Factors Affecting the Supply of Software Engineering Professionals in Commercial Banks in Kenya

Rebekah Njagi (150837)

A Dissertation Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Business Administration at Strathmore University

Strathmore Business School

Strathmore University Nairobi, Kenya

May 2025

Declaration

I declare that this project is my original work and has not been previously submitted and approved by Strathmore University or any other Institution for the award of a degree. To the best of my knowledge and belief; this project is original and borrowed materials has been done with due reference.

Sign: _____ Date: _____21/03/2025_____

Rebekah Njagi (150837)

Approval

The research project of Rebekah Njagi was reviewed and approved for examination by the following:

Sign: _____ Date: ____18/3/2025__

Dr. John Olukuru
Senior Lecturer, Strathmore Business School
Strathmore University

Dr. Ceasar Mwangi
Dean, Strathmore Business School
Strathmore University

Prof. Bernard Shibwabo
Director of Graduate Studies,
Strathmore University

Abstract

Over the last two decades, commercial banks in Kenya have faced challenges like globalization and increased competition. To stay competitive, they've adopted technological platforms, but a shortage of software engineers hinders the design and maintenance of these platforms. Therefore, this study sought to examine factors affecting the supply of software engineering professionals in commercial banks in Kenya. The specific objectives of the study were to determine how personal characteristics, industry demand for engineers, rapid technological advancements and educational quality affect the supply of software engineering professionals in commercial banks in Kenya. The study adopted a pragmatism research approach and mixed methods research design. The target population of this study were all the 507 staff working in Information and communication technology, human resources as well as strategy and development departments in 9 Tier 1 commercial banks in Kenya. The sample size was determined using Yamane's formula. The study used stratified random sampling in the selection of the sample size. The study employed primary data collection methods using semi-structured questionnaires and a key informant interview guide. Qualitative data was analysed using thematic analysis. Quantitative data was analysed using descriptive statistics including frequency distribution, percentages, mean, and standard deviation, facilitated by the Statistical Package for Social Sciences (SPSS version 28). Subsequently, inferential statistics such as Pearson correlation analysis and regression analysis was applied. The findings were presented visually using tables, bar charts, and pie charts. The study found that personal characteristic has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study also found that industry demand for engineers has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. Further, the study found that rapid technological advancements has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. Moreover, the study found educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study recommended promoting a positive attitude toward engineering through mentorship and awareness campaigns, while advising commercial banks to attract and retain skilled engineers with competitive compensation, career development, positive work environments, and investment in continuous professional development programs.

Keywords: *Personal Characteristics, Industry Demand, Technological Advancements, Educational Quality, Supply*

Table of Contents

List of Tables

List of Figures

Abbreviations and Acronyms

CBK:	Central Bank of Kenya
CNC:	Computer Numerical Control
CVET;	Continuous Vocational Education and Training
EBK:	Engineers Board of Kenya
ICT:	Information and Communication Technology
IoT:	Internet of Things
KCB:	Kenya Commercial Bank
KCSE:	Kenya Certificate of Secondary Education
NACOSTI:	National Commission for Science, Technology and Innovation
RE:	Requirements Engineering
SCCT:	Social Cognitive Career Theory
SE:	Software Engineering
SLR:	Systematic Literature Review
SoE:	School of Engineering
SPSS:	Statistical Package for Social Sciences
STEM:	Science, Technology, Engineering and Mathematics
STEP:	Skills Towards Employability and Productivity
TVET:	Technical and Vocational Education and Training
TVETA:	Technical and Vocational Education and Training Authority
UNSECO:	United Nations Educational, Scientific and Cultural Organization
US:	United States

Definitions of Key Terms

Educational quality: This refers to the alignment of curriculum relevance, provision of practical learning opportunities, cultivation of industry partnerships, and adherence to accreditation and registration standards to ensure the effectiveness and relevance of educational programs in preparing students for real-world challenges and professional success (McDool & Morris, 2022).

Industry demand for engineers: This refers to the quantitative and qualitative need within various sectors for professionals with engineering skills and expertise to fulfil roles related to design, development, implementation, and maintenance of products, systems, and infrastructure (McDool & Morris, 2022).

Personal characteristics: These refer to the individual traits, attributes, qualities, and behaviors that define a person's unique identity and influence their thoughts, emotions, and actions (Feldt & Maria, 2020).

Rapid technological This denotes the swift progression of innovations, leading to skill advancements: obsolescence and upgrading, increased specialization, a growing demand for multidisciplinary skills, and the necessity for enhanced access to resources and facilities (Wilson & Buchanan, 2020).

Supply of software This is the availability of individuals possessing the necessary engineering skills, knowledge, and expertise to meet the demand for software professionals: engineering roles within the industry (Campero, 2021).

Acknowledgement

I am deeply grateful to God for His grace and guidance throughout the process of conceptualizing and crafting this project. He guided every idea, decision, and effort invested in this endeavour. I could not have undertaken this journey without Johnson who impacted me and inspired this work. I am sincerely grateful for Johnson's unanimous support and continuous inspiration

I extend my heartfelt appreciation to my supervisor, who generously provided invaluable support, mentorship, and constructive feedback. Her expertise and commitment to excellence have been instrumental in shaping the project and elevating its quality. Finally, I wish to thank members of my family and close friends whose endless love, advice, support, and prayers kept my spirits and motivation high in this pursuit.

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Background Information

In the last three decades, commercial banks have been operating in a turbulent business environment, characterized by increased competition, globalization, changing needs of the consumers and increasing technological changes (Phan & Anwar, 2019). In response to intensified competition, commercial banks, around the world, have embarked on developing a diverse range of innovative products, including digital wallets, robo-advisors, and peer-to-peer payment systems, to cater for evolving customer preferences (Alhadeff, 2023). Simultaneously, they have bolstered their technological infrastructure by investing in advanced platforms such as mobile banking apps, online portals, and artificial intelligence-driven banking services, aimed at improving service delivery standards and enhancing overall customer experience (Corbae & D'Erasmo, 2021). These strategic endeavours aim not only to differentiate banks in a fiercely competitive market but also to provide greater convenience and value to their clientele.

As banks continue to innovate and introduce cutting-edge products and platforms, the necessity for skilled software engineers has grown exponentially (Yahyaie & Rabiei, 2024). These professionals are instrumental in every phase of the software development lifecycle, from conceptualization to implementation and maintenance (Elia, Stefanelli & Ferilli, 2023). They are responsible for ensuring the seamless functionality, robust security, and optimal user experience of digital banking services, addressing critical concerns in today's rapidly evolving technological landscape (Hamid, Iqbal & Ahmad, 2022). With their expertise, software engineers bridge the gap between banking concepts and tangible, user-friendly software solutions, enabling banks to adapt to changing customer demands and remain competitive in an increasingly digital-centric industry.

Despite the need for engineering skills in development, there has been a shortage in the supply of these skills around the world. The engineering industry is facing a severe skills shortage, which is causing a significant impact on global development and achievement of the United States Sustainable Development Goals (Tang & Guo, 2023). McDool and Morris (2022) observed that there is a more than 60% global shortage in engineering skills. According to Kodey and Bedard (2023), 30% of all engineering jobs in the United States go unfulfilled, every year. Amies (2024) discovered, in Belgium, that an annual deficit exceeding 500 engineers presents a significant

obstacle to the nation's economic growth and innovation potential. Nyemba, Chikuku and Magombo (2020) indicate that despite having over 20 institutions of higher learning, Zimbabwe has a critical engineering skills deficit of 62%, with the biggest gap evident in technology.

In addition, Moridnejad, Cooper and Kumari (2020) observed that only 20% of the engineers around the world are from the female gender, which highlights a substantial gender gap in engineering. Similarly, White and Massiha (2019) established that women account for less than 25% of the total engineering workforce around the world. Further, Mukhwana, Abuya, and Matanda (2020) noted regional differences in female representation, with higher percentages observed in Southeast Europe (39%), the Caribbean, Central Asia, and Latin America (34%), followed by the Arab States (27%), the European Union (23%), the European Free Trade Association (24%), and sub-Saharan Africa (20%).

Phillips (2023) observed that there are around 40 million software engineering jobs, around the world, that go unfulfilled due to lack of skilled talent. Further, job openings for software developers are projected to grow by 22% year over year between the year 2020 and 2030. As such, the United States (US) Labor Department estimates that the global shortage of software engineers may reach 85.2 million by 2030. Studies conducted in different parts of the world have looked at different factors affecting the supply of engineering professionals. Based on the social cognitive career theory, Kiernan, Walsh and White (2023) observed that factors affecting the uptake of engineering courses include occupational expectations, media influences, self-efficacy, perceptions, goal orientation, social influences and learning experiences.

In Indonesia, Wati, Rizza and Sugandi (2019) observed that factors such as student academic ability, family environment, peer environment, job attributes, attitude towards engineering, technological advancements, educational pathways and demand outpacing supply affect the supply of engineering professionals. In Ireland, Mukhwana, Abuya and Matanda (2020) observed that factors affecting the uptake of engineering courses in include negative attitudes towards science, technology, engineering and mathematics (STEM), peer to peer support, media influences, personal capabilities, job characteristics, personal ambition and academic preparation.

In Tanzania, Msafiri, Kangwa and Fute (2023) observed that factors affecting the supply of engineering professionals include personal characteristics, negative attitudes, self-efficacy, low motivation and rapid technological advancements and educational pathways. In addition, Were (2020) observed that factors affecting the uptake of engineering courses in Kenya include attitude Science, Technology, Engineering and Mathematics (STEM) courses, cultural beliefs, individual factors like educational quality, educational opportunities, industry demand, cultural perceptions, technological advancements, mathematic proficiency, self-efficacy and student motivation.

1.1.1 Overview of Commercial Banks in Kenya

Commercial banks in Kenya form a vital component of the country's financial sector, facilitating a wide range of banking services to individuals, businesses, and institutions (Central Bank of Kenya, 2023). Governed by the Central Bank of Kenya (CBK), the regulatory framework for commercial banks includes adherence to prudential guidelines, capital adequacy requirements, and anti-money laundering regulations to ensure stability and integrity within the banking system. As of 2023, Kenya's banking sector comprises 39 commercial banks, categorized into large, medium, and small banks based on their asset size and market presence. These banks offer an array of services, including deposit-taking, lending, foreign exchange, trade finance, wealth management, and digital banking solutions, catering to diverse customer needs and driving financial inclusion and economic growth in the country (Ntwiga, 2020).

In Kenya, commercial banks have been swift in adopting technological innovations to modernize their operations and enhance customer service. The introduction of mobile banking, internet banking, and digital payment solutions has revolutionized the banking sector, offering customers convenient and efficient ways to access financial services (Central Bank of Kenya, 2023). This rapid digital transformation has created a pressing need for software engineers who can develop, implement, and maintain sophisticated banking systems and platforms. Software engineers play a crucial role in designing user-friendly interfaces, ensuring data security, and optimizing the performance of banking applications (Ntwiga, 2020). Additionally, as banks continue to invest in advanced technologies such as artificial intelligence, block-chain, and data analytics, the demand for software engineers with expertise in these areas is expected to grow, highlighting the

importance of a skilled workforce to drive innovation and competitiveness in the banking industry.

The three tiers of commercial banks in Kenya have distinct operational structures. While many Tier 3 and some Tier 2 banks tend to outsource software engineering functions to other countries for cost efficiency or due to limited internal capacity, Tier 1 banks typically maintain dedicated ICT departments (Ouma, 2020). These departments are responsible for the in-house development and management of software engineering solutions. As larger, more financially capable institutions, Tier 1 banks invest heavily in technology infrastructure, including software engineering teams, to address their complex operational needs and offer cutting-edge digital banking services. In addition, these banks handle vast amounts of customer data and transactions, necessitating robust in-house systems that can be adapted to evolving technological demands and regulatory requirements. Karanja (2020) indicates that by maintaining dedicated ICT departments, Tier 1 banks can ensure greater control over their software development processes, enhance cybersecurity, and quickly implement innovations tailored to their specific business needs.

1.2 Problem Statement

Over the past two decades, commercial banks in Kenya have faced immense pressure from globalization, evolving consumer expectations, and intensified competition from new financial institutions, including microfinance banks and Savings and Credit Co-operatives (Otieno & Ndede, 2020). To maintain competitiveness, these banks have rapidly adopted various digital platforms such as agency banking, mobile banking, internet banking, and automated teller machines (Ntwiga, 2020). The implementation and upkeep of these digital innovations require the expertise of highly skilled software engineers. As such, software engineering professionals are essential in driving the digital transformation agenda and ensuring the operational efficiency and customer responsiveness of commercial banks in the era of technological disruption.

Despite Kenya being recognized as a technological hub in Africa, it is grappling with a notable shortage of skilled software engineers. According to the International Finance Corporation (2021), Kenya has approximately 60,000 software engineers, ranking second in Africa after Nigeria. However, over half of these professionals are employed by international firms such as

Microsoft, Google, and IBM or are engaged in global consultancy work (KPMG, 2020). This brain drain has left local commercial banks struggling to attract and retain software engineers with the requisite skills. Furthermore, Ouma (2020) reported a 65% deficit in the supply of engineers, while Chanji (2022) highlighted that Kenya requires at least 80,000 software engineers to meet national demand, yet around 50% of the existing professionals are absorbed by foreign companies. This shortage is compounded by concerns around the quality of engineers being trained, with the Engineers Board of Kenya (2023) reporting that about 50% of new engineering graduates lack the necessary competencies. UNESCO (2023) similarly noted issues with accreditation and weak training in advanced programming languages and emerging technologies such as edge computing (Kigotho, 2023).

Although various studies have explored general skill shortages and ICT integration in Kenya's financial sector, there remains limited empirical research specifically focused on the supply of software engineering professionals to commercial banks. The existing literature tends to address broader engineering issues without isolating the unique factors influencing software engineering talent within the banking sector. Notably, there is a lack of in-depth analysis of how personal characteristics, industry demand, technological changes, and the quality of education contribute to this supply. Additionally, the mismatch between training outcomes and the practical needs of the labor market in the financial industry remains underexplored, yet it is critical for informing policy, curriculum reforms, and talent development strategies.

Recent studies have been conducted in Kenya on supply of engineers. For instance, Nthuku and Muthima (2023) conducted a study on social determinants of female enrolment in engineering courses in public technical, vocational and education institution in Kakamega County; and Kipsaina (2023) studied factors influencing the performance of trainees in electrical engineering programmes in national polytechnics in Kenya. Nonetheless, Nthuku and Muthima (2023) was limited to female enrolment in engineering courses while Kipsaina (2023) looked at the performance of trainees in electrical engineering programmes. In addition, Nthuku and Muthima (2023) focused on factors such as social determinants, institutional determinants and policy determinants while Kipsaina (2023) looked at factors like trainee to trainer ratio, trainee attitude, instructional methods and trainer experience.

In light of these gaps, this study sought to comprehensively examine the factors influencing the supply of software engineering professionals in Kenya's commercial banks. By focusing on the intersection of education quality, industry demand, workforce readiness, and technological advancement, this research aims to generate empirical evidence to guide banks, policymakers, and educational institutions in addressing the software engineering talent shortage. This focus fills a critical gap in the literature and responds to the growing need for skilled professionals capable of sustaining digital transformation within Kenya's banking sector.

1.3 Research Objectives

The general objective of the study was to examine factors affecting the supply of software engineering professionals in commercial banks in Kenya. The specific objectives of the study were;

i) To determine how personal characteristics affect the supply of software engineering professionals in commercial banks in Kenya.

ii) To establish how industry demand for engineers affects the supply of software engineering professionals in commercial banks in Kenya.

iii) To determine how rapid technological advancements affect the supply of software engineering professionals in commercial banks in Kenya.

iv) To examine how educational quality affects the supply of software engineering professionals in commercial banks in Kenya.

1.4 Research Questions

i) How do personal characteristics affect the supply of software engineering professionals in commercial banks in Kenya?

ii) How does industry demand for engineers affect the supply of software engineering professionals in commercial banks in Kenya?

iii) How do rapid technological advancements affect the supply of software engineering professionals in commercial banks in Kenya?

iv) How does educational quality affect the supply of software engineering professionals in commercial banks in Kenya?

1.5 Scope of the Study

The study focused on four main factors affecting the supply of software engineering professionals in commercial banks in Kenya. These factors include personal characteristics, industry demand for engineers, technological advancements and educational quality. The study was conducted among Tier 1 Commercial Banks in Kenya, which include KCB Bank Kenya Limited; Equity Bank Kenya Ltd; NCBA Bank Kenya PLC; the Co-operative Bank of Kenya Ltd; Absa Bank Kenya Plc; Standard Chartered Bank (K) Ltd; Stanbic Bank Kenya Ltd; Diamond Trust Bank Kenya Limited and I &M Bank Limited. The study was conducted in Tier 1 commercial banks in Kenya. While many Tier 3 and some Tier 2 banks tend to outsource software engineering functions from other countries due to cost efficiency or lack of internal capacity, Tier 1 banks typically maintain dedicated ICT departments. These departments are tasked with the in-house development and management of software engineering solutions, making Tier 1 banks a more appropriate focus for the study. The target population of this study were all the 223 staff working in ICT departments in 9 Tier 1 commercial banks in Kenya. The study was conducted between October 2024 and November 2024.

1.6 Significance of the Study

The findings of this study were of great benefit to the management of commercial banks in kentia, policymakers, Engineering Board of Kenya as well as other researchers and academicians. To the management of commercial banks in Kenya, the study provided insight on factors affecting the supply of software engineering professionals. From the study findings, the management of commercial banks can gain a deeper understanding of the skill gaps present in the local talent pool. This insight might allow commercial banks to tailor their training and development programs to address these gaps, either by up-skilling existing employees or by collaborating with educational institutions to align their curriculum with industry needs. In addition, armed with knowledge about the factors influencing the supply of software engineers, banks can refine their recruitment strategies to attract and retain top talent more effectively.

A well-trained and skilled workforce in software engineering is essential for driving economic growth and innovation, particularly in sectors such as banking where technology plays a critical role. Policymakers could use the findings of the study to develop policies that support the growth

of the software engineering sector, attract investment in technology infrastructure, and foster a conducive environment for innovation and entrepreneurship. In addition, policymakers can leverage the findings of the study to strengthen public-private partnerships aimed at addressing the supply-demand imbalance in the software engineering labor market. The findings of the study informed Engineers Board of Kenya (EBK)'s accreditation standards for software engineering programs offered by universities and colleges in Kenya. By understanding the specific skills and competencies needed by software engineers in commercial banks, EBK can ensure that accredited programs adequately prepare graduates for careers in this sector.

To other researchers and academicians, the study helped identify gaps in existing research literature related to the supply of software engineering professionals in commercial banks. Researchers could use this information to pinpoint areas where additional research is needed, such as exploring the impact of specific interventions, assessing the effectiveness of workforce development programs, or investigating the factors influencing career decisions among software engineers. The findings of the study could serve as a foundation for further research on related topics within the field of software engineering and human resources. Researchers could also use the study's findings as a basis for comparative studies across different sectors, regions, or countries.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a literature review on factors influencing affecting the supply of software engineering professionals in commercial banks in Kenya. The chapter covers a theoretical review of the literature, an empirical review, and summary of the literature, research gaps and a conceptual framework.

2.2 Theoretical Review

A theory is a systematic and coherent framework of ideas or principles that seek to provide an abstract or conceptual understanding of a particular domain or concept (Devi, 2019). It often involves a set of assumptions and propositions used to make sense of complex phenomena or philosophical questions. This study was anchored on social cognitive career theory, labour market theory and innovation diffusion theory.

2.2.1 Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) was developed by Robert D. Lent, Steven D. Brown, and Gail Hackett in the late 1980s and early 1990s. SCCT integrates principles of social cognitive theory with career development, emphasizing the role of cognitive processes, social influences, and contextual factors in shaping individuals' career choices and behaviours (Belchior & Lyons, 2021). At its core, SCCT posits that individuals' career choices and actions are influenced by their self-efficacy beliefs, outcome expectations, personal goals, and contextual supports and barriers. It suggests that people are active agents in their career development, engaging in a continuous process of self-reflection, goal setting, and decision-making that is influenced by both internal and external factors (Wendling & Sagas, 2020).

SCCT operates on several key assumptions. Firstly, it assumes that individuals possess self-regulatory capabilities and the capacity to set and pursue career goals. Secondly, it emphasizes the importance of observational learning and social modelling in shaping individuals' career aspirations and behaviours, suggesting that people learn from observing the experiences and successes of others. Thirdly, SCCT assumes that individuals' beliefs about their own abilities (self-efficacy) and the expected outcomes of their actions (outcome expectations) play a central

role in guiding their career-related decisions and actions. Finally, SCCT recognizes the significance of environmental factors, such as social support, cultural norms, and economic opportunities, in influencing career development outcomes. SCCT provides a comprehensive framework for understanding the complex interplay between individual cognition, social influences, and environmental factors in shaping career development processes.

Social Cognitive Career Theory (SCCT) provides a valuable framework for analyzing the factors influencing the supply of software engineering professionals in commercial banks in Kenya, particularly by accounting for the dynamic interaction between individual, environmental, and behavioral determinants (Lent & Brown, 2019). Firstly, personal characteristics, as defined by SCCT, significantly shape individuals' career interests and trajectories. Indicators such as educational background, financial capability, attitude towards engineering, and previous career changes influence one's decision to pursue and persist in software engineering. For instance, individuals with strong technical self-efficacy, adequate financial support to undertake relevant training, and a positive orientation toward engineering are more likely to enter and remain in the field (Kusumawati & Wahyuningsih, 2020). Secondly, industry demand for software engineers plays a crucial role in determining the supply of professionals. This can be assessed through indicators such as the number of job openings, turnover rates, competition for talent, and the influence of the global talent pool. The increasing reliance of Kenyan commercial banks on digital platforms for efficiency and customer service has intensified the need for skilled software engineers, thereby shaping the supply pipeline.

Thirdly, rapid technological advancements have a dual effect on the supply of professionals. On one hand, they create opportunities for specialization and innovation; on the other, they pose challenges due to skill obsolescence, the need for continual skill upgrading, and the increasing demand for multidisciplinary expertise. Additionally, access to cutting-edge resources and training facilities influences professionals' ability to keep pace with technological trends. SCCT posits that individuals who exhibit a growth mindset and adaptability to technological change are better positioned to thrive in such an environment (Belchior & Lyons, 2021). Lastly, the quality of education and training serves as a critical factor in shaping the supply of software engineering professionals. SCCT emphasizes the importance of supportive learning environments and relevant

curricula. Institutions that provide high-quality instruction, practical training, and strong industry linkages contribute to producing a workforce that meets industry standards. This, in turn, influences outcomes such as the number of qualified software engineers, annual employment rates, retention rates, and the percentage deficit of professionals in the field.

2.2.2 Labor Market Theory

Labor market theory, as a comprehensive framework, has evolved over time with contributions from various economists and scholars. Its foundations can be traced back to the classical economists of the 18th and 19th centuries, such as Adam Smith and David Ricardo, who laid the groundwork for understanding the interaction of supply and demand in labor markets (Ehrenberg & Hallock, 2021). However, modern Labor Market Theory has been refined and expanded upon the fundamental concepts of labor market theory to provide insights into wage determination, unemployment, human capital, and the role of institutions in labor market dynamics. Labor market theory encompasses several fundamental propositions. Firstly, it posits that labor, like any other commodity, is subject to the forces of supply and demand. The theory explores how the supply of labor (workers) and the demand for labor (employers) interact to determine equilibrium wage rates and levels of employment (Herkenhoff & Mongey, 2022).

In addition, it suggests that wages tend to adjust to balance supply and demand in the labor market. When the supply of labor exceeds demand, wages may decrease, and conversely, when demand exceeds supply, wages may rise (Hermo & Shapiro, 2022). Additionally, Labor Market Theory considers the role of factors such as human capital, labor mobility, and institutional factors like government regulations and labor unions in shaping labor market outcomes. Its assumptions include the existence of rational decision-making by both employers and employees, the influence of market forces on wage determination, and the responsiveness of individuals and firms to changes in economic conditions (Otsu & Yuen, 2022). Overall, labor market theory provides a framework for understanding the functioning of labor markets and the factors that influence wages, employment, and economic outcomes.

Labor Market Theory offers valuable insights into the dynamics influencing the supply of software engineering professionals in commercial banks in Kenya, particularly through the lens of

demand and supply forces in the job market. Firstly, personal characteristics such as educational background, financial capability, attitude towards engineering, and career changes significantly shape individuals' decisions to pursue software engineering. According to Labor Market Theory, individuals assess career paths based on their skills and the expected returns from their investment in education and training. Those with a strong foundation in technical subjects, financial means to afford quality education, and a positive orientation towards the engineering field are more likely to enter and persist in the profession (Ehrenberg & Hallock, 2021).

Secondly, industry demand for software engineers is a major determinant of supply. This can be observed through factors such as the number of job openings, turnover rates, competition for talent, and the global talent pool. Commercial banks in Kenya are rapidly digitizing operations, increasing their reliance on software solutions to drive efficiency and customer satisfaction. This demand translates into attractive wages, growth opportunities, and job security, which influence individual career choices and incentivize entry into the field (Otsu & Yuen, 2022).

Thirdly, the quality of education and training programs in Kenya plays a central role in shaping the availability of software engineering professionals. Labor Market Theory emphasizes the role of educational institutions in producing a workforce that matches industry needs. Indicators such as curriculum relevance, access to practical training, and partnerships with industry stakeholders determine whether graduates are equipped with up-to-date, marketable skills. High-quality academic programs that align with employer expectations can enhance employment rates, reduce the deficit of skilled professionals, and improve retention in the sector (Herkenhoff & Mongey, 2022).

Furthermore, rapid technological advancements influence the labor supply by requiring constant adaptation. Indicators such as skill obsolescence, the need for upskilling, specialization, and access to modern facilities and resources determine how well software engineers can meet emerging demands. As technology evolves, professionals who engage in continuous learning and are exposed to updated training environments remain competitive, helping mitigate the shortage of qualified personnel. By understanding the interaction of personal attributes, industry demand, educational quality, and technological progress, stakeholders can develop informed strategies to

boost the number of software engineers, improve employment and retention rates, and close the talent gap in Kenya's commercial banking sector.

2.2.3 Innovation Diffusion Theory

Innovation Diffusion Theory, initially proposed by sociologist Everett Rogers in 1962, outlines how innovations spread and are adopted within a population or social system (Ho, 2022). Rogers synthesized research from various fields, including sociology, anthropology, and communication studies, to develop this theory. The theory suggests that the adoption of innovations follows a predictable pattern characterized by the stages of awareness, interest, evaluation, trial, and adoption. It also highlights the influence of communication channels, social networks, and individual characteristics on the diffusion process. The theory operates on several key assumptions (Yuen & Wang, 2021).

The theory assumes that innovations possess certain characteristics that influence their adoption, including relative advantage, compatibility, complexity, trialability, and observability (Ho, 2022). Secondly, it suggests that individuals within a social system differ in their readiness to adopt innovations, with some being early adopters and others late adopters. Thirdly, it posits that communication channels and social networks play a crucial role in facilitating the spread of innovations by providing information, reducing uncertainty, and influencing social norms. Generally, innovation diffusion theory provides a framework for understanding how innovations are introduced, accepted, and integrated into society, shedding light on the complex interplay of individual, social, and contextual factors in the diffusion process (Benhabib, Perla & Tonetti, 2021).

Innovation Diffusion Theory offers a comprehensive framework for understanding how various factors influence the supply of software engineering professionals in commercial banks in Kenya. The theory emphasizes the process by which innovations are adopted across a social system, ultimately shaping labor market dynamics. Personal characteristics are a foundational component influencing how individuals respond to the diffusion of innovation in the field of software engineering. Indicators such as educational background, financial capability, attitude towards engineering, and career change history determine an individual's readiness and ability to pursue

careers in this field. Those with a strong academic foundation in STEM, sufficient financial resources to afford quality training, and a positive perception of engineering are more likely to recognize and act upon emerging opportunities in the tech industry. Additionally, individuals transitioning from other careers may be motivated by perceived improvements in job stability and earnings potential, prompting them to adopt new skills and enter the profession (Ehrenberg & Hallock, 2021).

Industry demand for engineers serves as a critical driver of innovation adoption and labor market behavior. The number of job openings, turnover rates, competition for talent, and the increasing role of the global talent pool signal the attractiveness and urgency of acquiring software engineering skills. As commercial banks in Kenya rapidly digitize their services, the demand for software engineers capable of building and maintaining robust digital platforms has intensified (Yuen & Wang, 2021). This demand acts as a social cue, encouraging individuals to align their education and career paths with prevailing industry needs, thereby increasing the supply of professionals in the field.

Rapid technological advancements play a pivotal role in shaping both the skills required and the pathways individuals take to enter and remain in the software engineering workforce. Indicators such as skill obsolescence, the need for continuous skill upgrading, increased specialization, and demand for multidisciplinary expertise highlight the evolving complexity of the profession. The availability of resources and access to modern facilities also determines how effectively professionals can adapt to new technologies. According to Innovation Diffusion Theory, early adopters of cutting-edge technologies often gain a competitive advantage, influencing others to follow suit (Benhabib, Perla & Tonetti, 2021). In the software engineering context, this results in a workforce that is increasingly agile, specialized, and capable of meeting the dynamic needs of Kenya's banking sector.

Educational quality and responsiveness are equally crucial in shaping the supply of qualified professionals. Innovation Diffusion Theory underscores the role of institutions in facilitating the spread of new knowledge and technologies. Educational institutions that revise their curricula in response to technological shifts, offer hands-on training, and collaborate with industry stakeholders are better positioned to equip graduates with market-relevant skills. Indicators such

as the alignment of curricula with industry standards, access to practical training opportunities, and strength of industry-academic partnerships directly influence the number of qualified software engineers, annual employment rates, retention, and efforts to reduce the percentage deficit of professionals. A responsive education system ensures that as innovation spreads, the workforce evolves accordingly to meet labor market demands (Herkenhoff & Mongey, 2022).

2.3 Conceptual Literature

Conceptual literature refers to theoretical frameworks and models that explain the key concepts and variables related to a research problem. It provides a foundation for understanding how different factors are expected to relate to each other based on existing theories and scholarly perspectives. The conceptual literature covers supply of software engineering professionals, use of technology by commercial banks and factors affecting the supply of software engineering professionals.

2.3.1 Supply of Software Engineering Professionals

Software engineering professionals are experts who apply engineering principles to the design, development, testing, and maintenance of software systems (Ravindran & Griffin, 2023). They are skilled in programming, problem-solving, and software architecture, and work to ensure that software is efficient, reliable, and meets user requirements. Their responsibilities include writing code, performing quality assurance, updating software, and managing software projects, often collaborating with cross-functional teams (Johnson, Zimmermann & Bird, 2019). In industries like banking, they play a vital role in developing secure and robust systems that support financial transactions, data management, and digital services.

The supply of software engineering professionals is the availability of individuals possessing the necessary skills, knowledge, and expertise to meet the demand for software engineering roles within the industry. Campero (2021) defines supply of software engineers as the pool of individuals qualified to fill software engineering positions, emphasizing the importance of having a sufficient number of skilled professionals to support the development and maintenance of software systems. Similarly, Ravindran and Griffin (2023) highlighted the significance of a welltrained and competent workforce capable of designing, implementing, and managing

software projects effectively to meet organizational needs and objectives (Johnson, Zimmermann & Bird, 2019).

A robust supply of skilled professionals is essential for organizations to execute software projects efficiently, deliver high-quality products and services, and remain competitive in the global marketplace (Tsui, Karam & Bernal, 2022). In addition, software engineering professionals drive innovation and technological advancement, contributing to the creation of new products, solutions, and industries that enhance economic prosperity and societal well-being. Moreover, a sufficient supply of software engineering professionals is vital for addressing emerging challenges and opportunities in areas such as cybersecurity, data privacy, and digital transformation, ensuring the resilience and adaptability of organizations in an increasingly digital world.

The supply of software engineering professionals encompasses various factors that reflect the availability, retention, and demand for skilled individuals within the field. This includes metrics such as the number of software engineers graduating from educational programs or entering the workforce annually, which provides insights into the overall pool of available talent (Campero, 2021). Annual employment rates indicate the rate at which software engineers are being hired or absorbed into the job market, reflecting the demand for their skills and the growth of the industry (Tsui, Karam & Bernal, 2022). The percentage deficit of software engineers highlights any imbalance between supply and demand, identifying areas where there may be shortages or oversupply of talent. Additionally, retention rates within the software engineering profession play a crucial role in determining the stability and sustainability of the workforce, with higher retention rates indicating greater job satisfaction, career stability, and organizational commitment among software engineers.

2.3.2 Use of Technology by Commercial Banks

The integration of technology in commercial banks has transformed the banking landscape, enhancing operational efficiency and customer experience. Banks have adopted various digital tools, such as online banking platforms, mobile applications, and automated teller machines (ATMs), which provide customers with convenient access to banking services anytime and anywhere (Adebayo, 2021). These technologies enable users to perform transactions, check

account balances, and manage their finances with ease, significantly improving customer satisfaction. Additionally, the implementation of robust cybersecurity measures is crucial in protecting sensitive financial data, thereby fostering trust between banks and their customers (KPMG, 2020).

Moreover, the use of data analytics in commercial banks has revolutionized decision-making processes. By leveraging big data, banks can analyze customer behavior, preferences, and transaction patterns to tailor services and products to meet specific needs (Mwaura, 2019). This personalized approach not only enhances customer engagement but also allows banks to identify potential risks and opportunities more effectively. For instance, predictive analytics can help banks detect fraudulent activities in real-time, minimizing losses and improving overall security (OECD, 2022). Furthermore, artificial intelligence (AI) and machine learning algorithms are increasingly being utilized to automate processes such as credit scoring and loan approvals, streamlining operations and reducing human error.

In addition to improving customer service and operational efficiency, technology facilitates better regulatory compliance in the banking sector. Commercial banks are required to adhere to strict regulations concerning data protection, anti-money laundering (AML), and know-your-customer (KYC) practices. Technology-driven solutions, such as compliance management software and blockchain technology, enable banks to automate compliance processes, ensuring adherence to regulations while minimizing the risk of penalties (PwC, 2021). By embracing these technological advancements, commercial banks can enhance their operational resilience and maintain a competitive edge in an increasingly digital financial landscape.

2.3.3 Factors Affecting the Supply of Software Engineering Professionals

Various studies conducted around the world highlight different factors that affect the supply of software engineering professionals (Wati *et al.,* 2019; Msafiri *et al.,* 2023; Mukhwana *et al.,* 2020). The focus of this study was on personal characteristics, industry demand for engineers, technological advancements and educational quality. Personal characteristics encompass students' academic capability, financial capability, attitude towards engineering, and propensity for career change, reflecting their unique traits, qualities, and attributes that influence their educational and

professional pursuits (Kiernan *et al.,* 2023). Students' academic capability, including their mathematics and science capabilities, aptitude for technical subjects and problem-solving skills, impacts their readiness to pursue engineering careers. Financial capability also plays a significant role, as access to resources for education and training can affect individuals' ability to enter and succeed in the field (Mukhwana *et al.,* 2020). Moreover, attitude towards engineering, including passion, motivation, and interest in the subject matter, shapes students' decision to pursue engineering as a career path.

Industry demand for engineers refers to the quantitative and qualitative need within various sectors for professionals with engineering skills and expertise to fulfil roles related to design, development, implementation, and maintenance of products, systems, and infrastructure (Blersch *et al.,* 2020). A high number of job openings signifies robust demand for engineering talent across different industries, driven by ongoing projects, expansions, and technological advancements. However, this demand is often met with challenges such as high turnover rates among engineers, which can lead to vacancies that are difficult to fill and affect project timelines (Wati *et al.,* 2019). Furthermore, increased competition for talent intensifies the demand for qualified engineers, as organizations vie for top candidates with specialized skills and experience. The presence of a global talent pool further accentuates this competition, as companies seek to attract and retain skilled professionals from diverse geographic regions, leading to dynamic workforce dynamics and talent mobility within the engineering industry.

Rapid technological advancements denotes the swift progression of innovations, leading to skill obsolescence and upgrading, increased specialization, a growing demand for multidisciplinary skills, and the necessity for enhanced access to resources and facilities (Kiernan *et al.,* 2023). Skill obsolescence and upgrading pose significant challenges as technologies evolve swiftly, rendering certain skills outdated while demanding proficiency in emerging ones. Software engineers must continually update their skill sets to remain relevant and competitive in the field. Moreover, increased specialization within software engineering, driven by advancements in areas such as artificial intelligence, cybersecurity, and cloud computing, creates demand for professionals with specialized expertise (Blersch *et al.,* 2020). Additionally, the demand for multidisciplinary skills is rising as software engineering becomes increasingly integrated into

diverse sectors, requiring professionals to possess expertise beyond traditional programming domains. Also, access to resources and facilities, including cutting-edge technologies, laboratories, and educational programs, plays a vital role in equipping software engineers with the knowledge and tools needed to thrive in a rapidly evolving technological landscape.

Educational quality encompasses the alignment of curriculum relevance, provision of practical learning opportunities, cultivation of industry partnerships, and adherence to accreditation and registration standards to ensure the effectiveness and relevance of educational programs in preparing students for real-world challenges and professional success (McDool & Morris, 2022). Curriculum relevance ensures that educational programs align with the latest industry trends, technologies, and best practices, preparing students for the dynamic and evolving nature of the software engineering field (Wati *et al.,* 2019). Practical learning opportunities, such as hands-on projects, internships, and industry collaborations, provide students with real-world experience and skills application, bridging the gap between theoretical knowledge and practical application. Accreditation and registration standards ensure the quality and credibility of educational programs, providing assurance to employers and stakeholders that graduates possess the requisite knowledge and skills to succeed as software engineering professionals.

2.4 Empirical Review

This section presents empirical literature on the effect of personal characteristics, industry demand for engineers, rapid technological advancements and educational quality on supply of software engineering professionals.

2.4.1 Personal Characteristics and Supply of Software Engineering Professionals

Feldt and Maria (2020) investigated the potential correlation between the personalities of software engineers and their attitudes towards their professional activities. The study conducted an empirical study involving 47 professional engineers from various Swedish software development companies. Using the IPIP 50-item five-factor personality test, they evaluated the personalities of these engineers and inquired about their attitudes and basic views regarding their work. The results of the study revealed several significant associations between personality factors and software engineering attitudes. Interestingly, the tested individuals exhibited a higher degree of

homogeneity in personality compared to a broader sample of individuals from the general population. The findings suggest that understanding the personalities of software engineers can provide valuable insights into their attitudes towards their work.

A literature review (SLR), Soomro (2019) explored the relationship between software engineers' personality traits, team climate, and team performance. The objective of the paper was to investigate how the personality of software professionals correlates with team climate and subsequently affects team performance. Through the SLR methodology, the authors analyze existing literature to elucidate this relationship. The results of the review highlight 35 primary studies that have examined the connection between personality traits and team performance, excluding considerations of team climate. Software engineers possess a variety of personality traits that can impact their performance within a team setting. Traits such as conscientiousness, openness to experience, agreeableness, extraversion, and emotional stability can affect how individuals approach tasks, interact with team members, handle conflicts, and adapt to changing project requirements.

Yilmaz and Colomo-Palacios (2021) investigated the impact of individuals' personalities on software team configurations, aiming to address the social issues contributing to software project failures, such as team conflicts. While previous empirical studies have lacked systematic methods to relate personality traits to team structures, this study adopts an interactive personality profiling approach to uncover personality traits among software practitioners and explore effective team structures. Methodologically, the study employed a two-step empirical approach. First, a contextspecific survey instrument is developed and administered to 216 participants from a middle-sized software company to assess the personality traits of software practitioners. Second, a novel team personality illustration method is proposed to visualize team structures. The results of the study indicate that effective team structures tend to support teams with higher levels of emotional stability, agreeableness, extroversion, and conscientiousness among their members.

Hidellaarachchi, Hoda and Mueller (2023) delved into the influence of human aspects, particularly motivation and personality, on Requirements Engineering (RE)-related activities within software engineering (SE). Given the collaborative nature of RE activities involving various roles such as requirements engineers, stakeholders, and developers, understanding the

impact of human factors becomes crucial for improving RE and SE practices. The key findings from the research suggest that software practitioners emphasize the importance of motivation, domain knowledge, attitude, communication skills, and personality traits in RE-related activities. The study identified specific motivational factors deemed critical by practitioners in the context of RE activities, as well as essential personality characteristics conducive to successful involvement in RE.

Mukua (2020) examined disparities in academic performance between government-sponsored and self-sponsored (module II) students in the School of Engineering (SoE) at a university of Nairobi. Historically, self-sponsored programs have provided opportunities for individuals who are unable to access traditional university education due to limited government resources and restricted intake into regular programs. Specifically, the study focused on residence, entry grades, class attendance, and infrastructure as potential influencers of academic performance among self-sponsored students. A sample of 382 self-sponsored students from the Civil, Mechanical, and Electrical Engineering departments, spanning levels 1-4, was selected using systematic random sampling. The study found that residence, entry grades, class attendance, and the adequacy of infrastructure significantly impact academic performance among self-sponsored students.

Khajeha (2019) examined the influence of student's entry behaviours on students' academic achievement in engineering courses in Kisumu National Polytechnic, Kenya. Data spanning from 2010 to 2014 indicate a notable discrepancy in performance between engineering and nonengineering courses at TKNP and TENP. The study population comprises 645 students, 41 lecturers, 1 librarian, 3 technicians, and 1 principal. Various research methods, including questionnaires, interviews, and document analysis, were employed to gather both quantitative and qualitative data. The findings indicated that student's entry behaviours (KCSE scores) had a significant effect on students' academic achievement in engineering courses in Kisumu National Polytechnic. This suggests that the performance of students in engineering courses was influenced by their academic background and prior educational achievements, as measured by their KCSE scores. Students with higher KCSE scores tended to perform better academically in engineering courses compared to those with lower scores.

2.4.2 Industry Demand for Engineers and Supply of Software Engineering Professionals

Forbes and Zampelli (2018) conducted a study in the United States focusing on the growth, technology, and demand within the field of scientists and engineers. Their research employed an input-output approach to analyze shifts in employment within science and engineering. By utilizing highly detailed industry-occupation data, the study aimed to capture the complex interrelationships among different industries and occupations within these sectors. Their analysis indicated that around 30% of the variations in total science and engineering employment could be attributed to technological advancements. This contrasts with an earlier study that reported a 54% impact based on more aggregated data. The discrepancy underscores the significance of using detailed data to accurately grasp the nuanced effects of technological changes on employment within the science and engineering domains.

Qvist and Munk (2019) examined the relationship between the supply of engineers and their relative earnings using the opening of Aalborg University in Denmark as a natural experiment. The university's establishment in the 1980s resulted in a significant increase in the supply of electrical and construction engineers. The study compared the relative earnings of these engineers to a control group of chemical engineers, for whom the university did not supply education at the time. The findings suggest that the increased supply of electrical and construction engineers led to a decrease in their relative earnings compared to chemical engineers. This indicates that even engineers in high demand are susceptible to the effects of supply on earnings. The use of Aalborg University's opening as a natural experiment provides a unique opportunity to study the impact of supply shocks on engineer earnings. The results highlight the importance of considering supplydemand dynamics in understanding labor market outcomes for engineers.

Themba (2023) investigated the demand for industrial skills within South Africa's National Certificate (Vocational) Building and Civil Engineering Programme. The study conducted a critical analysis of the alignment of this program, offered by TVET Colleges, focusing on two vocational training institutions in Mpumalanga Province. Using a qualitative research approach, data were gathered through interviews and observations involving ten TVET teachers. The findings indicate that the NCV: Building and Civil Engineering program exhibits a lack of alignment with industry requirements, notably due to insufficient practical training time relative

to theoretical instruction. The study concludes that the TVET sector encounters challenges in meeting industrial skill demands and emphasizes the urgent need for evaluating and realigning the NCV program to better meet industry needs.

Rutto (2019) examined the relationship between industry demands and future of engineering education in Kenya. The study adopted a cross-sectional research design. The findings indicated that industry demands play a crucial role in shaping the curriculum of engineering education. As industries evolve and technologies advance, there is a growing need for engineers with specialized skills and knowledge. Engineering programs need to adapt their curricula to incorporate emerging technologies, industry trends, and real-world applications. This ensures that graduates are equipped with the relevant skills and competencies needed to address current and future challenges in the workplace. Industry demands emphasize the importance of practical training and hands-on experience in engineering education. Employers often prioritize candidates who have practical skills and experience in addition to theoretical knowledge.

2.4.3 Rapid Technological Advancements and Supply of Software Engineering Professionals

In the United States, Wilson and Buchanan (2020) examined the effect of new technology in the engineering industry. The study examined the effects of computer numerical control (CNC) on skill within the engineering industry. The research was based on qualitative data collected from three companies in the engineering industry. Through interviews, observations, and document analysis, the study examines the effects of CNC adoption on skill utilization and levels among workers. Comparative analysis is employed to identify common patterns and variations across the companies, providing insights into the shared experiences of technical change among workers. The findings of the research highlight that technical change, particularly the adoption of CNC technology, can have both positive and negative effects on skill within the engineering industry. While CNC technology enhances productivity and efficiency, it also poses challenges to traditional skills, particularly among turners. As a result, workers may collectively defend their common interests in response to threats posed by technical change, reflecting shared experiences and concerns regarding skill utilization and levels in the industry.

Beer and Mulder (2020) conducted a systematic literature review exploring the impact of technological advancements on work dynamics and their implications for continuous vocational

education and training (CVET). The review spanned multiple disciplines such as psychology, sociology, economics, and educational science. Their findings highlighted an increase in cognitive and complex tasks associated with automation and robotics, coupled with a decline in manual labor. They also noted that the autonomy afforded by digital communication devices contributes to increased workload and interruptions in workflow. The study emphasized that professional roles and career development opportunities are shaped by the interaction between professions and technology, particularly in automated systems. Regarding work demands, the study underscored the importance of technological literacy, adaptability, and self-management skills. For the design of effective learning environments, the integration of these skills into training curricula, adequate preparation of trainers, and flexibility in instructional approaches were identified as crucial factors.

In a critical analysis of literature, Mohammed (2020) examined the impacts software engineering brings to the technological industry. By examining historical patterns, current trends, and future possibilities, the research aimed to elucidate the deep-seated influence of software engineering. Key milestones such as the adoption of agile methods, DevOps practices, and open-source software are highlighted, reshaping how applications are developed, launched, and managed. Moreover, the study explores software engineering's contributions to advancements in artificial intelligence, cloud computing, cybersecurity, and data analytics, underscoring its importance in driving digital transformations and enhancing user experience. Notably, software engineering enhances personalization and customer experience through algorithms and AI-driven systems, while enabling the rapid growth of the Internet of Things (IoT) and smart devices. Moreover, it democratizes entrepreneurship, facilitates environmental sustainability, and promotes energyefficient technologies, shaping a more connected, innovative, and sustainable technological landscape.

Ra, Shrestha and Khatiwada (2019) examined the rise of technology and its impact on skills. The study adopted a systematic review of literature. The study found that that emerging occupations are likely to be concentrated in non-routine and cognitive tasks, necessitating skills that are less susceptible to automation. This shows the importance of enhancing learnability among workers to adapt to changing job requirements. The study also found emerging trends in education systems,

such as the increasing emphasis on lifelong learning and skills development. Additionally, it identifies trends among firms that prioritize employees with greater learnability, signalling a shift in hiring preferences towards adaptable and agile workers. Finally, the study proposed a transition towards a learning society that promotes learnability at all stages of workforce development. It advocates for policies and initiatives that facilitate lifelong learning, retraining, and upskilling to empower individuals to thrive in the rapidly evolving job market of the fourth industrial revolution.

2.4.4 Educational Quality and Supply of Software Engineering Professionals

Al-Zuhairi and Bulak (2022) examined factors influencing the quality of engineering education in a Turkish university setting. The research methodology adopted a qualitative approach to measure the quality of engineering education. A case study conducted at a Turkish university serves as the primary source of data collection. Qualitative data analysis techniques are employed to examine the relationship between quality systems, information quality, and the actual utilization of engineering education. Through in-depth interviews, document analysis, and observational studies, the study seeks to uncover the nuanced dynamics shaping the quality of engineering education. The results revealed a positive relationship between information quality and the actual use of engineering education. This indicates that the availability of accurate and reliable information enhances the effectiveness and utilization of educational resources. Additionally, the study highlights the positive impact of system quality on actual use, suggesting that wellfunctioning quality systems contribute to the overall quality of engineering education.

Gumaelius, Skogh, and Pantzos (2023) investigated how engineering education in the Nordic region is adapting to prepare future engineers for professional practice in an increasingly digital world. Utilizing Bernstein's pedagogical device model, the study focused on assessing the implementation of digital knowledge and its integration into the subject content of engineering education. The research gathered and analyzed narratives from 20 university teachers to explore the impact of digital transformation on educational content and pedagogical methods within engineering programs. The findings of the study identified three critical areas: the relationship between the recognition of digital knowledge and its incorporation into engineering curricula, variations in digital literacy across different generations of teachers, and the limited role that

universities currently play in driving digital innovation. The study concludes that educational institutions need to re-evaluate their approach to digitalization, provide on-going training for senior faculty members, and prioritize educational advancements to effectively tackle the challenges posed by digital transformation.

Kigotho (2021) observed that the quality of engineers in developing countries, specifically in Africa, is a pressing concern, indicating a stark regional disparity and low per capita representation of engineering professionals. With Africa experiencing the lowest number of engineers per capita globally, there is a worrying trend of insufficiently trained engineers, hindering progress in crucial sectors like technology. Furthermore, there is a risk of missed opportunities in emerging technologies such as artificial intelligence and smart engineering solutions, which is attributed to inadequate engineering education and accreditation standards across African countries. Moreover, with many African countries lacking proper accreditation mechanisms and national registration bodies, there is a significant gap in aligning engineering standards with international benchmarks. This discrepancy not only jeopardizes the employability of African engineering graduates globally but also limits their ability to address the continent's pressing challenges effectively.

Muriithi and Musili (2021) explored the impact of science, technology, engineering, and mathematics (STEM) skills on youth employment in Kenya. The study utilized secondary data from the World Bank's Skills towards Employability and Productivity (STEP) household wave-3 survey, which involved a stratified three-stage sampling design and collected information from 3,894 households. A multinomial logit model was employed to analyze the influence of STEM skills on youth employment and the nature of employment contracts. The study's key findings indicate that youths with STEM skills are more likely to engage in self-employment and hold temporary contracts. Additionally, the public sector is less inclined to hire youths with STEM skills, suggesting that employment opportunities for these individuals are predominantly found in the private sector and self-employment. Other significant factors influencing youth employment and the type of employment contract include work experience, level of education in STEM fields, and the duration of job search.

Keter and Okemwa (2020) investigated the alignment between technical skills acquired and those required for servicing electrical equipment among electrical engineering technicians in Kenya's manufacturing industries. The study utilized quantitative research methods, focusing on TVETAregistered Technical Training Institutions in Nandi and Uasin-Gishu counties. The target population included 96 electrical engineering trainers, 15 employees from manufacturing industries, and 65 electrical engineering technician trainers. A sample of 50 electrical engineering trainers, 7 employees from manufacturing industries, and 29 electrical engineering technician trainers was selected. Data were collected using questionnaires that were pre-tested for validity, and the analysis was conducted using descriptive and inferential statistics. The results demonstrated a positive and significant relationship between the training received by electrical engineering technicians at TVET institutions and the skills needed for servicing electrical equipment in Kenya's manufacturing industries.

Keter and Okemwa (2020) examined the relationship between technical skills acquired and skills required on electrical equipment servicing among electrical engineering technicians in manufacturing industries in Kenya. Quantitative research techniques were employed; focusing on TVETA registered Technical Training Institutions in Nandi and Uasin-Gishu counties. The target population comprised 96 electrical engineering trainers, 15 employees from manufacturing industries, and 65 electrical engineering technician trainers. A sample of 50 electrical engineering trainers, 7 manufacturing industry employees, and 29 electrical engineering technician trainers was selected. Questionnaires were used for data collection, pre-tested for validity, and analyzed using descriptive and inferential analysis. Results revealed a positive and significant relationship between electrical engineering technician training at TVET institutions and skills required for electrical equipment servicing in manufacturing industries in Kenya.

2.5 Summary of Knowledge Gaps

Table 2.1 presents a summary of reviewed literature, highlighting the focus, methodology, key findings, and identified knowledge gaps in previous studies.

Table 2. 1: Summary of the Literature

Study	Focus of the Study	Methodology	Findings	Gap in Knowledge
Feldt and Maria (2020)	Potential correlation between the personalities of software engineers and their attitudes towards their professional activities	Survey research design	There are significant associations between personality factors an d software engineering attitudes	This study was limited to Sweden and hence the findings cannot be generalized to Kenya. The study did not show how personal characteristics affect supply of engineers.
Soomro (2019)	Relationship between software engineers' personality traits, team climate, and team performance	Systematic literature review	Traits such as conscientiousness, openness to experience, agreeableness, extraversion, and emotional stability affect how individuals approach tasks.	The study used systematic review of literature and hence the findings are not specific to a particular sector. The dependent variable was team performance, which is different from supply of software engineers.
Forbes and Zampelli (2018)	Growth, technology, and the demand for scientists and engineers in the United States	The study used inputoutput approach	Highly disaggregated industry-occupation employment data are utilized to capture the intricate relationships between industries and occupations within the science and engineering sectors	Having been limited to the US, the findings cannot be generalized to Kenya
Keter and Okemwa (2020)	Relationship between technical skills acquired and skills required on electrical equipment servicing among electrical engineering technicians in manufacturing industries in Kenya	Quantitative research techniques	Positive and significant relationship between electrical engineering technicia n training at TVET institutions and skills required for electrical equipment servicing in manufacturing industries in Kenya	This study focused on electrical engineering technicians in manufacturing industries in Kenya, which are different from software engineers

2.6 Conceptual Framework

Figure 2.1 is a diagrammatic presentation of the relationship between the independent variables and dependent variables (Devi, 2019). The independent variables were personal characteristics, industry demand for engineers, technological advancements and educational quality. The

dependent variable was supply of software engineering professionals in commercial banks in Kenya.

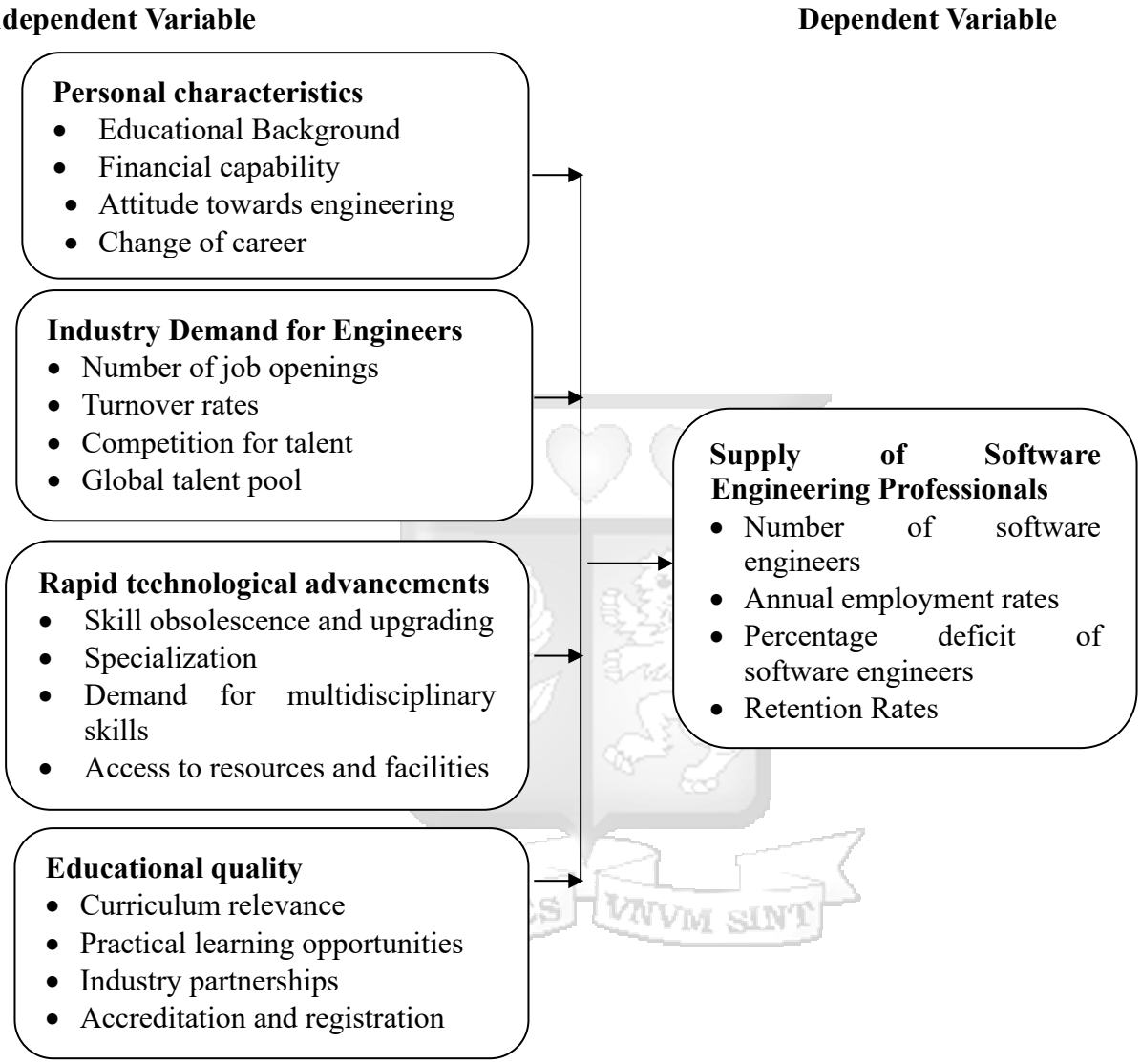

Figure 2. 1: Conceptual Framework

2.7 Operationalization of variables

Table 2.2 shows the operationalization of the independent variables and the dependent variable. It covers the study variables, measurement of the variables, scale of measurement of the variables, supporting literature and supporting theories.

Table 2. 2: Operationalization of Variables

Variable	Measurement	Scale of measurement	Supporting literature	Proposed method of data analysis
Personal characteristics	• Educational Background • Financial capability • Attitude towards engineering • Change of career	• Likert Scale	Feldt and Maria (2020); Soomro (2019); Yilmaz and Colomo-Palacios (2021); Khajeha (2019)	• Descriptive analysis • Correlation analysis • Regression analysis
Industry Demand for Engineers	• Number of job openings • Turnover rates • Competition for talent • Global talent pool	• Likert Scale	Forbes and Zampelli (2018); Qvist and Munk (2019); Rutto (2019); Themba (2023)	• Descriptive analysis • Correlation analysis • Regression analysis
Rapid technological advancements	• Skill obsolescence and upgrading • Specialization • Demand for multidisciplinary skills • Access to resources and facilities	• Likert Scale	Wilson and Buchanan (2020); Beer and Mulder (2020); Mohammed (2020); Ra, Shrestha and Khatiwada (2019)	• Descriptive analysis • Correlation analysis • Regression analysis
Educational quality	• Curriculum relevance • Practical learning opportunities • Industry partnerships • Accreditation and registration	• Likert Scale	Al-Zuhairi and Bulak (2022); Gumaelius, Skogh and Pantzos (2023); Kigotho (2021); Muriithi and Musili (2021)	• Descriptive analysis • Correlation analysis • Regression analysis
Supply of Software Engineering Professionals	• Number of software engineers • Annual employment rates • Percentage deficit of software engineers • Retention Rates	• Ratio		• Descriptive analysis • Correlation analysis • Regression analysis

2.8 Chapter Summary

The theoretical review encompasses three major theories: Social Cognitive Career Theory (SCCT), Labor Market Theory, and Innovation Diffusion Theory. SCCT emphasizes how individuals' career choices are shaped by their self-efficacy beliefs, outcome expectations, and

contextual factors. It suggests that personal characteristics, industry demand, technological advancements, and educational quality influence the supply of software engineering professionals. Labor Market Theory explores the interaction of supply and demand in labor markets, highlighting the role of factors like human capital and institutional factors. It underscores the importance of understanding industry demand and educational quality in shaping the supply of engineers. Innovation Diffusion Theory examines how innovations spread and are adopted, emphasizing the influence of communication channels and individual characteristics. It provides insights into how industry demand and rapid technological advancements impact the supply of software engineering professionals.

Empirical literature reviews provide further insights into the relationships between personal characteristics, industry demand, technological advancements, educational quality, and the supply of software engineering professionals. Studies show that personal characteristics such as motivation, personality traits, and academic background significantly influence individuals' decisions to pursue engineering careers. In addition, the empirical literature shows that industry demand for engineers plays a pivotal role in shaping the supply of professionals in the field. The literature also shows that rapid technological advancements have an effect on supply of software engineering professionals. In addition, the quality of education and training programs affects the readiness of graduates to meet industry needs. Collaboration between educational institutions and industry stakeholders is essential to bridge the gap between academia and the job market.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

A research methodology is a systematic and structured approach or framework that researchers use to plan, conduct, and evaluate their research (Bhattacherjee, 2018). This chapter outlines the study's research philosophy, target population, sampling frame, sample and sampling technique, data collection instrument, data collection procedures, research quality, data analysis as well as ethical considerations.

3.2 Research Philosophy

The study adopted a pragmatism research approach. Pragmatism is a philosophical and research approach that emphasizes practical consequences and real-world applications. In the context of research, pragmatism is considered a paradigm that allows researchers to choose methods and theories based on their practical utility for solving real-world problems (Kumar, 2019). In pragmatism, the integration of qualitative and quantitative methods is a key feature, reflecting the pragmatic view that the selection of research methods should be driven by their utility in addressing the research problem and achieving practical outcomes (Krishna, 2020). In this study, the study sought to determine factors affecting the supply of software engineering professionals in commercial banks in Kenya using mixed methods research.

3.3 The Research Design

This study adopted a mixed methods research design. A mixed methods research design integrates both qualitative and quantitative approaches to provide a more comprehensive understanding of a research problem (Creswell & Plano Clark, 2018). This design allows for the collection, analysis, and integration of both numerical data and in-depth qualitative insights, thereby enhancing the validity and richness of the findings. In this study, the mixed methods research design was used to examine the factors affecting the supply of software engineering professionals in commercial banks in Kenya by combining survey data with key informant interviews.

3.4 Population and Sampling

This section covers the study's target population, sampling frame as well as sample size and sampling technique.

3.4.1 Target Population

The target population, within the realm of research and sampling, encompasses the entirety of individuals or elements that constitute the focus of a study. It represents the larger group from which a researcher selects a sample to draw conclusions and make inferences about the population (Sileyew, 2019). The study was conducted in Tier 1 commercial banks in Kenya. The rationale for focusing on Tier 1 banks is justified by their distinct operational structures compared to Tier 2 and Tier 3 banks. Specifically, while many Tier 3 and some Tier 2 banks tend to outsource software engineering functions from other countries due to cost efficiency or lack of internal capacity, Tier 1 banks typically maintain dedicated ICT departments. These departments are tasked with the inhouse development and management of software engineering solutions, making Tier 1 banks a more appropriate focus for the study. Tier 1 banks, being larger and more financially capable, invest heavily in technology infrastructure, including software engineering teams, to meet their complex operational needs and provide cutting-edge digital banking services. The target population of this study were all the 507 staff working in ICT, human resources as well as strategy and development departments in 9 Tier 1 commercial banks in Kenya.

Table 3. 1: Target Population

Tier 1 Commercial Banks	ICT	Human Resource	Strategy and Development	Total
KCB Bank Kenya Limited	32	13	23	68
Equity Bank Kenya Ltd	30	10	20	60
NCBA Bank Kenya PLC	25	12	22	59
The Co-operative Bank of Kenya Ltd	22	14	18	54
Absa Bank Kenya Plc	23	16	16	55
Standard Chartered Bank (K) Ltd	24	16	14	54
Stanbic Bank Kenya Ltd	21	14	18	53
Diamond Trust Bank Kenya Limited	24	12	17	53
I &M Bank Limited	22	10	19	51
Total	**223**	**117**	**167**	**507**

3.4.2 Sampling Frame

A sampling frame is a specific, well-defined, and accessible population or group that represents the larger target population (Latwal, 2020). The purpose of a sampling frame is to serve as a practical and manageable basis for selecting a sample that can be used to make inferences about

the entire target population (Waddell, 2020). A good sampling frame should be comprehensive, up-to-date, and accurate to ensure that the sample selected from it is representative of the target population. This sampling frame of this study were 507 staff working in ICT, human resources as well as strategy and development departments in 9 Tier 1 commercial banks in Kenya.

3.4.3 Sample and Sampling Technique

The sample size was determined using a Yamane's formula. The formula calculated the sample size based on a specified margin of error and confidence level (Hall, 2020). The formula was used because it puts into consideration the target population.

$$n = \frac{N}{1 + N(e)^2}$$

Where: n = no. of samples; N = total population; and e = error margin / margin of error (0.05)

$$n = \frac{507}{1 + (507 * (0.05^2))}$$

$$n = 224$$

The study used stratified random sampling in the selection of the sample size in each of the banks.

Stratified Random Sampling is a probability sampling technique used to ensure that specific subgroups within a population are adequately represented in a sample. The population is first divided into distinct subgroups, or strata, based on a shared characteristic. Then, a random sample is taken from each stratum, proportionate to the stratum's size in the population or based on the researcher's objective (Hair, Page & Brunsveld, 2020). The strata in this study was ICT, human resources as well as strategy and development departments. By ensuring all subgroups are represented, stratified sampling reduces variability within each stratum and increases the precision of estimates. This method ensures that every subgroup has a chance of being included, reducing the likelihood of missing out on important segments of the population.

Table 3. 2: Sample Size

Tier 1 Commercial Banks	ICT	Human Resource	Strategy and Development	Total
KCB Bank Kenya Limited	14	6	10	30

Equity Bank Kenya Ltd	13	4	9	27
NCBA Bank Kenya PLC	11	5	10	26
The Co-operative Bank of Kenya Ltd	10	6	8	24
Absa Bank Kenya Plc	10	7	7	24
Standard Chartered Bank (K) Ltd	11	7	6	24
Stanbic Bank Kenya Ltd	9	6	8	23
Diamond Trust Bank Kenya Limited	11	5	8	23
I &M Bank Limited	10	4	8	23
Total	99	52	74	224

3.5 Data Collection Methods

3.5.1 Data Collection Instruments

The study gathered primary data using semi-structured questionnaires and a key informant interview guide. The semi-structured questionnaire, designed for ICT department staff, integrated both structured (closed-ended) and unstructured (open-ended) questions. This approach includes predefined response options for fixed-choice questions and allows for detailed qualitative responses through open-ended questions (Devi, 2019). Specifically, the questionnaire contained multiple-choice and Likert scale items (strongly agree, agree, neutral, disagree, strongly disagree), as well as closed-ended questions to collect basic demographic information such as age, gender, education, and occupation. Additionally, it featured open-ended questions to invite respondents to provide detailed narrative responses in their own words. The questionnaire had six questions. This first section collected data on the demographic information of the participants. The second, third, fourth and fifth sections covered questions on the independent variables (personal characteristics, industry demand for engineers, technological advancements and educational quality). The sixth section collected data on the dependent variable (supply of software engineering professionals).

A key informant interview (Appendix III) is a qualitative research technique that entails conducting in-depth, one-on-one interviews with individuals who have specialized knowledge or expertise on a specific subject pertinent to the research (Creswell & Creswell, 2022). In this study, the key informants were the heads of ICT departments in commercial banks in Kenya. A structured interview guide was utilized to collect qualitative data, addressing questions related to both the independent and dependent variables.

3.5.2 Data Collection Procedures

Data collection procedures refer to the specific methods, techniques, and steps used to gather data for a research study (Sileyew, 2019). These procedures are an essential aspect of the research process and are designed to ensure the collection of accurate and reliable data. The data collection process commenced with obtaining consent from the Strathmore Business School ethics committee, followed by the application for a research permit from the National Commission for Science, Technology and Innovation (NACOSTI). Data collection from the staff in ICT departments was conducted using Google Forms. Daily follow-ups was conducted to track the progress of respondents in completing the questionnaires. The data collection phase is anticipated to span approximately one month. The researcher also booked an appointment with the heads of ICT departments for face-to-face interviews.

3.6 Research Quality

Research quality pertains to the overall excellence and dependability of a study, including its design, execution, analysis, and reporting. High-quality research is vital for generating credible and valid results that meaningfully enhance the existing body of knowledge (Bhattacherjee, 2018).

3.6.1 Pre-Testing

A pre-test serves as a preliminary study aimed at assessing feasibility, duration, cost, adverse events, and refining the study design before embarking on a full-scale research project (Devi, 2019). A pre-test was conducted to identify and revise any ambiguous, misinterpreted or misunderstood questions. Moreover, the pre-test helped eliminate typographical errors and assess the relevance and appropriateness of the questions asked. The research instruments underwent pretesting at Bank of Baroda (K) Limited. The pre-test group was randomly sampled and consisted of 10% of the total sample size. According to Kumar (2019), 10% of the sample required for a full study should be used in a sample size.

3.6.2 Validity of Research Instruments

The validity of a research instrument is a critical element in research, evaluating how accurately and effectively the instrument measures its intended constructs (Waddell, 2020). This study

specifically addressed two types of validity: content validity and face validity. Face validity is a type of content validity that refers to the extent to which an assessment or measurement instrument appears, on the surface, to be a valid and appropriate tool for measuring a specific construct or concept (Hall, 2020). It involves a subjective and qualitative assessment conducted by experts or non-experts in the field, focusing on the instrument's appearance or external characteristics. In this study, face validity was enhanced through feedback from experts in information and communication technology, including the supervisor. Content validity evaluates if the instrument thoroughly and effectively encompasses all pertinent aspects of the concept or construct under investigation (Bhattacherjee, 2018). It gauges whether the questions, items, or tasks are fitting and representative of the construct. Content validity was improved by organizing the questionnaire questions according to the indicators and objectives of the study.

3.6.3 Reliability of Research Instruments

Reliability refers to the extent to which a data collection instrument, like a questionnaire, provides consistent data or results after repeated trials (Latwal, 2020). Data reliability, assessed by Cronbach's alpha coefficient ranging from 0 to 1, measures the internal consistency and average correlation among statements that gauge a construct. Cronbach's alpha reflects how closely interconnected a set of items are as a whole, indicating scale reliability (Krishna, 2020). A Cronbach's alpha (α) exceeding 0.7 is typically deemed acceptable, while values below 0.7 raise concerns about reliability. For this study, a Cronbach's alpha of 0.7 was considered satisfactory.

3.7 Data Analysis

The research instruments yielded both qualitative and quantitative data. Qualitative data obtained from open-ended questions and key informant interviews was analyzed using thematic analysis, a widely recognized method for systematically identifying, analyzing, and interpreting patterns or themes within qualitative data to enhance understanding of the research subject (Mukherjee, 2020). Thematic analysis offers a structured yet adaptable approach to comprehending intricate qualitative data.

Quantitative data collected through questionnaires was processed, coded, and entered into the Statistical Package for Social Sciences (SPSS version 28), a statistical software package. Analysis

of quantitative data encompassed descriptive statistics, including frequency distributions, percentages, measures of central tendency (mean), and measures of variability (standard deviation). Subsequently, inferential statistics such as Pearson correlation analysis and regression analysis was employed to examine relationships and make predictions. The findings was visually presented using tables, bar charts, and pie charts to facilitate interpretation.

Since independent variables in this research are four, the multivariate regression model was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Whereby:

Y = Supply of software engineering professionals;

β_0 = Constant;

$\beta_1, \beta_2, \beta_3, \beta_4$ = Coefficients of determination;

X_1 = Personal characteristics;

X_2 = Industry Demand for Engineers;

X_3 = Rapid technological advancements;

X_4 = Educational quality; and

ε = Error term

3.8 Ethical Considerations

In conducting the study, ethical considerations was paramount, guided by established codes of conduct and principles such as respect for human dignity, beneficence, and justice. Obtaining a data collection permit from the National Commission for Science, Technology and Innovation (NACOSTI) and seeking consent from the Strathmore Business School ethics committee was integral to the process. Information consent was sought from potential participants, ensuring their understanding and voluntary agreement to take part in the research. To maintain confidentiality, participants were assured that their information was treated with utmost confidentiality and used solely for learning purposes, with data documents stored securely and access restricted. Anonymity was also be upheld, with measures in place to prevent the collection of identifying information unless necessary for the study protocol, and participants were requested not to disclose personal details when completing questionnaires.

VT OMNES
VNVM SINT

CHAPTER 4: RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents data analysis, interpretation of results, and the study's findings in relation to both the general and specific objectives. The primary objective of the study was to examine the factors affecting the supply of software engineering professionals in commercial banks in Kenya. Additionally, the study aimed to determine the effect of personal characteristics, industry demand for engineers, rapid technological advancements and educational quality on organizational performance in digital credit providers in Kenya.

4.2 Response Rate

The study's sample size comprised of 224 staff working in ICT, human resources as well as strategy and development departments in 9 Tier 1 commercial banks in Kenya. The response rate results were as illustrated in Table 4.1.

Table 4. 1: Questionnaires' Response Rate

Tier 1 Commercial Banks	Sample Size	Responses	Response rate
KCB Bank Kenya Limited	30	29	96.67%
Equity Bank Kenya Ltd	27	25	92.59%
NCBA Bank Kenya PLC	26	25	96.15%
The Co-operative Bank of Kenya Ltd	24	23	95.83%
Absa Bank Kenya Plc	24	21	87.50%
Standard Chartered Bank (K) Ltd	24	22	91.67%
Stanbic Bank Kenya Ltd	23	20	86.96%
Diamond Trust Bank Kenya Limited	23	22	95.65%
I &M Bank Limited	23	21	91.30%
Total	**224**	**208**	**92.86%**

From a total sample size of 224, 208 responses were obtained resulting into a response rate of 92.86%. According to Creswell and Creswell (2022), a response rate of 70% is regarded as great, while 50% is commonly regarded as good for analysis, conclusions, and reporting reasons. Therefore, 92.86% response rate of the study is sufficient for analysis, conclusion-making, and reporting.

4.3 General Information

The general information of the staff working in ICT, human resources as well as strategy and development departments in 9 Tier 1 commercial banks in Kenya comprised gender, age, education level, duration of work in the organization and the number of software engineers within the departments.

4.3.1 Respondents' Gender

The respondents were requested to indicate their gender. From the findings, as illustrated in Figure 4.1, 76.9% of the respondents indicated that they were male while 23.1% were female. The findings imply that there is a significant gender imbalance in the ICT, human resources, strategy, and development departments of Tier 1 commercial banks in Kenya. However, this presents an opportunity for banks to enhance gender diversity through targeted recruitment, mentorship, and leadership development initiatives, fostering innovation and improved decision-making. Strengthening inclusivity policies can drive long-term industry growth, employee satisfaction, and a more balanced and competitive workforce in the financial sector.

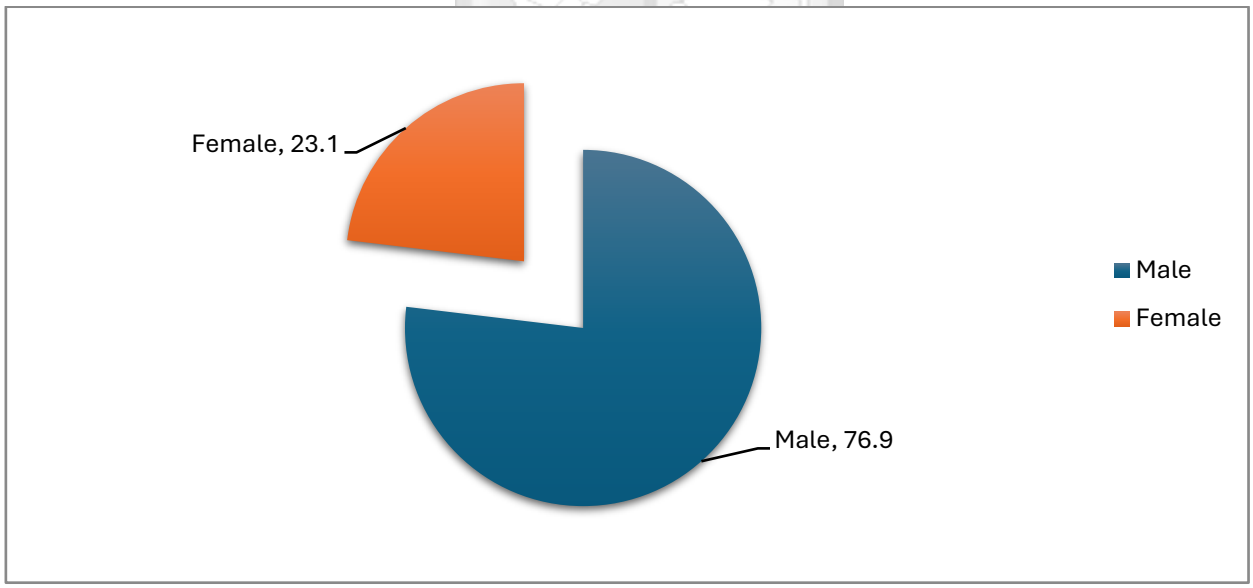

Figure 4. 1: Respondents' Gender

4.3.2 Age of the Respondents

The respondents' were requested to indicate their age. From the results as shown in Figure 4.2, 34.6% of the respondents indicated that they were aged between 30 and 34 years, 23.1% indicated that they were aged between35 and 39 years while 17.3% indicated that they were aged between

25 and 29 years. In addition, 15.4% of the respondents indicated that they were aged between 40 and 44 years while 9.6% indicated that they were aged between 20 and 24 years. The findings imply that the ICT, human resources, strategy, and development departments in Tier 1 commercial banks in Kenya have a relatively young and dynamic workforce, with the majority of employees aged between 30 and 39 years. This age distribution suggests a strong presence of experienced professionals who have likely developed industry-specific expertise while still being adaptable to evolving market trends and technological advancements.

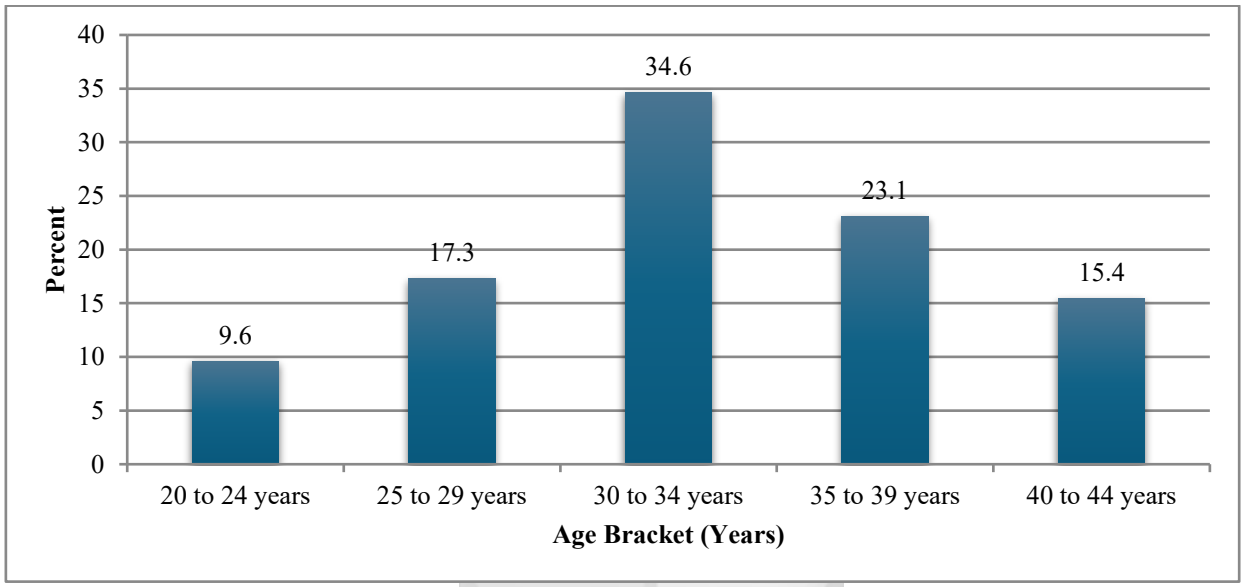

Figure 4. 2: Age of the Respondents

4.3.3 Respondents' Education Level

The respondents' were requested to indicate their education level. As illustrated in Figure 4.3, 67.3% of the respondents held undergraduate degrees, 28.8% had master's degrees, and 3.8% possessed diplomas. The findings indicate that the ICT, human resources, strategy, and development departments in Tier 1 commercial banks in Kenya have a highly educated workforce, with most employees holding undergraduate or master's degrees. This high level of academic qualification enhances technical expertise, strategic decision-making, and innovation within the sector. The presence of diploma holders also reflects a diverse skill set, positioning the workforce for adaptability, productivity, and long-term organizational growth.

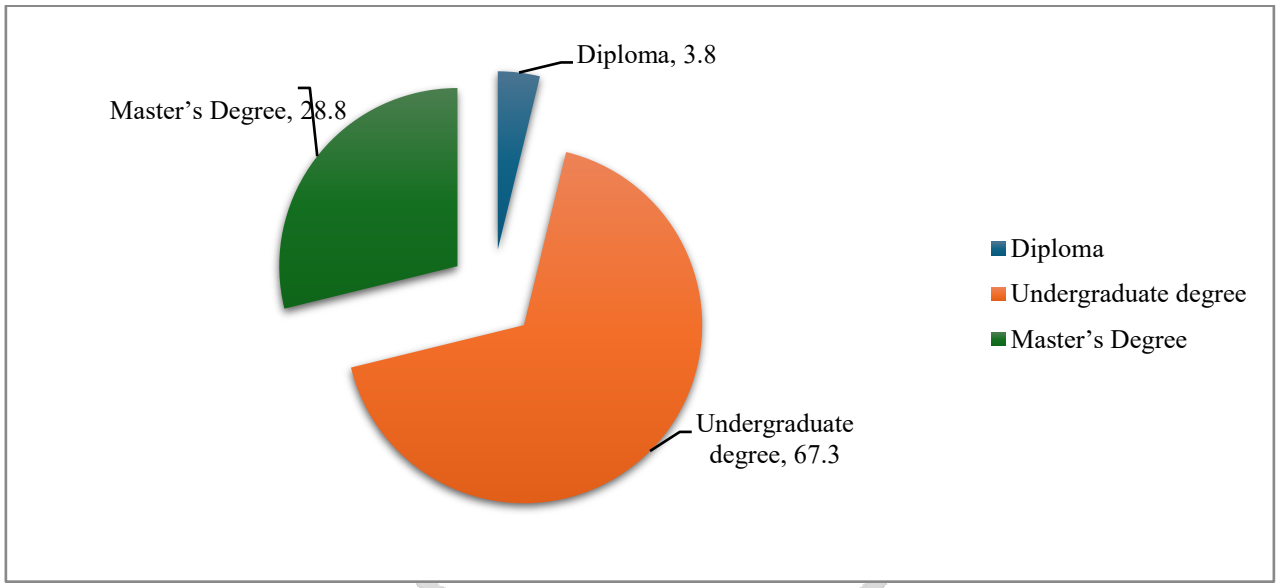

Figure 4. 3: Respondents' Education Level

4.3.4 Respondents' Work Duration

The respondents were asked to indicate the duration of time they have been working in the organization. As shown in Figure 4.4, 51.9% of the respondents indicated that they had been working in the organization for less than 3 years, 28.8% indicated that they had been working for between 4 and 7 years while 11.5% indicated that they had been working for between 8 and 11 years. In addition, 7.7% of the respondents indicated that they had been working in the organization for above 12 years. The findings imply that Tier 1 commercial banks in Kenya have a well-balanced workforce in ICT, human resources, strategy, and development departments, with a mix of new talent (51.9% with less than three years of experience) and experienced professionals who provide stability and mentorship. This diversity in tenure fosters innovation, knowledge transfer, and strategic growth, ensuring adaptability and long-term success in the evolving financial sector.

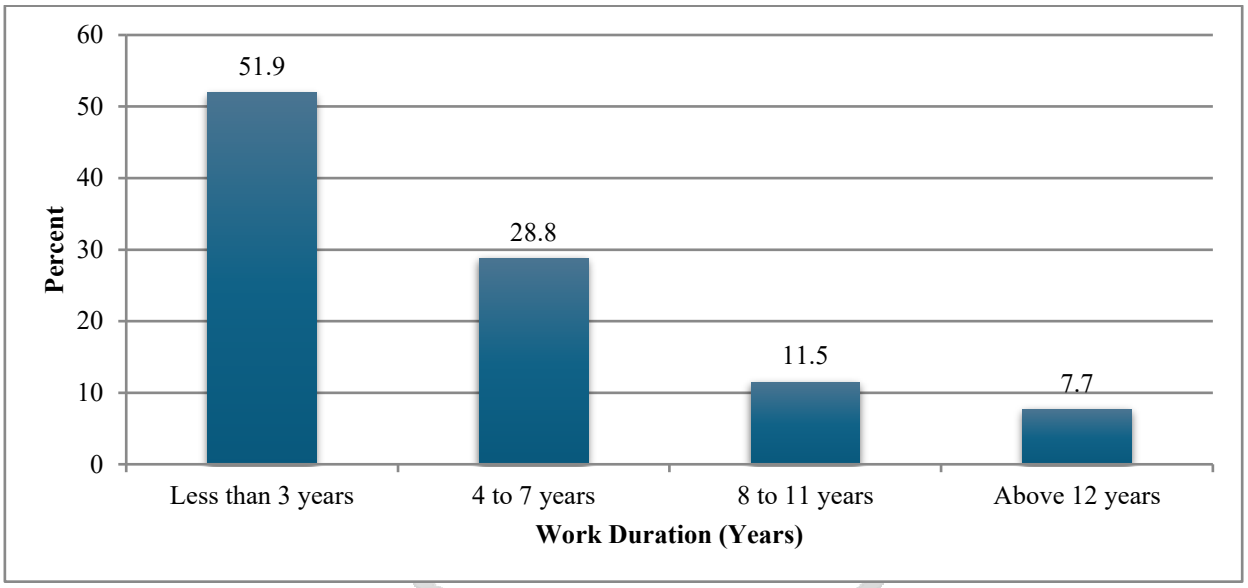

Figure 4. 4: Respondents' Work Duration

4.3.5 Number of Software Engineers within the Departments.

The data represents the number of engineers in commercial banks in Kenya. The average number of engineers per bank is 41.62, but the high standard deviation (34.75) suggests significant variation across banks. With a minimum of 4 and a maximum of 400, the distribution appears skewed, likely due to a few banks employing a disproportionately high number of engineers. This outlier effect inflates the average, meaning most banks likely have fewer engineers. Using the median instead of the mean could provide a clearer representation of the typical number of engineers in Kenyan commercial banks.

Table 4. 2: Number of Software Engineers within the Departments

Statistic	Value
Average Number of Engineers	42
Standard Deviation	34.75
Minimum	4
Maximum	400

4.4 Personal Characteristics

The first objective of the study was to determine how personal characteristics affect the supply of software engineering professionals in commercial banks in Kenya. The respondents' were asked to indicate the extent of their agreement with the following statements regarding personal characteristics of software engineers where 1 depicts strongly disagree, 2 depicts disagree, 3 depicts neutral, 4 depicts agree and 5 depicts strongly agree. As illustrated in Table 4.3, the respondents agreed with a mean of 4.442 (Std. Deviation=0.720) that attitude towards engineering significantly impacts individuals' motivation and commitment to pursuing and excelling in engineering roles. The respondents also agreed with a mean of 4.385 (Std. Deviation=0.860) that individuals with a negative attitude towards engineering may lack enthusiasm, curiosity, and passion for problem-solving and innovation in the field. Similarly, the respondents agreed with a mean of 4.385 (Std. Deviation=0.740) that a negative attitude towards engineering may discourage individuals from pursuing careers in the field. These findings align with Feldt and Maria (2020) observations that a negative attitude towards engineering can significantly deter individuals from entering the field.

With a mean of 4.212 (Std. Deviation=1.009), the respondents agreed that financial constraints may limit individuals' ability to pursue advanced degrees or certifications required for engineering roles. Further, with a mean of 4.192 (Std. Deviation=0.811) that inadequate financial resources can pose barriers to accessing quality education and training opportunities in engineering. These findings concur with Soomro (2019) observations that inadequate financial resources can pose significant barriers to accessing quality education and training opportunities in engineering. Also with a mean of 4.096 (Std. Deviation=0.948) that limited financial capability may hinder individuals' investment in professional development activities essential for success in engineering careers. Further, with a mean of 4.039 (Std. Deviation= 1.076) that hands-on experience during their academic program significantly contributed to their technical skills in software development. In addition, the respondents agreed with a mean of 3.428 (Std. Deviation=(1.105) that changes in career paths away from engineering can disrupt the supply and retention of engineers, potentially posing challenges for organizations and industries reliant on engineering talent.

With a mean of 3.346 (Std. Deviation =1.093), the respondents were neutral with the statement indicating that formal education in computer science or a related field has adequately prepared engineers for a career in software engineering. Similarly, the respondents were neutral that they believe that obtaining advanced degrees in software engineering enhances career opportunities in the field as shown by a mean of 3.346 (Std. Deviation =1.161). Also, the respondents were neutral with the statement indicating that career transitions from engineering to other fields can contribute to talent shortages and skill gaps within the engineering profession as shown by a mean of 3.135 (Std. Deviation=1.196). Moreover, with a mean of 3.058 (Std. Deviation=1.186), the respondents were neutral with the statement indicating that individuals leaving engineering careers may reduce the pool of available talent and expertise in the field, impacting industry innovation and competitiveness.

The respondents were further requested to indicate how else personal characteristics affect the supply of software engineering professionals in commercial banks in Kenya. From the findings, the respondents indicated that the supply of software engineering professionals in Kenyan commercial banks is influenced by various personal, educational, and industry-related factors. Key determinants include formal education, industry-specific certifications, work experience, and adaptability to new technologies. While software engineers have opportunities in the banking sector, many prefer tech-oriented companies or remote work, leading to a talent gap. Additionally, attitudes, passion, and professional development efforts play a significant role in career choices. Factors like remuneration, work-life balance, networking opportunities, and cultural adaptability impact employment trends. The entry of global firms offering better compensation further affects the availability of software engineers for local banks.

Table 4. 3: Aspects of Personal Characteristics

	Mean	Std. Deviation
Formal education in computer science or a related field has adequately prepared engineers for a career in software engineering.	3.346	1.093
I believe that obtaining advanced degrees in software engineering enhances career opportunities in the field.	3.346	1.161

Hands-on experience during my academic program significantly contributed to my technical skills in software development.	4.039	1.076
Inadequate financial resources can pose barriers to accessing quality education and training opportunities in engineering.	4.192	.811
Financial constraints may limit individuals' ability to pursue advanced degrees or certifications required for engineering roles.	4.212	1.009
Limited financial capability may hinder individuals' investment in professional development activities essential for success in engineering careers.	4.096	.948
A negative attitude towards engineering may discourage individuals from pursuing careers in the field.	4.385	.740
Attitude towards engineering significantly impacts individuals' motivation and commitment to pursuing and excelling in engineering roles.	4.442	.720
Individuals with a negative attitude towards engineering may lack enthusiasm, curiosity, and passion for problem-solving and innovation in the field.	4.385	.860
Career transitions from engineering to other fields can contribute to talent shortages and skill gaps within the engineering profession.	3.135	1.196
Individuals leaving engineering careers may reduce the pool of available talent and expertise in the field, impacting industry innovation and competitiveness.	3.058	1.186
Changes in career paths away from engineering can disrupt the supply and retention of engineers, potentially posing challenges for organizations and industries reliant on engineering talent.	3.428	1.105

The key informant interviewees were asked to identify the key personal traits essential for software engineering professionals working in commercial banks. From the findings, the key informant interviewees indicated that adaptability and continuous learning were crucial due to the rapid evolution of banking technologies, security protocols, and regulatory requirements. According to one interviewee,

> *"Software engineers in banking must be quick learners. The industry is evolving rapidly, and those who fail to keep up with new technologies and compliance requirements will struggle to remain relevant."KII2*

The key informants highlighted that problem-solving skills and analytical thinking are essential, as engineers must be able to quickly diagnose and resolve system issues. It was noted that engineers need to be quick thinkers, capable of troubleshooting effectively under pressure, as even minor errors in banking software can have significant financial implications. In addition,

integrity and attention to detail were emphasized as critical, given the sensitive nature of financial transactions and customer data. The importance of maintaining high ethical standards and precision was stressed, as small mistakes or security flaws could result in fraud or data breaches.

The key informant interviewees were asked to explain how factors such as gender, age, and family responsibilities impact the decision to pursue a career in software engineering within the banking sector. They noted that gender-related challenges still persist, with women often facing societal biases and workplace expectations that may discourage them from entering or advancing in the field. It was mentioned that, despite progress toward inclusivity, women in software engineering are often required to prove themselves more than their male counterparts, especially in leadership roles. Age was also highlighted as an influencing factor, with younger professionals being seen as more adaptable to emerging technologies but sometimes facing skepticism about their experience. It was pointed out that banks tend to prefer more experienced engineers, making it challenging for younger professionals to break into the industry unless they have strong credentials or internship experience. Family responsibilities, particularly for individuals with caregiving duties, were identified as another critical factor influencing career choices. The importance of work-life balance was emphasized, with interviewees mentioning that long hours and demanding projects can be difficult for professionals with families. They noted that many banks have yet to fully implement flexible work policies to support employees in this regard.

In addition, the key informant interviewees were asked to share their opinions on whether factors such as individual motivation, career goals, and financial aspirations influence the supply of software engineers in the banking industry. If so, they were requested to explain how. The key informant interviewee acknowledged that individual motivation, career goals, and financial aspirations significantly influence the supply of software engineers in the banking industry.

According to the interviewee, motivation plays a critical role in determining whether an individual pursues and remains in a software engineering career within the banking sector. According to one interviewee,

> *"Software engineering is a demanding field, and those who are highly motivated to solve complex problems and innovate in financial technology are more likely to thrive in banking institutions." KII2*

Career goals were identified as a significant factor influencing the supply of engineers in the banking sector. It was noted that some engineers view the banking sector as a stepping stone to more lucrative opportunities in fintech or global technology firms. It was observed that while many software engineers see banking as a stable career path, some eventually transition to startups or international companies that offer more dynamic projects and career growth. Also, financial aspirations were also highlighted as a major driver affecting both recruitment and retention. Interviewees pointed out that competitive salaries and benefits are crucial for attracting talent. If banks fail to offer competitive compensation packages, engineers are likely to move to fintech startups or global firms that provide better financial incentives.

4.5 Industry Demand for Engineers

The second objective of the study was to establish how industry demand for engineers affects the supply of software engineering professionals in commercial banks in Kenya. The respondents were requested to indicate their level of agreement with various statements regarding the industry demand for engineers. With a mean of 4.327 (Std. Deviation = 0.873), the respondents agreed that increased competition for talent can drive innovation and excellence within the engineering industry. Similarly, with a mean of 4.327 (Std. Deviation = 0.779), the respondents agreed that access to a global talent pool provides opportunities for diverse perspectives and expertise within the engineering industry. With a mean of 4.289 (Std. Deviation = 0.989), the respondents agreed that turnover rates impact productivity and continuity in projects within the engineering industry.

Similarly, with a mean of 4.289 (Std. Deviation = 0.690), they agreed that increased competition for talent highlights the demand for skilled engineers in the industry. Additionally, with a mean of 4.286 (Std. Deviation = 0.819), the respondents agreed that the global talent pool allows engineering firms to tap into specialized skills and knowledge from around the world. With a mean of 4.250 (Std. Deviation = 0.758), the respondents agreed that a global talent pool enhances the competitiveness and adaptability of the engineering industry by leveraging talent from diverse backgrounds and regions. Further, with a mean of 4.231 (Std. Deviation = 0.825), they agreed that turnover rates among engineers may suggest issues with job satisfaction or organizational culture that need to be addressed.

The respondents agreed with a mean of 4.173 (Std. Deviation = 0.957) that turnover rates among engineers can indicate challenges in retaining talent within the industry. In addition, the respondents agreed with a mean of 4.135 (Std. Deviation = 0.943) that competition for talent among engineering firms underscores the importance of attracting and retaining top professionals. The respondents agreed with a mean of 4.077 (Std. Deviation = 1.037) that the number of job openings suggests ample opportunities for engineers to find employment and advance their careers. Similarly, the respondents agreed with a mean of 4.077 (Std. Deviation = 0.979) that the number of job openings reflects a thriving industry with opportunities for growth and development for engineers. Moreover, the respondents agreed with a mean of 4.019 (Std. Deviation = 1.103) that the presence of a high number of job openings indicates strong demand for engineers in the industry.

The respondents were requested to indicate how else industry demand for engineers affects the supply of software engineering professionals in commercial banks in Kenya. The findings revealed that the increasing demand for skilled software engineers, driven by digital transformation, has created both opportunities and challenges. Engineers benefit from higher salaries and better career prospects, but talent shortages persist, especially in banking, where competition from tech firms and global companies is intense. Many engineers are drawn to top tech companies like Microsoft and Google, as well as fintech startups, which offer better pay, flexibility, and innovative work environments. Banks struggle to retain talent and often cannot match the culture and compensation of tech firms. Additionally, the broad demand for engineers discourages specialization, leading to a workforce with general skills but limited expertise.

Table 4. 4: Aspects of Industry Demand for Engineers

	Mean	Std. Deviation
The presence of a high number of job openings indicates strong demand for engineers in the industry.	4.019	1.103
The number of job openings suggests ample opportunities for engineers to find employment and advance their careers.	4.077	1.037
The number of job openings reflects a thriving industry with opportunities for growth and development for engineers.	4.077	.979
Turnover rates among engineers can indicate challenges in retaining talent within the industry.	4.173	.957
Turnover rates among engineers may suggest issues with job satisfaction or organizational culture that need to be addressed.	4.231	.825
Turnover rates impact productivity and continuity in projects within the engineering industry.	4.289	.989
Increased competition for talent highlights the demand for skilled engineers in the industry.	4.289	.690
Competition for talent among engineering firms underscores the importance of attracting and retaining top professionals.	4.135	.943
Increased competition for talent can drive innovation and excellence within the engineering industry.	4.327	.873
Access to a global talent pool provides opportunities for diverse perspectives and expertise within the engineering industry.	4.327	.779
The global talent pool allows engineering firms to tap into specialized skills and knowledge from around the world.	4.286	.819
A global talent pool enhances the competitiveness and adaptability of the engineering industry by leveraging talent from diverse backgrounds and regions.	4.250	.758

The key informant interviewees were asked to identify whether commercial banks seek specific skills or expertise in software engineers. If so, they were requested to specify which ones. The study found that commercial banks seek software engineers with a combination of technical expertise, industry-specific knowledge, and problem-solving abilities. They key informant interviewees highlighted that proficiency in programming languages such as Python, Java, and C# is essential, along with experience in database management and cloud computing. According to one interviewee,

"Banks are looking for engineers who are not only proficient in coding but also understand database management systems like SQL and cloud platforms such as AWS and Azure,"KII2

Also, cybersecurity skills were identified as a top priority due to the sensitive nature of banking transactions. It was highlighted that, with the increasing risks of cyber threats and fraud, banks require software engineers who possess expertise in cybersecurity frameworks, encryption technologies, and secure coding practices. In addition to technical skills, soft skills such as adaptability, teamwork, and problem-solving were noted as crucial. Key informants emphasized that software engineers in banking must be capable of working in cross-functional teams, adapting quickly to regulatory changes, and finding innovative solutions to complex financial problems.

In addition, the key informant interviewees were asked to share their views on how demand from other industries, such as fintech or telecommunications, affects the supply of software engineers in the banking sector. The key informant interviewee highlighted that demand from other industries, such as fintech and telecommunications, significantly impacts the supply of software engineers to the banking sector. They explained that fintech companies, in particular, offer highly competitive salaries, flexible work environments, and opportunities to work with cutting-edge technologies, making them attractive to software engineers. One key informant interviewee stated that,

"Fintech startups and global tech firms provide more dynamic and innovative workspaces compared to traditional banks, drawing top talent away from the banking sector." KII4

Similarly, the telecommunications industry competes for software engineers with expertise in network security, cloud computing, and mobile application development. It was noted that telecom companies are investing heavily in digital transformation and require skilled engineers for projects such as 5G networks, IoT solutions, and cybersecurity. As a result, commercial banks often face challenges in attracting and retaining top software engineering talent, as they may not always offer the same level of compensation, work flexibility, or opportunities for innovation. One key informant interviewee explained,

"Banks typically have more structured work environments with strict regulatory requirements, which can be less appealing to young engineers who seek creativity and rapid career growth," KII2

Further, the key informant interviewees were asked how shifts in industry demand influence the need for software engineers in commercial banks. It was emphasized that these shifts directly impact the demand for software engineers, primarily driven by evolving customer expectations, regulatory changes, and technological advancements. As digital banking continues to expand, there is an increasing need for software engineers to develop secure, efficient, and user-friendly platforms.

The key informant interviewees highlighted that the rise of digital payments, artificial intelligence, and blockchain technology has created an urgent need for specialized engineering skills. It was noted that as more customers shift toward online and mobile banking, banks must invest in software engineers who can enhance cybersecurity, automate processes, and integrate AI-driven solutions. Also, changes in regulatory requirements, such as data protection laws and compliance standards, have further increased the demand for skilled professionals. It was emphasized that banks need engineers who understand financial regulations and can develop systems that comply with these evolving standards. Moreover, competition from fintech firms and global tech companies has prompted banks to accelerate their digital transformation efforts. It was pointed out that if banks fail to keep up with industry demand, they risk losing customers to fintech startups that offer faster and more innovative financial solutions.

4.6 Rapid Technological Advancements

The third objective of the study was to determine how rapid technological advancements affect the supply of software engineering professionals in commercial banks in Kenya. The respondents were requested to indicate the extent on which they agree with various statements on rapid technological advancements. With a mean of 4.673 (Std. Deviation = 0.546), the respondents strongly agreed that rapid technological advancements necessitate continuous skill upgrading among engineers to remain relevant in the industry. Similarly, with a mean of 4.615 (Std. Deviation = 0.561), the respondents strongly agreed that opportunities for skill upgrading are essential to keep pace with rapid technological advancements and maintain competitiveness in the

engineering field. With a mean of 4.500 (Std. Deviation = 0.799), the respondents strongly agreed that access to resources and facilities is crucial for engineers to develop, test, and implement innovative solutions in the engineering field. The respondents agreed with a mean of 4.462 (Std. Deviation = 0.666), that skill obsolescence is a challenge in the face of rapid technological advancements, requiring engineers to constantly update their knowledge and expertise.

Similarly, the respondents agreed with a mean of 4.462 (Std. Deviation = 0.605) that engineering professionals with multidisciplinary skills are well-equipped to tackle diverse and dynamic challenges, driving innovation and problem-solving in the industry. Also, the respondents agreed with a mean of 4.442 (Std. Deviation = 0.720) that adequate access to resources and facilities enhances engineers' ability to experiment, prototype, and iterate solutions, driving creativity and innovation. Further, the respondents agreed with a mean of 4.404 (Std. Deviation = 0.817) that increased specialization in engineering fields allows professionals to develop expertise in niche areas, enhancing the quality and depth of services provided. Similarly, with a mean of 4.404 (Std. Deviation = 0.659), the respondents agreed that the demand for multidisciplinary skills reflects the evolving nature of engineering projects, which require expertise across various domains. With a mean of 4.346 (Std. Deviation = 0.854), the respondents agreed that specialization enables engineers to tackle complex challenges with precision and innovation, driving advancements in the industry.

In addition, with a mean of 4.269 (Std. Deviation = 0.813), the respondents agreed that multidisciplinary skills are essential for engineers to address interconnected challenges and opportunities in today's complex projects. Furthermore, with a mean of 4.269 (Std. Deviation = 0.985), the respondents agreed that limited access to resources and facilities can hinder engineers' ability to explore new ideas and technologies, impacting their productivity and competitiveness in the industry. Moreover, with a mean of 4.192 (Std. Deviation = 0.964), the respondents agreed that embracing increased specialization fosters collaboration and knowledge exchange among engineers, leading to interdisciplinary solutions and advancements.

The respondents were also asked to indicate how else rapid technological advancements affect the supply of software engineering professionals in commercial banks in Kenya. The respondents

indicated that the Rapid technological advancements in AI, blockchain, and cloud computing have significantly influenced the demand for software engineers in Kenyan commercial banks. Engineers must continuously upskill to remain relevant, posing challenges for fresh graduates and career switchers. The fast-paced changes favor adaptable individuals while leaving behind those who struggle to keep up. Remote work has increased competition for skilled talent, pushing banks to offer competitive salaries and training. However, the demand for specialized skills has led to a skills gap, with limited professionals proficient in emerging technologies. Governments can address the talent shortage through policies like tax incentives, education funding, and startup support. Collaboration between banks, universities, and research institutions can drive innovation. While upskilling expands the talent pool, automation may reduce the need for some engineering roles.

Table 4. 5: Aspects of Rapid Technological Advancements

	Mean	Std. Deviation
Rapid technological advancements necessitate continuous skill upgrading among engineers to remain relevant in the industry.	4.673	.546
Skill obsolescence is a challenge in the face of rapid technological advancements, requiring engineers to constantly update their knowledge and expertise.	4.462	.666
Opportunities for skill upgrading are essential to keep pace with rapid technological advancements and maintain competitiveness in the engineering field.	4.615	.561
Increased specialization in engineering fields allows professionals to develop expertise in niche areas, enhancing the quality and depth of services provided.	4.404	.817
Specialization enables engineers to tackle complex challenges with precision and innovation, driving advancements in the industry.	4.346	.854
Embracing increased specialization fosters collaboration and knowledge exchange among engineers, leading to interdisciplinary solutions and advancements.	4.192	.964
The demand for multidisciplinary skills reflects the evolving nature of engineering projects, which require expertise across various domains.	4.404	.659
Multidisciplinary skills are essential for engineers to address interconnected challenges and opportunities in today's complex projects.	4.269	.813

Engineering professionals with multidisciplinary skills are well-equipped to tackle diverse and dynamic challenges, driving innovation and problemsolving in the industry.	4.462	.605
Access to resources and facilities is crucial for engineers to develop, test, and implement innovative solutions in the engineering field.	4.500	.799
Adequate access to resources and facilities enhances engineers' ability to experiment, prototype, and iterate solutions, driving creativity and innovation.	4.442	.720
Limited access to resources and facilities can hinder engineers' ability to explore new ideas and technologies, impacting their productivity and competitiveness in the industry.	4.269	.985

The key informant interviewees were requested to indicate how recent technological advancements have impacted the demand for software engineers in commercial banks. From the results, the key informant interviewee emphasized that recent technological advancements have significantly increased the demand for software engineers in commercial banks. As noted by one key interviewee,

> *"With the rise of digital banking, artificial intelligence, and blockchain technology, banks are actively seeking top software engineering talent to enhance their digital platforms and remain competitive," KII3*

The key informant interviewee also noted that the adoption of cloud computing, automation, and data analytics has reshaped IT strategies within the banking sector. It was highlighted that many banks are transitioning to cloud-based infrastructures, creating a strong demand for engineers skilled in cloud security, DevOps, and scalable architectures. Also, advancements in AI and machine learning have also transformed customer service and risk management. It was pointed out that, with the rise of AI-powered chatbots, predictive analytics, and automated credit scoring, banks require engineers proficient in AI and big data to optimize their digital services.

The key informant interviewees were also asked to specify the strategies commercial banks employ to help their software engineers stay updated with new technologies. The key informant interviewees revealed that banks organize regular in-house training sessions and workshops to provide hands-on experience with cutting-edge technologies such as cloud computing, cybersecurity, artificial intelligence, and blockchain. These training programs help engineers stay current with industry standards and best practices. As one key informant noted,

"Banks understand that the financial sector is evolving rapidly. To keep up, we conduct frequent training sessions focused on the latest technologies, from cloud computing to cybersecurity measures."KII2

The key interviewees also revealed that encouraging engineers to pursue professional certifications is also a common practice. Certifications in areas such as cloud computing (AWS, Microsoft Azure), cybersecurity, DevOps, and software development are highly valued in the banking sector. Many banks provide financial assistance or reimbursement for certification programs to motivate employees to enhance their technical expertise. As one interviewee emphasized,

"Certifications are now a necessity rather than an advantage. We encourage our engineers to pursue certifications in cloud security and AI, and we provide financial support to help them achieve these credentials."KII6

In addition, participation in industry conferences, hackathons, and networking events is another critical strategy. These events expose engineers to the latest trends, foster collaboration with industry leaders, and provide opportunities for practical problem-solving. Banks often sponsor their engineers to attend both local and international fintech summits to enhance their knowledge. It was emphasized that attending global fintech conferences and local hackathons allows engineers to interact with industry leaders and stay ahead of trends that impact digital banking solutions.

Furthermore, the key informant interviewees were asked whether, in their opinion, technological advancements are creating new challenges or opportunities that impact the supply of software engineers in commercial banks. The study established that one of the key opportunities arising from technological advancements is the increased demand for specialized roles in areas such as AI-driven banking solutions, cybersecurity, and automation. As banks integrate emerging technologies into their operations, they require engineers with expertise in these fields. This has led to better compensation packages, career growth opportunities, and the attraction of top talent to the banking sector. As one key informant explained,

"The banking industry is constantly evolving, and with advancements like AI and blockchain, there is a growing need for specialized skills. This has created more job opportunities and higher salaries for software engineers in the sector."KII8

However, the rapid evolution of technology also presents challenges, particularly in the form of a skills gap. Many software engineers may struggle to keep up with emerging trends, making it difficult for banks to find professionals with the required expertise. As a result, commercial banks have been forced to invest in upskilling programs and professional development initiatives to bridge the talent gap. It was noted that technological advancements are progressing faster than engineers can acquire new skills, requiring significant investment in training to ensure teams remain relevant.

Another challenge is the increased competition for software engineers from other industries, such as fintech, e-commerce, and global tech firms, which often offer more flexible work environments, higher salaries, and greater opportunities for innovation. As a result, commercial banks struggle to attract and retain top-tier engineers. It was emphasized that with the rise of fintech startups and global tech companies, banks are constantly competing for skilled engineers. Many professionals prefer working in more flexible environments with cutting-edge projects rather than in traditional banking institutions.

4.7 Educational Quality

The fourth objective of the study was to examine how educational quality affects the supply of software engineering professionals in commercial banks in Kenya. The respondents were asked to indicate the extent at which they agree with different statements on educational quality. The respondents strongly agreed with a mean of 4.846 (Std. Deviation = 0.412) that engaging in practical learning opportunities enhances students' problem-solving skills and prepares them for the complexities of real-world engineering projects. Similarly, the respondents strongly agreed with a mean of 4.789 (Std. Deviation = 0.409), that practical learning opportunities, such as internships and hands-on projects, are valuable for bridging the gap between theory and practice in engineering education.

With a mean of 4.750 (Std. Deviation = 0.477), the respondents strongly agreed that providing ample practical learning opportunities is essential for fostering experiential learning and enhancing the overall quality of engineering education. In addition, with a mean of 4.615 (Std. Deviation = 0.595), the respondents strongly agreed that collaborations with industry partners

enrich engineering education by providing insights into industry trends, challenges, and best practices. Further, with a mean of 4.596 (Std. Deviation = 0.688), the respondents strongly agreed that establishing strong industry partnerships enhances the relevance and applicability of engineering education to current industry needs and trends. In addition, with a mean of 4.558 (Std. Deviation = 0.664), the respondents strongly agreed that industry partnerships offer students access to realworld projects, mentorship opportunities, and potential career pathways.

Furthermore, with a mean of 4.442 (Std. Deviation = 0.634), the respondents agreed that ensuring curriculum relevance is crucial for producing graduates who are well-equipped to meet the demands of the engineering profession. Similarly, with a mean of 4.365 (Std. Deviation = 0.787), the respondents agreed that the relevance of the curriculum to industry standards and practices is essential for preparing engineers for real-world challenges. In addition, with a mean of 4.308 (Std. Deviation = 0.775), the respondents agreed that a curriculum that is aligned with industry needs enhances the practical applicability of engineering education.

The respondents agreed with a mean of 3.654 (Std. Deviation = 1.242) that being accredited and registered enhances the credibility and recognition of engineering programs, benefiting both students and employers. The respondents also agreed with a mean of 3.596 (Std. Deviation = 1.216) that accreditation and registration ensure that engineering programs meet established standards of quality and rigor. Further, with a mean of 3.558 (Std. Deviation = 1.153), the respondents agreed that accreditation and registration provide assurance to stakeholders that graduates of engineering programs possess the necessary knowledge and skills to excel in the profession.

The respondents were further asked to indicate how else educational quality affects the supply of software engineering professionals in commercial banks in Kenya. The study found that the quality of education significantly impacts the competence and industry readiness of engineers in Kenya. While global educational sources and online platforms help bridge gaps, traditional university curricula often fail to align with industry needs. In addition, many lecturers lack real-world experience, necessitating further industry training for graduates. Poor reputation and outdated teaching methods in some local universities push students toward private institutions.

Theoretical foundations remain essential, but practical skills are equally crucial. The financial sector lags in developing in-house tech talent, relying on external expertise. Improving educational quality, aligning curricula with industry trends, and fostering hands-on experience can enhance graduate employability and innovation.

Table 4. 6: Aspects of Educational Quality

	Mean	Std. Deviation
The relevance of the curriculum to industry standards and practices is essential for preparing engineers for real-world challenges.	4.365	.787
A curriculum that is aligned with industry needs enhances the practical applicability of engineering education.	4.308	.775
Ensuring curriculum relevance is crucial for producing graduates who are well-equipped to meet the demands of the engineering profession.	4.442	.634
Practical learning opportunities, such as internships and hands-on projects, are valuable for bridging the gap between theory and practice in engineering education.	4.789	.409
Engaging in practical learning opportunities enhances students' problemsolving skills and prepares them for the complexities of real-world engineering projects.	4.846	.4117
Providing ample practical learning opportunities is essential for fostering experiential learning and enhancing the overall quality of engineering education.	4.750	.477
Collaborations with industry partners enrich engineering education by providing insights into industry trends, challenges, and best practices.	4.615	.595
Industry partnerships offer students access to real-world projects, mentorship opportunities, and potential career pathways.	4.558	.664
Establishing strong industry partnerships enhances the relevance and applicability of engineering education to current industry needs and trends.	4.596	.688
Accreditation and registration ensure that engineering programs meet established standards of quality and rigor.	3.596	1.216
Being accredited and registered enhances the credibility and recognition of engineering programs, benefiting both students and employers.	3.654	1.242
Accreditation and registration provide assurance to stakeholders that graduates of engineering programs possess the necessary knowledge and skills to excel in the profession.	3.558	1.153

The key informant interviewees were requested to assess the current state of software engineering education in Kenya. The key informant interviewees indicated that one key issue is the gap between academic training and industry requirements. Many graduates possess theoretical knowledge but lack the hands-on experience and practical problem-solving skills required in real world banking environments. Employers often find that new graduates require extensive on-the job training before they can effectively contribute. One key informant interviewee noted,

> *"While Kenyan universities produce a large number of software engineering graduates, many lack practical experience. We often have to invest in extensive training programs to get them industry-ready."KII2*

Another major concern is the rapid evolution of technology compared to the pace of curriculum updates. Emerging fields such as artificial intelligence, blockchain, cybersecurity, and cloud computing are becoming critical in the banking sector, yet many institutions still focus on outdated programming languages and software development methodologies. As a result, graduates may not be adequately prepared for the demands of modern banking technology. It was noted that many university curriculums are not evolving quickly enough to keep pace with industry trends, leading to graduates entering the workforce with skills that may have been relevant five years ago but are no longer sufficient today. Additionally, there is a shortage of qualified lecturers with industry experience. Many instructors come from purely academic backgrounds and may not have hands on expertise in modern banking technologies. This limits students' exposure to the latest tools and best practices in the field.

In addition, the key informant interviewees were asked whether specific skills or knowledge areas are lacking among graduates entering the banking sector as software engineers. The study established that one of the most significant gaps is in cybersecurity and secure coding practices. Given the sensitive nature of financial transactions, banks require software engineers who understand how to develop secure systems, identify vulnerabilities, and protect customer data from cyber threats. However, many graduates have limited exposure to cybersecurity principles beyond basic encryption and authentication methods. A key informant noted,

> *"One of the biggest challenges we face with new hires is their lack of cybersecurity awareness. They can write code, but they often don't consider security risks, which is a major concern in banking."KII7*

The key informant interviewees indicated that banking industry relies on specialized systems such as core banking software, digital payment platforms, and regulatory compliance tools. Many graduates are unfamiliar with these systems, which makes their on boarding process longer. Moreover, graduates often lack experience with cloud computing and modern software architectures. Many banks are shifting toward cloud-based infrastructures and micro services, yet most universities still emphasize traditional monolithic application development. This knowledge gap makes it difficult for new hires to contribute effectively to cloud-native banking solutions.

Moreover, the key informant interviewees were asked to indicate the role of partnerships between universities and commercial banks in improving the quality of software engineering education. The study established that one key area where partnerships are beneficial is curriculum enhancement. Many universities still teach outdated programming languages and software development methodologies that do not align with the rapidly evolving banking industry. Through collaborations, banks can provide input on the latest technologies, security protocols, and regulatory requirements, ensuring that course content remains relevant. A key informant noted,

> *"Universities need to work closely with banks to tailor their curriculum to industry needs. The financial sector is evolving, and students must graduate with skills that align with emerging technologies."KII1*

The key interviewee noted that another critical aspect is internships and industrial attachments. Many graduates lack hands-on experience with real-world banking systems, making their transition to employment challenging. By partnering with universities, banks can offer structured internship programs that provide students with exposure to live banking applications, cybersecurity protocols, and regulatory compliance frameworks. Further, joint research initiatives and innovation hubs also play a significant role in advancing software engineering education. Through partnerships, universities and banks can establish research centers focused on fintech solutions, blockchain technology, artificial intelligence in banking, and cybersecurity. These initiatives allow students to work on real-world banking challenges, fostering innovation and problem-solving skills. Additionally, partnerships facilitate mentorship and knowledge transfer from industry experts. By engaging software engineers from commercial banks as guest lecturers, universities can expose students to practical insights, industry best practices, and real-world challenges.

4.8 Supply of Software Engineering Professionals

The dependent variable, supply of software engineering professionals, was measured in terms of the number of software engineers, annual employment rates, percentage deficit of software engineers, and retention rates. From the findings, the supply of software engineering professionals in Tier 1 commercial banks in Kenya experienced some fluctuations in the number of engineers employed from 2019 to 2023. The number of software engineers employed began at 39 in 2019, increased to 40 in 2020, peaked at 43 in 2021, then dropped to 39 in 2022, and slightly rose to 42 in 2023. These fluctuations suggest that while there was a general upward trend in the number of engineers employed, the supply did not consistently increase, reflecting possible adjustments in staffing based on changing needs or external factors.

The annual employment rates exhibited slight variations over the five years. They began at 2.00% in 2019, decreased to 1.90% in 2020, and then gradually increased to 2.30% in 2022, before slightly declining to 2.20% in 2023. These changes indicate a modest increase in the proportion of software engineers within the workforce, though the growth was not uniform, reflecting fluctuating demand for technical talent within the banking sector. The percentage deficit of software engineers showed an increasing trend, rising from 17% in 2019 to 21% in 2023, signaling that the gap between the required number of software engineers and the actual number employed widened, indicating growing challenges in fulfilling the demand for engineers.

Meanwhile, the retention rates for software engineers experienced some decline, dropping from 80% in 2019 to 76% in 2023. This decrease suggests that commercial banks faced increasing difficulty in retaining software engineering talent, possibly due to competition from other industries or factors like work conditions and career advancement opportunities. Despite the fluctuations in employment numbers and retention rates, the supply of software engineering professionals in the banking sector showed signs of growth, though the increasing deficit and declining retention rates point to challenges in meeting the sector's growing demand for skilled engineers.

Table 4. 7: Supply of Software Engineering Professionals

Year	2019	2020	2021	2022	2023
Number of Software Engineers	39	40	43	39	42
Annual Employment Rates (%)	2.00	1.90	2.10	2.30	2.20
Percentage Deficit of Software Engineers (%)	17	19	18	20	21
Retention Rates (%)	80	82	81	79	76

4.9 Inferential Statistics

Inferential statistics were utilized to examine factors affecting the supply of software engineering professionals in commercial banks in Kenya. These factors include personal characteristics, industry demand for engineers, rapid technological advancements and educational quality. Inferential statistics in this research comprised of correlation analysis and regression analysis.

4.9.1 Correlation Analysis

Correlation analysis is a statistical technique utilized to measure the strength and direction of the relationship between two or more variables. Pearson correlation coefficient (r) ranges from -1 to 1. The results of correlation analysis were as presented in Table 4.8.

Table 4. 8: Correlation Analysis

		Supply of Software Engineering Professionals	Personal characteristics	Industry Demand for Engineers	Rapid technological advancements	Educational quality
Supply of Software Engineering Professionals	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	208				
Personal characteristics	Pearson Correlation	.781**	1			
	Sig. (2-tailed)	.000				
	N	208	208			
Industry Demand for Engineers	Pearson Correlation	.757**	.062	1		
	Sig. (2-tailed)	.000	.212			
	N	208	208	208		
Rapid technological advancements	Pearson Correlation	.799**	.107	.142	1	
	Sig. (2-tailed)	.000	.145	.108		
	N	208	208	208	208	
Educational quality	Pearson Correlation	.741**	.098	.062	.101	1
	Sig. (2-tailed)	.000	.178	.212	.167	
	N	208	208	208	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

There exists a strong positive correlation between personal characteristics and supply of software engineering professionals in commercial banks in Kenya (r=0.781, p-value=0.000). This indicates that as personal characteristics increases, supply of software engineering professionals tends to increase as well. Also, there exists a strong positive correlation between industry demand for engineers and supply of software engineering professionals in commercial banks in Kenya (r=0.757, p-value=0.000). This means that when industry demand for engineers increases, it positively influences the supply of software engineering professionals in commercial banks in Kenya.

In addition, there exists, a strong positive correlation exists between rapid technological advancements and supply of software engineering professionals in commercial banks in Kenya

(r=0.799, p-value=0.000). This implies that as rapid technological advancements accelerate the supply of software engineering professionals in Kenyan commercial banks increases, driven by the growing need for skilled talent, curriculum updates, and continuous upskilling initiatives. Further, there exists, a strong positive correlation exists between educational quality and supply of software engineering professionals in commercial banks in Kenya (r=0.741, p-value=0.000). This means that higher educational quality positively influences the supply of software engineering professionals in Kenyan commercial banks by equipping graduates with relevant skills, industry aligned knowledge, and practical competencies needed to meet market demands.

4.9.2 Regression Analysis

Linear regression analysis was used to examine factors affecting the supply of software engineering professionals in commercial banks in Kenya. The r squared (R^2) represents the proportion of variance in the outcome variable (supply of software engineering professionals in commercial banks in Kenya) that can be explained by the predictors included in the model. In this case, as illustrated in Table 4.9, the R-Squared value (0.684) represents the proportion of variance in the supply of software engineering professionals that can be explained by the predictors. In this case, approximately 68.4% of the variance in supply of software engineering professionals can be accounted for by the predictors (personal characteristics, industry demand for engineers, rapid technological advancements and educational quality) included in the model.

Table 4. 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827[a]	.684	.518	.69643

a. Dependent Variable: Supply of Software Engineering Professionals
b. Predictors: (Constant), Educational quality , Personal characteristics, Rapid technological advancements, Industry Demand for Engineers

The ANOVA table results for the regression model offer valuable insights into the model's overall fit and significance in predicting supply of software engineering professionals. The F-calculated (102.386) was higher than the F-critical (2.372) from f-distribution table. In addition, the p-value (0.000) was less than a significance level (0.05) indicates that the regression model is statistically significant. This indicates that the regression model as a whole is statistically significant in predicting the dependent variable.

Table 4. 10: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	99.321	4	24.830	102.386	.000[b]
	Residual	49.231	203	0.243		
	Total	148.552	207			

a. Dependent Variable: Supply of Software Engineering Professionals
b. Predictors: (Constant), Educational quality , Personal characteristics, Rapid technological advancements, Industry Demand for Engineers

The results show that personal characteristics have a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya (β_1=0.387, p-value-0.000). This implies that a one-unit enhancement in personal characteristics is expected to lead to a 0.387unit increase in the supply of software engineering professionals. Since the p-value (0.000) is positively and significantly significant, the relationship was deemed to be significant.

Also, the findings show that industry demand for engineers has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya (β_2=0.463, p-value, 0.004). This suggests that a one-unit increase in industry demand for engineers is expected to result in a 0.463-unit increase in the supply of software engineering professionals. Since the p-value (0.004) is positively and significantly significant, the relationship was deemed to be significant.

In addition, the results indicated that rapid technological advancements have a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya (β_3=0.359, p-value, 0.000). This indicates that a one-unit increase in rapid technological advancements is likely to lead to a 0.359-unit rise in the supply of software engineering professionals. Since the p-value (0.00) is positive and statistically significant, the relationship is considered significant.

Further, the findings revealed that educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya (β_4=0.304, p-value,

0.000). This indicates that a one-unit enhancement in educational quality is expected to result in a 0.304-unit increase in the supply of software engineering professionals. Since the p-value (0.00) is both positive and statistically significant, the relationship is deemed significant.

Table 4. 11: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.672	0.292		5.726	0.000
	Personal characteristics	0.387	0.082	0.195	4.720	0.000
	Industry Demand for Engineers	0.463	0.091	0.285	5.088	0.000
	Rapid technological advancements	0.359	0.088	0.160	4.080	0.004
	Educational quality	0.304	0.081	0.166	3.753	0.009

a. Dependent Variable: Supply of Software Engineering Professionals
b. Predictors: (Constant), Educational quality , Personal characteristics, Rapid technological advancements, Industry Demand for Engineers

Using the unstandardized coefficients, the regression equation was as follows;

Supply of Software Engineering Professionals =1.672 + 0.387 Personal characteristics + 0.463 Industry Demand for Engineers+ 0.359 Rapid technological advancements + 0.304 Educational quality + ε

The findings show that the supply of software engineering professionals in commercial banks in Kenya is significantly influenced by four key factors: personal characteristics, industry demand for engineers, rapid technological advancements, and educational quality. Each of these factors demonstrated a positive and statistically significant effect on the supply of software engineering professionals.

4.10 Chapter Summary

The study found that personal characteristics positively influence the supply of software engineering professionals in commercial banks in Kenya with education background, financial capability, attitude toward engineering and change of career being particularly beneficial. The study established that industry demand for engineers comprising of number of job openings,

turnover rates, competition for talent and global talent pool significantly and positively affects the supply of software engineering professionals. Further, rapid technological advancements involving rapid obsolescence and upgrading, specialization, demand for multidisciplinary skills and access to resource and facilities plays a crucial role in increasing the supply of software engineering professionals in Kenyan commercial banks. Moreover, educational quality facilitated through curriculum relevance, practical learning opportunities, industry partnerships and accreditation and registration were found to have a significant and positive effect on the supply of software engineering professionals in commercial banks in Kenya. The study's regression analysis further validated these relationships, emphasizing the significant influence of personal characteristics, industry demand for engineers, rapid technological advancements and educational quality on the supply of software engineering professionals. These findings underscore the importance of personal characteristics, industry demand for engineers, rapid technological advancements, and educational quality in shaping the supply of software engineering professionals in commercial banks in Kenya.

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The chapter initiates with the discussion of the findings as per the objective of the study encompassing the effect of personal characteristics, industry demand for engineers, rapid technological advancements and educational quality on the supply of software engineering professionals in commercial banks in Kenya. This is followed by the study's limitations, conclusions, policy and practice recommendations, and suggestions for further research.

5.2 Discussion of the Findings

5.2.1 Personal Characteristics and Supply of Software Engineering Professionals

The study found that personal characteristic has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The findings agree with Soomro (2019) observation that personal characteristics significantly affect the supply of software engineering professionals. The findings also concur with Yilmaz and Colomo-Palacios (2021) observations that personal characteristics play a crucial role in influencing the supply of software engineering professionals. The findings further agree with Feldt and Maria (2020) argument that personal characteristics elements have a significant effect on the supply of software engineering professionals.

The study established that attitude towards engineering significantly impacts individuals' motivation and commitment to pursuing and excelling in engineering roles. The study also established that individuals with a negative attitude towards engineering may lack enthusiasm, curiosity, and passion for problem-solving and innovation in the field. Similarly, the study found that a negative attitude towards engineering may discourage individuals from pursuing careers in the field. These findings align with Mukua (2020) observations that a negative attitude towards engineering can significantly deter individuals from entering the field. The study found that financial constraints may limit individuals' ability to pursue advanced degrees or certifications required for engineering roles.

Further, study found that inadequate financial resources can pose barriers to accessing quality education and training opportunities in engineering. Also the study established that limited

financial capability may hinder individuals' investment in professional development activities essential for success in engineering careers. Further, the study revealed that hands-on experience during their academic program significantly contributed to their technical skills in software development. In addition, the study found that changes in career paths away from engineering can disrupt the supply and retention of engineers, potentially posing challenges for organizations and industries reliant on engineering talent. The study findings revealed that formal education in computer science or a related field has adequately prepared engineers for a career in software engineering. These findings align with Hidellaarachchi, Hoda and Mueller (2023) observations that formal education in computer science or a related field has effectively equipped engineers with the necessary skills and knowledge for a career in software engineering.

Moreover, the study found that they believe that obtaining advanced degrees in software engineering enhances career opportunities in the field. Also, the study found that career transitions from engineering to other fields can contribute to talent shortages and skill gaps within the engineering profession. Moreover, the study found that individuals leaving engineering careers may reduce the pool of available talent and expertise in the field, impacting industry innovation and competitiveness. These findings concur with Khajeha (2019) observations that individuals transitioning out of engineering careers may diminish the available talent pool and expertise within the field.

5.2.2 Industry Demand for Engineers and Supply of Software Engineering Professionals

The study found that industry demand for engineers has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The findings agree with Qvist and Munk (2019) observations that industry demand for industry engineers positively influences the supply of software engineering professionals. In addition, the findings align with Themba (2023) observations that industry demand for engineers drives the availability of software engineering professionals. Further, the findings align with Forbes and Zampelli (2018) findings that demand for industry engineers play a significant role in influencing the supply of software engineering professionals.

The study found that increased competition for talent plays a crucial role in driving innovation and excellence within the engineering industry. The study also found that access to a global

talent pool provides opportunities for diverse perspectives and expertise within the engineering industry. Similarly, the study found that turnover rates impact productivity and continuity in projects, within the industry. The study found that increased competition for talent highlights the demand for skilled engineers in the industry. These findings align with Rutto's (2019) observations that heightened competition for talent underscores the growing demand for skilled engineers in the industry.

The study established that a global talent pool allows engineering firms to tap into specialized skills and knowledge from around the world. The findings align with Qvist and Munk's (2019) observations that a global talent pool enables engineering firms to access specialized skills and expertise from around the world. The study also found that this enhances competitiveness and adaptability of the engineering industry by leveraging talent from diverse backgrounds and regions. The study further found that turnover rates among engineers may suggest issues with job satisfaction or organizational culture that need to be addressed. The study revealed that turnover rates among engineers can indicate challenges in retaining talent within the industry.

The study found that the number of job openings in the engineering industry suggests ample opportunities for career advancement. Similarly, the study established that the number of job openings reflects a thriving industry with opportunities for growth and development for engineers. The study established that the presence of a high number of job openings indicates strong demand for engineers in the industry. These findings are in line with Forbes and Zampelli's (2018) argument that a high number of job openings signify a strong demand for engineers in the industry.

5.2.3 Rapid Technological Advancements and Supply of Software Engineering Professionals

The study found that rapid technological advancements have a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. These findings conform to Beer and Mulder (2020) observations that rapid technological advancements positively and significantly impact the supply of software engineering professionals. The findings also agree with Mohammed (2020) who found that rapid technological advancements play a crucial role in significantly increasing the supply of software engineering professionals. In

addition, the findings concur Ra, Shrestha and Khatiwada (2019) findings that significant and positively impact the supply of software engineering professionals.

The study also found that rapid technological advancements necessitate continuous skill upgrading among engineers to remain relevant in the industry. These findings conform to Wilson and Buchanan (2020) observations that rapid shifts in technology demand ongoing professional development, compelling engineers to acquire new competencies. Similarly, the study found that opportunities for skill upgrading are essential to keep pace with rapid technological advancements and maintain competitiveness in the engineering field. The study established that access to resources and facilities is crucial for engineers to develop, test, and implement innovative solutions in the engineering field. The study also established that skill obsolescence is a challenge in the face of rapid technological advancements, requiring engineers to constantly update their knowledge and expertise.

In addition, the study found that engineering professionals with multidisciplinary skills are well-equipped to tackle diverse and dynamic challenges, driving innovation and problem-solving in the industry. Also, the study findings revealed that adequate access to resources and facilities enhances engineers' ability to experiment, prototype, and iterate solutions, driving creativity and innovation. Further, the study established that increased specialization in engineering fields allows professionals to develop expertise in niche areas, enhancing the quality and depth of services provided. These findings concur with Mohammed (2020) observations that specialization fosters in-depth knowledge, improves problem-solving capabilities, and drives innovation, ultimately leading to higher standards of engineering practice. Further the study found that the demand for multidisciplinary skills reflects the evolving nature of engineering projects, which require expertise across various domains.

The study established that specialization enables engineers to tackle complex challenges with precision and innovation, driving advancements in the industry. These findings concur with Beer and Mulder (2020) observations that a focused expertise in specific engineering domains enhances problem-solving capabilities and contributes to overall industry progress. In addition, the study found that multidisciplinary skills are essential for engineers to address interconnected challenges and opportunities in today's complex projects. Furthermore, the study found that

limited access to resources and facilities can hinder engineers' ability to explore new ideas and technologies, impacting their productivity and competitiveness in industry. Moreover, the study findings revealed that embracing increased specialization fosters collaboration and knowledge exchange among engineers, leading to interdisciplinary solutions and advancements.

5.2.4 Educational Quality and Supply of Software Engineering Professionals

The study found educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. These findings concur with Gumaelius, Skogh, and Pantzos (2023) observations that educational quality positively and significantly affect the supply of software engineering professionals. Further, the findings agree with Kigotho (2021) observations that educational quality plays a crucial role in influencing the supply of software engineering professionals. The findings Muriithi and Musili (2021) Educational quality significantly and positively impacts the supply of software engineering professionals.

The study established that engaging in practical learning opportunities enhances students' problemsolving skills and prepares them for the complexities of real-world engineering projects. These findings are in line with Al-Zuhairi and Bulak (2022) observations that engaging in practical learning opportunities strengthens students' problem-solving skills and equips them to navigate the complexities of real-world engineering projects effectively. Similarly, the study found that practical learning opportunities, such as internships and hands-on projects, are valuable for bridging the gap between theory and practice in engineering education.

The study further established that providing ample practical learning opportunities is essential for fostering experiential learning and enhancing the overall quality of engineering education. In addition, the study found that collaborations with industry partners enrich engineering education by providing insights into industry trends, challenges, and best practices. Also, the study revealed that establishing strong industry partnerships enhances the relevance and applicability of engineering education to current industry needs and trends. In addition, the study established that industry partnerships offer students access to real-world projects, mentorship opportunities, and potential career pathways. These findings agree with Gumaelius, Skogh, and Pantzos (2023)

observations that industry partnerships provide students access to real-world projects, mentorship opportunities, and potential career pathways.

Furthermore, the study found that ensuring curriculum relevance is crucial for producing graduates who are well-equipped to meet the demands of the engineering profession. Similarly, the study established that the relevance of the curriculum to industry standards and practices is essential for preparing engineers for real-world challenges. These findings align with Kigotho (2021) observations that a well-structured, industry-aligned curriculum enhances graduates' employability. In addition, the study established that a curriculum that is aligned with industry needs enhances the practical applicability of engineering education.

The study found that being accredited and registered enhances the credibility and recognition of engineering programs, benefiting both students and employers. The findings also indicated that accreditation and registration ensure that engineering programs meet established standards of quality and rigor. Further, the study revealed that accreditation and registration provide assurance to stakeholders that graduates of engineering programs possess the necessary knowledge and skills to excel in the profession. These findings are in agreement with Keter and Okemwa (2020) findings that accreditation frameworks ensure engineering education meets established quality standards.

5.3 Theoretical Implications

The study's finding support Social Cognitive Career Theory (SCCT) which posits that individuals' career choices and actions are influenced by their self-efficacy beliefs, outcome expectations, personal goals, and contextual supports and barriers. The theory suggests that people are active agents in their career development, engaging in a continuous process of self-reflection, goal setting, and decision-making that is influenced by both internal and external factors. In this study the theory provides a useful lens through which to analyse the supply of software engineering professionals in commercial banks in Kenya, considering the interplay of personal characteristics, industry demand, technological advancements, and educational quality.

Labor market theory posits that labor, like any other commodity, is subject to the forces of supply and demand. The theory explores how the supply of labor (workers) and the demand for labor

(employers) interact to determine equilibrium wage rates and levels of employment. It suggests that wages tend to adjust to balance supply and demand in the labor market. When the supply of labor exceeds demand, wages may decrease, and conversely, when demand exceeds supply, wages may rise. In this study Labor Market Theory offers valuable insights into the dynamics shaping the supply of software engineering professionals in commercial banks in Kenya. Personal characteristics such as technical aptitude, problem-solving skills, and a passion for computer science significantly influence individuals' decisions to pursue careers in software engineering

Innovation Diffusion Theory suggests that the adoption of innovations follows a predictable pattern characterized by the stages of awareness, interest, evaluation, trial, and adoption. It also highlights the influence of communication channels, social networks, and individual characteristics on the diffusion process. In this context, Innovation Diffusion Theory offers insights into how industry demand for engineers and rapid technological advancements influence the supply of software engineering professionals in commercial banks in Kenya. Industry demand serves as a significant driver for the adoption of innovations, including the need for software engineering expertise in commercial banks.

5.4 Conclusions

The study concludes that personal characteristic has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study findings revealed that personal characteristic measured in terms of education background, financial capability, attitude toward engineering and change of career being particularly beneficial has an effect on the supply of software engineering professionals in commercial banks in Kenya. The findings imply that an improvement in personal characteristic would results to an improvement on the supply of software engineering professionals in commercial banks in Kenya.

The study also concludes that industry demand for engineers has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study revealed that industry demand for engineers measured in terms of number of job openings, turnover rates, competition for talent and global talent pool has an effect on the supply of software engineering professionals in commercial banks in Kenya. The findings imply that an

increase in industry demand for engineers would lead to a corresponding rise in the supply of software engineering professionals in commercial banks in Kenya.

Further, the study concludes that rapid technological advancements have a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study established those rapid technological advancements measured in terms of rapid obsolescence and upgrading, specialization, demand for multidisciplinary skills and access to resource and facilities has an effect on the supply of software engineering professionals in commercial banks in Kenya. This means that an increase in rapid technological advancements would result to an increase in the supply of software engineering professionals in commercial banks in Kenya.

Furthermore, the study concludes that educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study established that educational quality measured in terms of curriculum relevance, practical learning opportunities, industry partnerships and accreditation and registration has an effect on the supply of software engineering professionals in commercial banks in Kenya. This suggests that enhancing educational quality would result in a greater supply of software engineering professionals in commercial banks in Kenya.

The study concludes that the supply of software engineering professionals in commercial banks in Kenya is significantly influenced by four key factors: personal characteristics, industry demand for engineers, rapid technological advancements, and educational quality. Each of these factors demonstrated a positive and statistically significant effect on the availability of software engineering talent.

5.5 Recommendations

5.5.1 Recommendations for Management

The study found that personal characteristic has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. Therefore, the study recommends that efforts should be made to promote a positive attitude toward engineering through mentorship programs and awareness campaigns. Financial support initiatives such as

scholarships and grants should be enhanced to help individuals pursue engineering education and professional development. Practical, hands-on training should be integrated into academic programs to strengthen technical skills. Further, strategies should be developed to retain engineering talent and minimize career transitions to other fields.

The study also found that industry demand for engineers has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. Thus the study recommends that companies should implement strategies to attract and retain skilled engineers, such as competitive compensation, career development programs, and positive workplace environments. Expanding access to a global talent pool can foster innovation by incorporating diverse expertise. In addition, addressing turnover issues through improved job satisfaction and organizational culture is essential. Strengthening industry-academic partnerships can also help align education with industry needs and ensure a steady supply of skilled engineers.

In addition, the study found that rapid technological advancements has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. Therefore, the study recommends that industries should invest in continuous professional development programs, including training, certifications, and workshops. Enhancing access to resources and facilities will support innovation, enabling engineers to experiment and develop cutting-edge solutions. In addition, promoting collaboration and knowledge exchange will drive innovation and industry-wide progress.

The study found educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study therefore recommends that institutions should integrate more practical learning opportunities, such as internships and handson projects, to strengthen students' problem-solving skills. Establishing strong industry partnerships will provide students with exposure to real-world challenges, mentorship, and career opportunities. Ensuring curriculum alignment with industry standards will better prepare graduates for the workforce. Further, accreditation and registration of engineering programs should be prioritized to uphold quality standards and enhance professional credibility.

5.5.2 Policy Recommendations

The study found that personal characteristic, industry demand for engineers, rapid technological advancements and educational quality has a positive and significant effect on the supply of software engineering professionals in commercial banks in Kenya. The study recommended the development of policies that promote STEM education from an early stage to enhance the personal characteristics necessary for careers in software engineering. The study also recommended collaboration between the government and industry stakeholders to create initiatives that increase the demand for engineers through job creation, competitive salaries, and career development programs. Furthermore, the study recommended the implementation of policies that encourage continuous professional development and reskilling programs to help engineers adapt to rapid technological advancements. Additionally, the study recommended that regulatory bodies enforce high educational standards in computer science and related fields to improve the quality of engineering graduates.

5.6 Recommendation for Further Studies

The main objective of the study was to examine factors affecting the supply of software engineering professionals in commercial banks in Kenya. However, the study was limited to commercial banks in Kenya and hence the findings cannot be applied to microfinance banks in Kenya. Therefore, the study recommends that further research should be done to focusing on microfinance banks in Kenya. In addition, the study found that personal characteristics, industry demand for engineers, rapid technological advancements and educational quality could explain 68.4% of variation in the supply of software engineering professionals in commercial banks in Kenya. Therefore, further research should be done to examine other factors affecting the supply of software engineering professionals in commercial banks in Kenya.

5.7 Limitations of the Study

Research limitations refer to methodological constraints that may hinder the interpretation of findings. This study focused on commercial banks in Kenya, therefore, generalizing the findings to microfinance banks and SACCOs may be limited due to contextual differences, regulatory variations, and unique industry dynamics. In addition, the use of semi-structured questionnaires

and a key informant interview guide may introduce limitations, as indicated by Sileyew (2019) regarding potential biases in responses, the subjectivity of interpretations, and the possibility of missing nuanced insights that a more flexible. To mitigate these challenges, the researcher ensured pre-testing of the instruments, as well as the validity and reliability of the questions, while also maintaining confidentiality to encourage honest and unbiased responses.

REFERENCES

Adebayo, A. (2021). The impact of technology on the banking sector: A study of commercial banks in Nigeria. *International Journal of Finance & Banking Studies, 10*(2), 34-45. https://doi.org/10.20525/ijfbs.v10i2.1122

Alhadeff, D. A. (2023). *Competition and Controls in Banking: a study of the regulation of bank competition in Italy, France and England*. University of California Press.

Al-Zuhairi, S. & Bulak, M. E. (2022). Determining the Factors Affecting the Quality of Engineering Education. *Journal of Positive School Psychology, 6*(10), 3361-3367.

Amies, N. (2024). *Belgian industry faces critical shortage of engineers.* Retrieved from https://www.brusselstimes.com/954454/belgian-industry-faces-critical-shortage-of-engineers.

Beer, P. & Mulder, R. H. (2020). The Effects of Technological Developments on Work and Their Implications for Continuous Vocational Education and Training: A Systematic Review. *Frontiers in Psychology, 8*(1), 101-113.

Belchior, R. F., & Lyons, R. (2021). Explaining entrepreneurial intentions, nascent entrepreneurial behavior and new business creation with social cognitive career theory–a 5-year longitudinal analysis. *International Entrepreneurship and Management Journal*, *17*(4), 1945-1972.

Benhabib, J., Perla, J., & Tonetti, C. (2021). Reconciling models of diffusion and innovation: A theory of the productivity distribution and technology frontier. *Econometrica*, *89*(5), 2261-2301.

Bhattacherjee, A. (2018). *Social Science Research: Principles, Methods, and Practices*. New York: Free Press.

Blersch, C L, Shrand, B C, & Ronnie, L. (2020). Factors that keep engineers committed to their organisations: A study of south African knowledge workers. *Journal of the South*

African Institution of Civil Engineering, *62*(1), 42-52. https://dx.doi.org/10.17159/2309-8775/2020/v62n1a5

Campero, S. (2021). Hiring and intra-occupational gender segregation in software engineering. *American Sociological Review*, *86*(1), 60-92.

Central Bank of Kenya (2023). *Bank Supervision Report of 2022*. Retrieved from https://www.centralbank.go.ke

Chanji, T. (2022). *Shortage of engineers poses challenges to Kenya growth*. Retrieved from https://www.businessdailyafrica.com/bd/economy/shortage-of-engineers-pose-challenges-to-kenya-growth-2025836

Corbae, D., & D'Erasmo, P. (2021). Capital buffers in a quantitative model of banking industry dynamics. *Econometrica*, *89*(6), 2975-3023.

Creswell, W. & Creswell, D. (2022). *Research design: Qualitative, quantitative, and mixed methods approaches*. New York: SAGE Publications, Inc.

Devi, P. S. (2019). *Research methodology: A handbook for beginners*. New Delhi: Notion Press.

Ehrenberg, R. & Hallock, K. (2021). *Modern labor economics: Theory and public policy*. Routledge.

Elia, G., Stefanelli, V., & Ferilli, G. B. (2023). Investigating the role of Fintech in the banking industry: what do we know?. *European Journal of Innovation Management*, *26*(5), 1365-1393.

Engineers Board of Kenya (2023). *Half of new engineering recruits lack the right skills*. Retrieved from https://www.ebk.go.ke

Feldt, R. & Maria, S. (2020). Links between the personalities, views and attitudes of software engineers. *Information and Software Technology, 52,* 611-624.

Forbes, K. & Zampelli, E. (2018). Growth, Technology, and the Demand for Scientists and Engineers. *Industrial Relations: A Journal of Economy and Society, 30*, 294 - 301.

Gumaelius, L., Skogh, A. & Pantzos, P. (2023) Engineering education in change. A case study on the impact of digital transformation on content and teaching methods in different engineering disciplines. *European Journal of Engineering Education, 12*, 1-24

Hair, J. O., Page, M. & Brunsveld, N. (2020). *Essentials of Business Research Methods.* London: Routledge.

Hall, R. (2020). *Qualitative, Quantitative and Combined Methods: Mixing Methods in Social Research.* New York: SAGE Publications Ltd.

Hamid, K., Iqbal, M. W. & Ahmad, S. (2022). Usability evaluation of mobile banking applications in digital business as emerging economy. *International Journal of Computer Science and Network Security*, *22*(1), 250-260.

Herkenhoff, K., & Mongey, S. (2022). Labor market power. *American Economic Review*, *112*(4), 1147-1193.

Hermo, S. & Shapiro, J. M. (2022). Labor market returns and the evolution of cognitive skills: Theory and evidence. *The Quarterly Journal of Economics*, *137*(4), 2309-2361.

Hidellaarachchi, D., Hoda, R., & Mueller, I. (2023). The influence of human aspects on requirements engineering-related activities: Software practitioners' perspective. *ACM Transactions on Software Engineering and Methodology*, *32*(5), 1-37.

Ho, J. C. (2022). Disruptive innovation from the perspective of innovation diffusion theory. *Technology Analysis & Strategic Management*, *34*(4), 363-376.

International Finance Corporation. (2021). *Kenya's Digital Economy: Opportunities for Growth*. Retrieved from https://www.ifc.org

Johnson, B., Zimmermann, T., & Bird, C. (2019). The effect of work environments on productivity and satisfaction of software engineers. *IEEE Transactions on Software Engineering*, *47*(4), 736-757.

Karanja, J. (2020). The impact of technology on the banking sector in Kenya. *International Journal of Business Management and Commerce, 5*(1), 34-45.

Keter, A. & Okemwa, P. (2020). Relationship between Technical Skills Acquired and Skills Required on Electrical Equipment Servicing among Electrical Engineering Technicians in Manufacturing Industries in Kenya. *International Journal of Engineering and Management Research, 10*, 43-50. 10.31033/ijemr.10.4.7.

Khajeha, H. (2019). *Influence of Selected Factors on Students' Academic Achievement in Engineering Courses in Kisumu National Polytechnic, Kenya.* Retrieved from https://repository.maseno.ac.ke/bitstream/handle/123456789/795/KHAJEHA%20HARIET.pdf?sequence=3&isAllowed=y

Kiernan, L., Walsh, M., & White, E. (2023). Gender in Technology, Engineering and Design: factors which influence low STEM subject uptake among females at third level. *International Journal of Technology and Design Education*, *33*(2), 497-520.

Kigotho, W. (2021). *Low quality of African engineers disconcerting – UNESCO.* Retrieved from https://www.universityworldnews.com/post.php?story

Kigotho, W. (2023). *Glaring gaps in computer science classes hitting hard on job skills*. Retrieved from https://www.standardmedia.co.ke/counties/article/2001357812/glaring-gaps-in-computer-science-classes-hitting-hard-on-job-skills

Kipsaina, C. C. (2023). *Factors Influencing the Performance of Trainees in Electrical Engineering Programmes in National Polytechnics in Kenya: A Case of Selected National Polytechnics.* Retrieved from http://erepository.uoeld.ac.ke

Kodey, A. & Bedard, J. (2023). *The US Needs More Engineers. What's the Solution?* Retrieved from https://www.bcg.com/publications/2023/addressing-the-engineering-talent-shortage

KPMG. (2020). Digital Transformation in Banking: Embracing the Future. Retrieved from https://home.kpmg/xx/en/home/insights/2020/01/digital-transformation-in-banking.html

KPMG. (2020). Digital Transformation in Banking: Embracing the Future. Retrieved from https://home.kpmg/xx/en/home/insights/2020/01/digital-transformation-in-banking.html

Krishna, B. (2020). *Guide to Research Methodology and Biostatitics*. London: Rutledge.

Kumar, R. (2019). *Research Methodology: A Step-by-Step Guide for Beginners*. New York: SAGE Publications Ltd.

Kusumawati, E., & Wahyuningsih, D. D. (2020). The effectiveness of social cognitive career theory on career decision making. *KONSELI: E-Journal*, *7*(2), 107-116.

Latwal, G. S. (2020). *Research Methodology.* Florida: CRC Press.

Lent, R. W., & Brown, S. D. (2019). Social cognitive career theory at 25: Empirical status of the interest, choice, and performance models. *Journal of Vocational Behavior*, *115*, 103316.

McDool, E., & Morris, D. (2022). Gender differences in science, technology, engineering and maths uptake and attainment in post-16 education. *The Manchester School*, *90*(5), 473-499.

Mohammed, I. A. (2020). Critical Analysis on the Impact of Software Engineering in the Technological Industry. *International Journal of Research and Analytical Reviews, 7*, 182-186.

Moridnejad, M., Cooper, J., & Kumari, S. (2020). A review of influencing factors for selection of engineering pathway for women: A case study of females studying engineering at Waikato Institute of Technology (Wintec), New Zealand. *Journal of Financial Reporting and Accounting*, *22*(2), 308-326.

Msafiri, M., Kangwa, D. & Fute, A. (2023). A systematic review of the factors affecting girls' participation in science, technology, engineering, and mathematics subjects. *Computer Applications in Engineering Education, 32*, 101-123.

Mukherjee, S.P. (2020). *A Guide to Research Methodology: An Overview of Research Problems, Tasks and Methods.* New York: CRC Press.

Mukhwana, A. M., Abuya, T. & Matanda, D. (2020). *Factors which Contribute to or Inhibit Women in Science, Technology, Engineering, and Mathematics in Africa*. Nairobi.

Mukua, H. N. (2020). *Factors Influencing Academic Performance of Self-sponsored Students in the School of Engineering, University Of Nairobi, Kenya*. Retrieved from http://erepository.uonbi.ac.ke

Muriithi, G. M. & Musili, W. M. (2021). *The Effect of Science, Technology, Engineering and Mathematics Skills on Youth Employment in Kenya.* Retrieved from https://repository.kippra.or.ke

Mwaura, C. (2019). The role of technology in improving banking services in Kenya. *Journal of Business Research, 11*(3), 85-97.

Nthuku, D. M. & Muthima, L. (2023). Social Determinants of Female Enrolment in Engineering Courses in Public Technical, Vocational and Education Institution in Kakamega County, Kenya. *Kenyatta University Women's Economic Empowerment (KU-WEE) Journal, 1*(1), 146-154.

Ntwiga, D. B. (2020). Technical efficiency in the Kenyan banking sector: Influence of fintech and banks collaboration. *Journal of Finance and Economics*, *8*(1), 13-22.

Nyemba, W. R., Chikuku, T. & Magombo, L. (2020). Industrial design thinking and innovations propelled by the Royal Academy of Engineering in Sub-Saharan Africa for capacity building. *Procedia CIRP*, *91*, 770-775.

OECD. (2022). Digital Economy Outlook 2022. Retrieved from https://www.oecd.org/digital/digital-economy-outlook-2022-9789264879780-en.htm

Otieno, O. S., & Ndede, D. F. (2020). Adoption of digital banking technology and financial performance of commercial banks in Kenya. *International Journal of Current Aspects in Finance, Banking and Accounting*, *2*(1), 42-50.

Otsu, Y., & Yuen, C. K. (2022). Health, crime, and the labor market: Theory and policy analysis. *Journal of Economic Dynamics and Control*, *144*, 104529.

Ouma, W. (2020). *Kenya faces shortage of certified engineers*. Retrieved from https://nation.africa/kenya/news/kenya-faces-shortage-of-certified-engineers-407534

Phan, H. T. & Anwar, S. (2019). Competition, efficiency and stability: An empirical study of East Asian commercial banks. *The North American Journal of Economics and Finance*, *50*, 100990.

Phillips, T. (2023). *Is There a Shortage of Developers? Developer Shortage Statistics in 2022*. Retrieved from https://codesubmit.io/blog/shortage-of-developers/

PwC. (2021). Financial Services Technology 2021 and Beyond: Embracing the Digital Revolution. Retrieved from https://www.pwc.com/gx/en/financial-services/assets/pdf/financial-services-technology-2021-and-beyond.pdf

Qvist, H., & Munk, M. (2019). Demand and Supply Effects and Returns to College Education: Evidence from a Natural Experiment with Engineers in Denmark. *The Scandinavian Journal of Economics, 123*, 111-132.

Ra, S., Shrestha, U. & Khatiwada, S. (2019). The rise of technology and impact on skills. *International Journal of Training Research*, *17*(1), 26–40.

Ravindran, A. R. & Griffin, P. M. (2023). *Supply chain engineering: Models and applications*. CRC Press.

Rutto, D. (2019). Industry Demands and Future of Engineering Education in Kenya. *International Journal of Engineering Pedagogy, 5*, 103-119.

Sileyew, K. (2019). *Research Design and Methodology.* Washington DC: Intechopen.

Soomro, A.B. (2019). The effect of software engineers' personality traits on team climate and performance: A Systematic Literature Review. *Information and Software Technology, 73*, 52-65.

Tang, X., & Guo, H. (2023). Factors Influencing the Professional Development of Engineering Students under the Plan for Educating and Training Outstanding Engineers. *ECNU Review of Education, 1*(9), 101-122. https://doi.org/10.1177/20965311231206835

Themba, P. (2023). Understanding the Demand for Industrial skills through the National Certificate (Vocational) Building and Civil Engineering Programme. *International Journal of Learning, Teaching and Educational Research, 22*, 674-687. 10.26803/ijlter.22.5.35

Tsui, F., Karam, O., & Bernal, B. (2022). *Essentials of software engineering*. Jones & Bartlett Learning.

UNSECO (2023). *Regional perspectives on engineering: Africa*. Retrieved from https://unesdoc.unesco.org

Waddell, C.D. (2020). *A Step-by-Step Guide to Complete a Dissertation: Using a Quantitative Research Methodology*. London: SAGE Publications.

Wati, C. W., Rizza, M., & Sugandi, M. (2019). *The determinant factors in the selection of Specialization on Building Engineering Program Expertise for New Students at vocational high school in Malang on readiness work in construction services industry*. New York: Atlantis Press.

Wendling, E., & Sagas, M. (2020). An application of the social cognitive career theory model of career self-management to college athletes' career planning for life after sport. *Frontiers in psychology*, *11*, 501019.

Were, C. A. (2020). *Factors Influencing the Retention of Female Students in Science, Technology, Engineering and Mathematics (STEM) Courses, at the Technical University of Kenya*. Retrieved from http://erepository.uonbi.ac.ke/handle/11295/153865

White, J. L. & Massiha, G. H. (2019). The Retention of Women in Science, Technology, Engineering, and Mathematics: A Framework for Persistence. *International Journal of Evaluation and Research in Education, 5*(1), 1- 8.

Wilson, F. M., & Buchanan, D. A. (2020). The Effect of New Technology in the Engineering Industry: Cases of Control and Constraint. *Work, Employment and Society, 2*(3), 366-380. https://doi.org/10.1177/0950017088002003006

Yahyaie, M., & Rabiei, M. (2024). The Impact of Agile Software Development on Banking Software Providers: A Case Study. *Journal of Systems and Software*, *186*, 111197.

Yilmaz, M. & Colomo-Palacios, R. (2021). An examination of personality traits and how they impact on software development teams. *Information and Software Technology, 86*, 122-143.

Yuen, K. F. & Wang, X. (2021). Factors influencing autonomous vehicle adoption: An application of the technology acceptance model and innovation diffusion theory. *Technology Analysis & Strategic Management*, *33*(5), 505-519.

APPENDIX I: LETTER TO THE RESPONDENTS

Rebekah Njagi

Strathmore University

4th May 2024

Dear Participant,

Subject: Invitation to Participate in a Research Study

My name is Rebekah Njagi, and I am a student at Strathmore University pursuing Master of Business Administration. I am currently undertaking a research study on the factors influencing the supply of software engineering professionals in commercial banks in Kenya. This study aims to shed light on the various dynamics shaping the availability of skilled professionals in the software engineering field within the banking sector. By examining different factors our research endeavors to provide valuable insights for stakeholders seeking to address challenges and capitalize on opportunities in this evolving landscape.

Your participation in this research will not only contribute to a deeper understanding of the factors affecting the supply of software engineering professionals but also help shape the future of talent management and development in our industry. We look forward to your involvement and collaboration in this important endeavour.

Thank you in advance for your time and cooperation. Your contribution to this research is greatly appreciated.

Sincerely,

Rebekah Njagi

APPENDIX II: INFORMED CONSENT

FACTORS AFFECTING THE SUPPLY OF SOFTWARE ENGINEERING PROFESSIONALS IN COMMERCIAL BANKS IN KENYA

Introduction

You are invited to participate in a research study conducted by Rebekah Njagi from Strathmore University. The purpose of this study is to examine the factors affecting the supply of software engineering professionals in commercial banks in Kenya. Before you decide to participate, please read this consent form carefully to understand the purpose, procedures, potential benefits, risks, and your rights as a participant.

Purpose of the Study

This study aims to assess how various factors, including personal characteristics, industry demand, technological advancements, and educational quality, impact the supply of software engineering professionals in commercial banks in Kenya.

Procedures

If you agree to participate in this study, you will be required to:

- Respond to survey questions or participate in an interview.
- Allow the researcher to use your responses for data analysis.

Voluntary Participation

Your participation in this study is entirely voluntary. You may choose to withdraw at any time without any consequences. If you decide not to participate, there will be no penalties or loss of benefits.

Confidentiality and Data Protection

Your identity will remain confidential, and all data collected will be anonymized. The information you provide will be used solely for research purposes and stored securely. Only the researcher and authorized personnel will have access to the data.

Potential Risks and Benefits

There are no known risks associated with participating in this study. However, if any questions make you uncomfortable, you may choose not to answer. The findings from this research may contribute to better policies, educational improvements, and workforce strategies in the banking sector.

Fair Distribution and Access to Research Benefits

The findings of this study will be disseminated to key stakeholders, including participants, academic institutions, and industry professionals. The results will be made accessible through academic publications. Participants and relevant organizations will be given the opportunity to utilize the research findings to improve workforce development and policy-making. Special efforts will be made to ensure equitable access to the benefits of this research, particularly for underrepresented groups in the software engineering field.

Keeping Participants Informed

Participants will be kept informed of the study's progress and findings through regular updates via email. A summary of the research findings will also be shared upon completion. Additionally, participants will have access to publications where the research outcomes will be published. This ensures that all interested parties remain engaged and are aware of how the research findings can be applied in practice.

Respect for Participants' Welfare, Rights, and Beliefs

The study has due regard for the welfare, rights, perceptions, customs, and cultural heritage of all participants. The research will be conducted with the highest ethical standards, ensuring that participants are treated with respect and dignity. Special consideration will be given to cultural sensitivities and ethical concerns to ensure inclusivity. The results will be utilized responsibly and ethically to enhance the understanding and development of software engineering talent in the banking sector while promoting diversity and equal opportunity in the field.

Consent Declaration

I have read and understood the information provided in this consent form. I voluntarily agree to participate in this study, with the understanding that I can withdraw at any time without any consequences.

Participant's Name: _____
Signature: _____
Date: _____
Researcher's Name: **Rebekah Njagi**

Signature: _____
Date: _____

APPENDIX III: QUESTIONNAIRE

This questionnaire aims to collect information on the factors affecting the supply of software engineering professionals in commercial banks in Kenya. Confidentiality will be upheld on any information provided. Kindly fill the questionnaire appropriately.

A. General Information

1. Gender

   Male [ ] Female [ ]

2. Age Bracket:

   20 to 25 years [ ] 26 to 30 years [ ]

   31 to 35 years [ ] 36 to 40 years [ ]

   41 to 45 years [ ] Above 46 years [ ]

3. Education level

   Primary education [ ] Secondary School [ ]

   Diploma [ ] Undergraduate degree [ ]

   Master's Degree [ ] PhD [ ]

4. For how long have you been working in your organisation?

   Less than 3 years [ ] 4 to 7 years [ ]

   8 to 11 years [ ] Above 12 years [ ]

5. How many software engineers does you department have? …….

B. Personal characteristics

6. Please indicate the extent of your agreement with the following statements regarding personal characteristics of software engineers using the following scale: 1 - Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree .

STATEMENT	1	2	3	4	5
Educational Background					
Formal education in computer science or a related field has adequately prepared engineers for a career in software engineering.					
I believe that obtaining advanced degrees in software engineering enhances career opportunities in the field.					
Hands-on experience during my academic program significantly contributed to my technical skills in software development.					
Financial capability					
Inadequate financial resources can pose barriers to accessing quality education and training opportunities in engineering.					
Financial constraints may limit individuals' ability to pursue advanced degrees or certifications required for engineering roles.					
Limited financial capability may hinder individuals' investment in professional development activities essential for success in engineering careers.					
Attitude towards engineering					
A negative attitude towards engineering may discourage individuals from pursuing careers in the field.					
Attitude towards engineering significantly impacts individuals' motivation and commitment to pursuing and excelling in engineering roles.					
Individuals with a negative attitude towards engineering may lack enthusiasm, curiosity, and passion for problem-solving and innovation in the field.					
Change of career					
Career transitions from engineering to other fields can contribute to talent shortages and skill gaps within the engineering profession.					
Individuals leaving engineering careers may reduce the pool of available talent and expertise in the field, impacting industry innovation and competitiveness.					
Changes in career paths away from engineering can disrupt the supply and retention of engineers, potentially posing challenges for organizations and industries reliant on engineering talent.					

7. How else do personal characteristics affect the supply of software engineering professionals in commercial banks in Kenya? ……

C. Industry Demand for Engineers

8. Please indicate your level of agreement with various statements regarding the industry demand for engineers, using the following scale: 1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 –

   Agree; 5 – Strongly Agree

STATEMENT	1	2	3	4	5
Number of job openings					
The presence of a high number of job openings indicates strong demand for engineers in the industry.					
The number of job openings suggests ample opportunities for engineers to find employment and advance their careers.					
The number of job openings reflects a thriving industry with opportunities for growth and development for engineers.					
Turnover rates					
Turnover rates among engineers can indicate challenges in retaining talent within the industry.					
Turnover rates among engineers may suggest issues with job satisfaction or organizational culture that need to be addressed.					
Turnover rates impact productivity and continuity in projects within the engineering industry.					
Competition for talent					
Increased competition for talent highlights the demand for skilled engineers in the industry.					
Competition for talent among engineering firms underscores the importance of attracting and retaining top professionals.					
Increased competition for talent can drive innovation and excellence within the engineering industry.					
Global talent pool					
Access to a global talent pool provides opportunities for diverse perspectives and expertise within the engineering industry.					
The global talent pool allows engineering firms to tap into specialized skills and knowledge from around the world.					
A global talent pool enhances the competitiveness and adaptability of the engineering industry by leveraging talent from diverse backgrounds and regions.					

9. How else does industry demand for engineers affect the supply of software engineering professionals in commercial banks in Kenya?

   ……

   ……

D. Rapid technological advancements

10. Please indicate your level of agreement with various statements regarding rapid technological advancements in the banking industry, using the following scale: 1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree

STATEMENT	**1**	**2**	**3**	**4**	**5**
Skill obsolescence and upgrading					
Rapid technological advancements necessitate continuous skill upgrading among engineers to remain relevant in the industry.					
Skill obsolescence is a challenge in the face of rapid technological advancements, requiring engineers to constantly update their knowledge and expertise.					
Opportunities for skill upgrading are essential to keep pace with rapid technological advancements and maintain competitiveness in the engineering field.					
Specialization					
Increased specialization in engineering fields allows professionals to develop expertise in niche areas, enhancing the quality and depth of services provided.					
Specialization enables engineers to tackle complex challenges with precision and innovation, driving advancements in the industry.					
Embracing increased specialization fosters collaboration and knowledge exchange among engineers, leading to interdisciplinary solutions and advancements.					
Demand for multidisciplinary skills					
The demand for multidisciplinary skills reflects the evolving nature of engineering projects, which require expertise across various domains.					
Multidisciplinary skills are essential for engineers to address interconnected challenges and opportunities in today's complex projects.					
Engineering professionals with multidisciplinary skills are well-equipped to tackle diverse and dynamic challenges, driving innovation and problem solving in the industry.					
Access to resources and facilities					
Access to resources and facilities is crucial for engineers to develop, test, and implement innovative solutions in the engineering field.					

Adequate access to resources and facilities enhances engineers' ability to experiment, prototype, and iterate solutions, driving creativity and innovation.					
Limited access to resources and facilities can hinder engineers' ability to explore new ideas and technologies, impacting their productivity and competitiveness in the industry.					

11. In your own opinion, indicated how else do rapid technological advancements affect the supply of software engineering professionals in commercial banks in Kenya?

    …….

    …….

E. Educational quality

12. Please indicate your level of agreement with various statements regarding educational quality among software engineers, using the following scale: 1 - Strongly Disagree; 2 – Disagree; 3 –

    Neutral; 4 – Agree; 5 - Strongly Agree

STATEMENT	**1**	**2**	**3**	**4**	**5**
Curriculum relevance					
The relevance of the curriculum to industry standards and practices is essential for preparing engineers for real-world challenges.					
A curriculum that is aligned with industry needs enhances the practical applicability of engineering education.					
Ensuring curriculum relevance is crucial for producing graduates who are well-equipped to meet the demands of the engineering profession.					
Practical learning opportunities					
Practical learning opportunities, such as internships and hands-on projects, are valuable for bridging the gap between theory and practice in engineering education.					
Engaging in practical learning opportunities enhances students' problem-solving skills and prepares them for the complexities of real-world engineering projects.					
Providing ample practical learning opportunities is essential for fostering experiential learning and enhancing the overall quality of engineering education.					
Industry partnerships					

Collaborations with industry partners enrich engineering education by providing insights into industry trends, challenges, and best practices.					
Industry partnerships offer students access to real-world projects, mentorship opportunities, and potential career pathways.					
Establishing strong industry partnerships enhances the relevance and applicability of engineering education to current industry needs and trends.					
Accreditation and registration					
Accreditation and registration ensure that engineering programs meet established standards of quality and rigor.					
Being accredited and registered enhances the credibility and recognition of engineering programs, benefiting both students and employers.					
Accreditation and registration provide assurance to stakeholders that graduates of engineering programs possess the necessary knowledge and skills to excel in the profession.					

13. Indicate in your own opinion, how else does educational quality affect the supply of software engineering professionals in commercial banks in Kenya

……

……

E Supply of Software Engineering Professionals

14. Please provide the following information on the measures of supply of software engineering professionals for the period between 2019 and 2023.

	2019	**2020**	**2021**	**2022**	**2023**
Number of software engineers					
Annual employment rates					
Percentage deficit of software engineers					
Retention Rates					

APPENDIX IV: KEY INFORMANT INTERVIEW GUIDE

Thank you for taking the time to participate in this interview. The purpose of this interview is to gather information on the factors affecting the supply of software engineering professionals in commercial banks in Kenya. Your insights will contribute to a better understanding of the issues faced in this area. All responses will be confidential, and no individual or institution will be identified in the final report.

Section 1: Personal Characteristics

1. What personal traits do you think are essential for software engineering professionals working in commercial banks?
2. How do you believe factors such as gender, age, or family responsibilities impact the decision to pursue a career in software engineering within the banking sector?
3. In your opinion, do factors like individual motivation, career goals, and financial aspirations influence the supply of software engineers in the banking industry? If yes, how?

Section 2: Industry Demand for Engineers

4. Are there specific skills or expertise that commercial banks are seeking in software engineers? If so, which ones?
5. In your view, how does the demand from other industries, such as fintech or telecommunications, affect the supply of software engineers to the banking sector?
6. How do shifts in industry demand influence the need for software engineers in commercial banks?

Section 3: Technological Advancements

7. How have recent technological advancements impacted the demand for software engineers in commercial banks?

8. What strategies do commercial banks employ to help their software engineers stay updated with new technologies?

9. In your opinion, are technological advancements creating new challenges or opportunities that affect the supply of software engineers in commercial banks?

Section 4: Educational Quality

10. What is your assessment of the current state of software engineering education in Kenya?

11. Are there specific skills or knowledge areas that are lacking among graduates entering the banking sector as software engineers?

12. What role do partnerships between universities and commercial banks play in improving the quality of software engineering education?

APPENDIX V: INTRODUCTION LETTER

Ole Sangale Rd, Madaraka Estate
P. O Box 59857 - 00200, Nairobi, Kenya
Cell: +254 703 034 414/6/7
X/Twitter/Tiktok: @SBSKenya
Facebook/LinkedIn: Strathmore University Business School

Email: **sbsinfo@strathmore.edu** or visit **www.sbs.strathmore.edu**

Strathmore UNIVERSITY BUSINESS SCHOOL

Thursday, 20th February 2025

To Whom It May Concern,

RE: FACILITATION OF RESEARCH—REBEKAH NJOKI NJAGI.

This is to introduce Rebekah Njoki Njagi, a Master of Business Administration student at Strathmore University Business School, admission number MBA\150837\22

As part of our MBA program, Rebekah is expected to do applied research and undertake a project. This partially fulfills the requirements of the MBA course; to this effect, she would like to request appropriate data from your organization.

Rebekah is undertaking a research paper on "**Factors Affecting the Supply of Software Engineering Professionals in Commercial Banks in Kenya.**" The information obtained shall be treated confidentially and used for academic purposes only.

Our MBA Program seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to the industry. We would be glad to share our findings with you after the research, and we trust that you will find them of great interest and practical value to your organization.

We appreciate your support and will be willing to provide further information if required.

Yours sincerely,

Alois Njenga.
Manager, Graduate Programs

Strathmore University Business School is a Proud member of:

Association of African Business Schools AABS EFMD AACSB

APPENDIX VI: ETHICAL APPROVAL

Strathmore UNIVERSITY

13th February 2025

Ms Njagi Rebekah,
rebekah.njagi@strathmore.edu

Dear Ms Njagi,

RE: Factors Affecting the Supply of Software Engineering Professionals in Commercial Banks in Kenya

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU-masters** proposal. Your application reference number is **SU-ISERC2468/24.** The approval period is from **13th February 2025 to 12th February 2026.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 72 hours of notification.
iv. Any changes anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 72 hours.
v. Clearance for the export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and obtain other clearances needed.

Yours sincerely,

Mr Ambrose Rachier,
Chairperson; SU-ISERC

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu

APPENDIX VII: NACOSTI PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 841900

Date of Issue: 10/March/2025

RESEARCH LICENSE

This is to Certify that Ms.. Rebekah Njagi of Strathmore University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: FACTORS AFFECTING THE SUPPLY OF SOFTWARE ENGINEERING PROFESSIONALS IN COMMERCIAL BANKS IN KENYA for the period ending : 10/March/2026.

License No: NACOSTI/P/25/416468

841900

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions