnerabilities, save time on costly fixes later, and ensure compliance with industry regulations. Integration also fosters a culture of shared responsibility, where developers are empowered and trained to write secure code, and security teams act as enablers rather than gatekeepers. This end-to-end visibility and accountability create a more resilient and agile development environment (Wanjeri & Ndikaru, 2024).

Automated security testing is a critical component of modern software development, allowing teams to detect vulnerabilities and weaknesses in code quickly and efficiently (Onyuma & Kibet, 2020). By integrating tools such as Static Application Security Testing (SAST), Dynamic Application Security Testing (DAST), and Software Composition Analysis (SCA) into CI/CD pipelines, organizations can perform continuous security scans without slowing down development cycles. These tools automatically analyze source code, running applications and third-party dependencies for known security issues every time code is committed or deployed (Ramaj, Sánchez-Gordón & Gkioulos, 2024). For instance, SAST tools catch insecure coding patterns before the application is even compiled, while DAST tools simulate attacks on running applications to uncover runtime vulnerabilities. Automation ensures consistent and repeatable testing across projects, helping to enforce security policies, reduce human error, and respond faster to emerging threats. Ultimately, automated security testing enhances both the speed and quality of software delivery by ensuring that security is built into the development process (Adewole, 2020).

Automated security monitoring and response systems play a vital role in detecting, analyzing, and responding to threats in real time, especially in complex cloud and micro services environments (Abiona, Oladapo & Modupe, 2024). These systems use a combination of tools such as Security Information and Event Management (SIEM), Intrusion Detection Systems (IDS), and Extended Detection and Response (XDR) platforms to continuously monitor network traffic, application logs, and user behavior for signs of malicious activity. Machine learning and behavior analytics are often employed to identify anomalies that may signal a security incident. Once a threat is detected, automated response mechanisms can isolate

compromised systems, block suspicious IP addresses, or trigger alerts to security teams. Integration with incident response workflows allows for faster mitigation, reducing the window of exposure and minimizing potential damage. This proactive and intelligent approach to monitoring enhances organizational resilience and supports compliance with real-time auditing and alerting requirements (Wanjeri & Ndikaru, 2024).

Process Optimization

Process optimization refers to the deliberate and systematic improvement of organizational workflows and procedures to achieve maximum performance, consistency, and value creation (Mwaura & Karanja, 2020). It involves the continuous analysis, redesign, and integration of processes using technology-driven and data-informed approaches to enhance productivity and quality of outcomes. Through the adoption of agile and adaptive systems, organizations are able to streamline operations, minimize redundancies, and align processes with strategic objectives (Ndirangu, 2022). Effective process optimization ensures that resources—whether human, technological, or financial—are utilized efficiently while maintaining flexibility to adapt to changing operational environments and stakeholder demands (Mutuku & Wanyembi, 2018).

A key indicator of process optimization is process efficiency, which reflects how well an organization converts inputs into desired outputs with minimal time, effort, and resource wastage (Njiru & Njeru, 2021). Process efficiency emphasizes the elimination of bottlenecks, automation of repetitive tasks, and improvement of communication and coordination across different functional areas (Allahawiah, 2023). By focusing on efficiency, organizations can enhance performance reliability, reduce delays, and improve overall operational agility. Optimized processes also support timely decision-making and enable organizations to achieve higher productivity levels without compromising on accuracy or quality, which are essential for sustained competitiveness (Salehi, 2021).

Operational costs and customer experience are additional critical indicators of process optimization. Streamlined processes directly contribute to cost reduction by minimizing duplication, waste, and unnecessary administrative tasks (Somanathan, 2024). The integration of automation, data analytics, and continuous improvement mechanisms allows organizations to lower maintenance and labor costs while achieving higher output levels. Simultaneously, process optimization improves customer experience by enabling faster, more personalized, and reliable service delivery (Allahawiah, 2023). When processes are well-designed and efficiently executed, customers experience consistency, convenience, and satisfaction in their interactions with the organization. Thus, process optimization, as reflected through enhanced efficiency, reduced operational costs, and improved customer experience, represents a fundamental driver of organizational excellence and long-term sustainability (Godbless, 2022).

Empirical Review

ICT Tools and Process Optimization

Loh, Flicker and Horner (2020) conducted a study on the effect of attitudes toward information and communication technology (ICT) in residential aged care in Western Australia. A survey initially followed by focus groups that centered on 4 questions. How can computers help improve care? What kind of electronic services and products could help improve care? Who should have access to the technology and why was the technology not used? The survey revealed there was awareness of information and communication technology (ICT) in RACF. The study concluded that more training for staff is required to enable them to use ICT efficiently. ICT hardware and software at the user interface must be designed to maintain confidentiality with ease of access

Nyakito, Amimo and Allida (2021) conducted a study on the effect of challenges of integrating information and communication technology in teaching among national teachers' colleges in Uganda. The study was qualitative, using focus group discussions, interview and observation with 10 college lecturers from each of the 4 colleges and 4 Principals, one from each college. The findings revealed a host of challenges, despite a high level of appreciation among college lecturers on the importance of ICT integration into classroom instructional practices. The study concluded that Successful integration of ICT in the teaching and learning process depends on various factors. The result of this study revealed that there are many interrelated challenges that impede the lecturers in the National Teachers' Colleges from successfully integrating ICT in their teaching and were in draft form in some colleges could not be verified because they were not availed

Ojwang, Lee and Waruru (2020) conducted a study on the effect of using information and communications technology in a national population-based survey: the Kenya aids indicator survey 2012. The second Kenya AIDS Indicator Survey (KAIS 2012) was a population-based survey of persons aged 18 months to 64 years. A software application was designed to capture the interview, specimen collection, and home-based testing and counseling data. KAIS 2012 was conducted between October 2012 and February 2013. Overall, 68,202 records for the interviews, specimen collection, and home-based testing and counseling were entered into the application. The study concluded that KAIS 2012 demonstrated the feasibility of using EDC in a population-based survey. The benefits of EDC were apparent in data quality and minimal time needed for data cleaning

Githinji (2021) conducted a study on the effect of application of information and communication technologies for development (ICT4D) to rural communities in Kenya. This study uses a participatory ethnographic research method that combines participatory techniques and ethnographic research, with the potential of feeding into action research. The research makes use of the communicative ecology approach in evaluating communication and ICTs for development. Based on the findings from this study, the Nguruman CKC has the characteristics of a basic telecentre that acts as a community access point where people can use conventional ICT tools such as computers, newspapers, the internet, and telephone and it provides knowledge and training services such as basic computer skills. The overall conclusions indicate that the ICT has changed some people's lives that have used it to varying degrees.

Mokaya (2020) conducted a study on the adoption of information and communication technology by small enterprises in Thika municipality, Kenya. Both qualitative and quantitative methods were used to analyze data. Chi-square tests were conducted to establish the relationship between variables under study. The study revealed that most SEs use basic communication tools such as cell phone; text and voice and internet. Adoption and use of ICT tools has not been well embraced by SEs. The results indicate a statistically significant relationship between financial capacity and ICT adoption. Small enterprise operators perceive the cost of ICT to be very high, with a negative effect on adoption. The study concludes that ICT has not been well embraced by SEs in Kenya. All the variables under study have a statistically significant effect on ICT adoption.

RESEARCH METHODOLOGY

The study adopted a descriptive research design, which enabled the collection of data at a single point in time to describe existing conditions objectively. This design was appropriate for assessing perceptions and attitudes concerning the research variables, allowing for detailed examination without manipulation of variables (Creswell & Creswell, 2019). It facilitated the exploration of prevailing practices and behaviors within commercial banks in Nairobi City County.

The study targeted management employees in 40 commercial banks in Nairobi City County, comprising 41 top-level, 82 middle-level, and 123 lower-level managers, totaling 246 respondents. Using Krejcie and Morgan's (1970) formula, a representative sample of 152 participants was determined. Stratified random sampling ensured proportional representation across management levels, while simple random sampling within each stratum minimized selection bias.

Data were collected using a semi-structured, self-administered questionnaire designed to capture both qualitative and quantitative responses. The instrument utilized a five-point Likert scale to measure perceptions, with 1 representing the lowest and 5 the highest level of agreement. Prior to full data collection, the researcher obtained authorization from relevant institutions, including JKUAT and NACOSTI, and distributed questionnaires to respondents for completion and later retrieval. To ensure reliability, the study employed Cronbach's Alpha, with a threshold of 0.70 as the acceptable internal consistency benchmark (Hair et al., 2019). Validity was evaluated through content, face, and construct validity. Content validity was established through expert review to ensure item relevance, face validity through supervisory consultation for clarity, and construct validity using exploratory factor analysis (EFA), with a loading cutoff of 0.50 for acceptable item inclusion (Byrne, 2017).

Data were coded, cleaned, and analyzed using SPSS Version 25. Descriptive statistics—frequencies, means, and standard deviations—were employed to summarize data, while inferential analysis used multiple regression and correlation to test relationships among variables at a 95% confidence level.

RESEARCH FINDINGS AND DISCUSSIONS

The sample size of this study was 152. The researcher distributed 152 questionnaires to the respondents during data collection process and 134 were fully filled and returned to the researcher thus making a response rate of 88.2%. Geteria (2019) argues that a response rate which is more than 50% is considered adequate while excellent response rate is usually above 70%. This implies that the response rate in this study is good for making conclusions as well as recommendations.

Descriptive Statistics Analysis

ICT Tools and Process Optimization

The first specific objective of the study was to examine the effect of adoption of ICT tools in process optimization in commercial banks in Nairobi City County, Kenya. The respondents were requested to indicate their level of agreement on statements relating to ICT tools and process optimization in commercial banks in Nairobi City County, Kenya. The results were as presented in Table 1.

From the results, the respondents agreed that cloud-based services improve the speed and reliability of banking operations ($M=3.843$, $SD=0.610$). In addition, the respondents agreed that security measures in cloud computing are sufficient to protect sensitive customer data ($M=3.831$, $SD=0.936$). Further, the respondents agreed that project management tools help teams track progress and meet deadlines effectively ($M=3.817$, $SD=0.876$).

From the results, the respondents agreed that project management tools facilitate transparent communication and accountability in projects ($M=3.808$, $SD=0.714$). In addition, the respondents agreed that collaboration tools enable seamless teamwork regardless of employees' physical locations ($M=3.794$, $SD=0.725$). Further, the respondents agreed that communication platforms are user-friendly and support real-time information sharing ($M=3.761$, $SD=0.815$).

Table 1: ICT Tools and Process Optimization

	Mean	Std. Deviation
Cloud-based services improve the speed and reliability of banking operations.	3.843	0.610
Security measures in cloud computing are sufficient to protect sensitive customer data.	3.831	0.936
Project management tools help teams track progress and meet deadlines effectively.	3.817	0.876
Project management tools facilitate transparent communication and accountability in projects.	3.808	0.714
Collaboration tools enable seamless teamwork regardless of employees' physical locations.	3.794	0.725
Communication platforms are user-friendly and support real-time information sharing.	3.761	0.815
Aggregate	3.809	0.779

DevSecOps Systems and Process Optimization

The second specific objective of the study was to assess the effect of DevSecOps systems in process optimization in commercial banks in Nairobi City County, Kenya. The respondents were requested to indicate their level of agreement on various statements relating to DevSecOps systems and process optimization in commercial banks in Nairobi City County, Kenya. The results were as presented in Table 2.

From the results, the respondents agreed that security practices are incorporated at every stage of the software development lifecycle ($M=3.896$, $SD=0.724$). In addition, the respondents agreed that developers receive adequate training on integrating security into their coding processes ($M=3.884$, $SD=0.859$). Further, the respondents agreed that automated security testing tools are regularly used to identify vulnerabilities early in development ($M=3.861$, $SD=0.850$).

From the results, the respondents agreed that automated tests cover a wide range of security threats relevant to their banking applications ($M=3.833$, $SD=0.793$). In addition, the respondents agreed that continuous automated monitoring detects security threats in real-time ($M=3.827$, $SD=0.775$). Further, the respondents agreed that the system promptly triggers automated responses to mitigate identified security risks ($M=3.800$, $SD=0.753$).

Table 2: DevSecOps Systems and Process Optimization

	Mean	Std. Deviation
Security practices are incorporated at every stage of the software development lifecycle.	3.896	0.724
Developers receive adequate training on integrating security into their coding processes.	3.884	0.859
Automated security testing tools are regularly used to identify vulnerabilities early in development.	3.861	0.850
Automated tests cover a wide range of security threats relevant to our banking applications.	3.833	0.793
Continuous automated monitoring detects security threats in real-time.	3.827	0.775
The system promptly triggers automated responses to mitigate identified security risks.	3.800	0.753
Aggregate	3.850	0.792

Process Optimization

The respondents were requested to indicate their level of agreement on various statements relating to process optimization of commercial banks in Nairobi City County, Kenya. The results were as presented in Table 3.

From the results, the respondents agreed that automation tools are effectively used to speed up routine banking operations ($M=3.863$, $SD=0.854$). In addition, the respondents agreed that employees are trained to follow standardized procedures to ensure consistent process efficiency ($M=3.824$, $SD=0.845$). Further, the respondents agreed that the bank regularly evaluates processes to identify opportunities for cost reduction ($M=3.804$, $SD=0.809$).

From the results, the respondents agreed that investments in technology help lower the overall operational expenses ($M=3.791$, $SD=0.793$). In addition, the respondents agreed that process improvements result in faster service delivery to customers ($M=3.784$, $SD=0.775$). Further, the respondents agreed that customers receive clear communication and timely updates during service transactions ($M=3.731$, $SD=0.753$).

Table 3: Process Optimization

	Mean	Std. Deviation
Automation tools are effectively used to speed up routine banking operations.	3.863	0.854
Employees are trained to follow standardized procedures to ensure consistent process efficiency.	3.824	0.845
The bank regularly evaluates processes to identify opportunities for cost reduction.	3.804	0.809
Investments in technology help lower the overall operational expenses.	3.791	0.793
Process improvements result in faster service delivery to customers.	3.784	0.775
Customers receive clear communication and timely updates during service transactions.	3.731	0.753
Aggregate	3.800	0.805

Correlation Analysis

The present study used Pearson correlation analysis to determine the strength of association between independent variables (ICT tools, DevSecOps systems) and the dependent variable (process optimization of commercial banks in Nairobi City County, Kenya) dependent variable. Pearson correlation coefficient range between zero and one, where by the strength of association increase with increase in the value of the correlation coefficients.

Table 4: Correlation Coefficients

		Process Optimization	ICT Tools	DevSecOps Systems
Process Optimization	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	134		
ICT Tools	Pearson Correlation	.837**	1	
	Sig. (2-tailed)	.001		
	N	134	134	
DevSecOps Systems	Pearson Correlation	.863**	.147	1
	Sig. (2-tailed)	.000	.098	
	N	134	134	134

From the results, there was a very strong relationship between ICT tools and process optimization of commercial banks in Nairobi City County, Kenya ($r = 0.837$, p value $= 0.001$). The relationship was significant since the p value 0.001 was less than 0.05 (significant level). The findings are in line with the findings of Loh, Flicker and Horner (2020) who indicated that there is a very strong relationship between ICT tools and process optimization.

Further, the results revealed that there is a very strong relationship between DevSecOps systems and process optimization of commercial banks in Nairobi City County, Kenya ($r = 0.863$, p value $= 0.000$). The relationship was significant since the p value 0.000 was less than 0.05 (significant level). The findings are in line with the findings of Abiona, Oladapo and Modupe (2024) that there is a very strong relationship between DevSecOps systems and process optimization

Regression Analysis

Multivariate regression analysis was used to assess the relationship between independent variables (ICT tools, DevSecOps systems) and the dependent variable (process optimization of commercial banks in Nairobi City County, Kenya).

Table 5: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.241	0.062		3.887	0.000
	ICT Tools	0.332	0.088	0.331	3.773	0.001
	DevSecOps Systems	0.358	0.093	0.357	3.849	0.000

a Dependent Variable: process optimization of commercial banks in Nairobi City County, Kenya

The regression model was as follows:

$$Y = 0.241 + 0.332X_1 + 0.358X_2 + \varepsilon$$

According to the results, ICT tools has a significant effect on process optimization of commercial banks in Nairobi City County, Kenya ($\beta_1 = 0.332$, p value $= 0.001$). The relationship was considered significant since the p value 0.001 was less than the significant level of 0.05 . The findings are in line with the findings of Loh, Flicker and Horner (2020) who indicated that there is a very strong relationship between ICT tools and process optimization.

Furthermore, the results revealed that DevSecOps systems has significant effect on process optimization of commercial banks in Nairobi City County, Kenya ($\beta_1 = 0.358$, p value $= 0.000$). The relationship was considered significant since the p value 0.000 was less than the significant level of 0.05 . The findings are in line with the findings of Abiona, Oladapo and Modupe (2024) that there is a very strong relationship between DevSecOps systems and process optimization

Conclusions

The study concludes that ICT tools have a positive and significant effect on process optimization in commercial banks in Nairobi City County, Kenya. Findings revealed that cloud computing, project management tools and collaborations and communication tools influences process optimization in commercial banks in Nairobi City County, Kenya.

Further, the study concludes that DevSecOps systems have a positive and significant effect on process optimization in commercial banks in Nairobi City County, Kenya. Findings revealed that integrated security in development lifecycle, automated security testing and automated security monitoring & response influences process optimization in commercial banks in Nairobi City County, Kenya.

Recommendations

The study recommends that the management of commercial banks in Kenya should invest in the integration of advanced ICT tools such as enterprise resource planning (ERP) systems and robotic process automation (RPA) to enhance process optimization. These technologies streamline routine banking operations, reduce manual errors, and improve transaction speed and accuracy.

Further, the study recommends that the management of commercial banks in Kenya should adopt and institutionalize DevSecOps systems to enhance process optimization through secure, efficient, and continuous software delivery. By integrating security practices into every stage of the software development lifecycle, DevSecOps ensures that applications and digital banking platforms are not only optimized for performance but also resilient against cybersecurity threats.

Suggestions for Further Studies

This study was limited to the effect of agile virtual ICT systems on process optimization of commercial banks in Nairobi City County, Kenya hence the study findings cannot be generalized to performance of other financial institutions in Kenya. The study therefore suggests further studies on the effect of agile virtual ICT systems on performance of other financial institutions in Kenya.

REFERENCES

- Abiona, O. O., Oladapo, O. J., & Modupe, O. T. (2024). The emergence and importance of DevSecOps: Integrating and reviewing security practices within the DevSecOps pipeline in Kenya. *World Journal of Advanced Engineering Technology and Sciences*, 11(2), 127–133.
- Adewole, S. A. (2020). *Navigating the complexities of DevSecOps: A comprehensive exploration of organizational, cultural & sociotechnical factors in Nigeria*. <https://www.diva-portal.org/smash/get/>
- Allahawiah, S. R. (2023). An agile model for assessing quality of e-commerce systems in small and medium enterprises (SMEs) in Jordan. *Journal of Management Research*, 5(1), 179–197.
- Amar, H., & Haag, H. (2022). Exploring the critical success factors of virtual-agile IT projects: A grounded theory study. *International Journal of Innovation, Management and Technology*, 8(6), 426–434.
- Barno, N. J., & Rotich, G. (2023). Effect of agile virtual ICT systems on performance of commercial banks in Kenya. *European Journal of Business and Strategic Management*, 3(7), 1–22.
- Creswell, R. (2019). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications. (You cited “Creswell & Creswell, 2019” in the methodology, but this is the closest item in your list.)
- Cunha, M. M., & Putnik, G. D. (2023). On the dynamics of agile/virtual enterprise reconfiguration. *International Journal of Networking and Virtual Organizations*, 3(1), 102–124.
- Githinji, R. W. (2021). Application of information and communication technologies for development (ICT4D) to rural communities in Kenya. *Science Mundi*, 2(1), 15–25.
- Godbless, E. (2022). *Influence of ICT project management system on performance of microfinance institutions in Tanzania*. <http://repository.out.ac.tz/id/eprint/>
- Loh, P. K., Flicker, L., & Horner, B. (2020). *Attitudes toward information and communication technology (ICT) in residential aged care in Western Australia*. <https://web.archive.org/web/>

- Mohamud, A. M. (2021). *Influence of agile virtual ICT systems on quality of education at secondary schools in Mogadishu, Somalia*. <https://erepository.uonbi.ac.ke/bitstream/handle/>
- Mokaya, S. O. (2020). Adoption of information and communication technology by small enterprises in Thika municipality, Kenya. *International Journal of Business and Social Science*, 3(13), 172–177.
- Mugenda, O. M., & Mugenda, A. G. (2019). *Research methods: Quantitative and qualitative approaches*. African Centre for Technology Studies.
- Mwania, P. L., & Kyule, A. (2024). Influence of agile virtual ICT systems on performance of manufacturing firms in Nairobi City County, Kenya. *International Journal of Social Sciences Management and Entrepreneurship*, 8(4), 1196–1214.
- Ndirangu, W. L. (2022). *Agile virtual ICT systems and performance of private universities in Nairobi City County, Kenya*. <https://ir-library.ku.ac.ke/server/api/core/>
- Niyigena, F., & Mbonigaba, C. (2021). *The impact of agile virtual ICT systems on crisis response and business continuity in Rwanda*. file:///C:/Users/user/Downloads/
- Nyakito, C., Amimo, C., & Allida, V. B. (2021). Challenges of integrating information and communication technology in teaching among national teachers' colleges in Uganda. *East African Journal of Education and Social Sciences*, 2(3), 157–171.
- Nyang'au, M. K., & Nyang'au, S. P. (2024). Agile virtual ICT systems and performance of e-resources centre project in Rift Valley Region, Kenya. *International Journal of Social Sciences Management and Entrepreneurship*, 8(4), 31–42.
- Obonyo, C. O., & Muchelule, Y. (2023). Agile virtual ICT systems and performance of telecommunication infrastructure projects in Nairobi City County, Kenya. *International Journal of Social Sciences Management and Entrepreneurship*, 8(2), 626–641.
- Ojwang, J. K., Lee, V. C., & Waruru, A. (2020). Using information and communications technology in a national population-based survey: The Kenya AIDS Indicator Survey 2012. <https://pmc.ncbi.nlm.nih.gov/articles/>
- Omoruyi, M. G., Sobanke, V. O., & Ijidakinro, O. (2023). *Assessment of agile project management adoption in information technology projects in Nigeria*. file:///C:/Users/user/Downloads/
- Onyuma, S. O., & Kibet, L. K. (2020). Does economic growth influences the relationship between financial intermediaries and securities market development in Kenya? *Journal of Economics and Sustainable Development*, 8(16), 19–30.
- Ramaj, X., Sánchez-Gordón, M., & Gkioulos, V. (2024). On DevSecOps and risk management in critical infrastructures: Practitioners' insights on needs and goals in Spain. <https://dl.acm.org/doi/pdf/>
- Salehi, F. (2021). Role of artificial intelligence on agile planning and organizational performance in the ICT industry. *Asian Journal of Economics, Finance and Management*, 4(1), 581–586.
- Somanathan, S. (2024). Optimizing agile project management for virtual teams: Strategies for collaboration, communication, and productivity in remote settings. *International Journal of Applied Engineering & Technology*, 5(2), 1–12.
- Tamanda, J. (2024). Impact of Agile Virtual ICT Systems on project success in software development in Malawi. *International Journal of Project Management*, 6(2), 62–74.
- Wanjeri, J. K., & Ndikaru, J. (2024). Information security services outsourcing on security culture development among commercial state corporations in Kenya. *Journal of Economics, Management Sciences and Procurement*, 3(1), 70–81.