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An Evaluation of determinants of innovation adoption by analytical laboratories in Kenya.

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AN EVALUATION OF DETERMINANTS OF INNOVATION ADOPTION BY ANALYTICAL LABORATORIES IN KENYA

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the document contains no material previously published or written by another person except where due reference is made in the research concept itself.

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Approval

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DEDICATION

I dedicate this work to the Almighty God and my family, for their love and support.

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ABSTRACT

Innovation plays a key role in improving the performance of firms. However, innovation adoption in Kenya is generally low in most sectors, including the analytical laboratories sector where most testing is still performed using old methods and technologies. Therefore, the aim of this research was to examine the determinants of innovation adoption by analytical laboratories in Kenya. The specific objectives of this study were to examine the effect of firm level, industry-level, and macro-environment determinants of innovation in analytical laboratories in Kenya. The theories that guided this research were Technology Acceptance Model and the Open versus Closed Innovation model. The positivism philosophy was adopted for this research. The methodological approach research entailed the use of the descriptive cross-sectional research design to investigate the associations between the dependent and independent variables. The target sample size for this research was 100 respondents. Data was collected using questionnaires that were administered to 88 respondents comprising of general managers, senior analysts, analysts, business development and marketing managers, quality managers/officers, finance managers, head of research and development (R&D) and human resource managers. The findings of this study showed that firm level, industry level and macroenvironment determinants had a significant positive influence on innovation adoption in analytical laboratories in Kenya. First, the findings suggested that firm level determinants have a significant positive influence on innovation adoption in analytical laboratories in Kenya. These findings imply that innovation adoption was higher in large firms, those with high product diversification, those that focus on continually developing new products/services rather than improving existing ones, older firms, those with high financial and human capabilities, and those pursuing open and closed innovation strategies. This finding suggests that enhancing firm-level determinants can improve the adoption of innovation in analytical laboratories. Secondly, the results showed that industry level determinants have a positive influence on innovation adoption in analytical laboratories in Kenya. The findings suggested that high innovation adoption was associated with high intensity of competition, high buyer power, high supplier power, high threat of substitutes and low entry barriers. This finding suggests that enhancing industry level determinants can improve the adoption of innovation in analytical laboratories. Lastly, the results showed that macro-environment determinants have a positive influence on innovation adoption in analytical laboratories in Kenya. Economic growth, regulatory environment and sustainability standards were found to have a positive influence on innovation adoption in analytical laboratories. This finding suggests that enhancing macroenvironment determinants can enhance the adoption of innovation in analytical laboratories. From the study, it is recommended that policy makers need to strengthen the regulatory environment, develop industry standards and foster compliance in order to encourage innovation in analytical laboratories. Additionally, managers of analytical laboratories should consider strengthening their firm level determinants through increasing their human and financial capacity for innovation. Managers of these firms also need to monitor industry-level determinants as well as changes in the regulatory and economic environment and respond appropriately using innovation.

Keywords: Analytical laboratories, firm-level determinants, industry-level determinants, innovation adoption, macro-environment determinants,

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ABBREVIATIONS AND ACRONYMS

B2B	Business-to-Business
B2C	Business-to-Consumer
BRICS	Brazil, Russia, India, China, and South Africa
KENAS	Kenya National Accreditation Service
KNIA	Kenya National Innovation Agency
NACOSTI	National Commission for Science, Technology and Innovation
R&D	Research and Development
SMEs	Small and Micro Enterprises
SPSS	Statistical Package for Social Sciences (SPSS)
SU-ISERC	Strathmore University Institutional Scientific Ethics Review Committee
TAM	Technology Acceptance Model

DEFINITION OF KEY TERMS

Firm-level Determinants.

Firm level determinants refer to elements that an organization's management, to a significant extent, has control over. Examples of these determinants include size, product diversification, age of firm, financial capabilities, and human capabilities (skill sets) (Regasa et al., 2021).

Industry-level Determinants

Industry level determinants refer to variables relating to the characteristics derived from an industry, such as the intensity of competition, buyer power, entry barriers and threats of substitutes. These determinants are based on Michael Porter's five forces and have an influence on the extent to which firms in an industry embrace innovation (Nam et al., 2019).

Innovation Adoption

Innovation adoption is defined as the ability to develop and implement unique and new concepts, products, services, business models and processes that support the financial viability and mission of an organization (Lei et al., 2020).

Macroenvironment Determinants

Macroenvironment determinants are related to the overall economy, such as economic growth, regulatory environment, and sustainability standards, which might potentially impact innovation in firms (Tomizawa et al., 2020).

CHAPTER ONE

INTRODUCTION TO THE STUDY

This chapter presents an introduction to the overall topic of the research including its background and a brief description of the variables in relation to the analytical laboratories sector – innovation adoption, and firm-level, industry level and macroenvironment determinants. In addition, this chapter describes the statement of the problem, objectives of the research, research questions, and the scope and significance of the research.

1.1 Background to the Study

The context of the current study was analytical laboratories. These laboratories provide services for classifying and analyzing biological, material, chemical, environmental, and geological samples. The rationale for studying analytical laboratories stem from their importance in ensuring consumers' public health and safety. The analytical laboratories sector is important in ensuring the safety of consumers (Konieczka & Namiesnik, 2018). Analytical laboratories offer a broad range of services including microbial testing, chemical testing, bio-analytical testing, physical characterization, environmental monitoring, method validation, raw material testing, and batch release testing (Konieczka & Namiesnik, 2018). The primary goal of such testing is to quantitatively and qualitatively analyze samples for the purpose of measurement, classification or characterization. Analytical testing services assist pharmaceutical, environmental, food, and biotech companies in ensuring quality control and safety assurance for the products they make for consumers. Determining the biological and chemical properties of consumer products play a key role in saving lives (Konieczka & Namiesnik, 2018).

Additionally, proper analytical testing can be used to enhance the formulation of existing consumer products. The findings of analytical tests can also offer critical information regarding the potential impacts of a product that is scheduled to be released in the market. Additionally, the importance of the analytical laboratories sector in Kenya stems from its linkages to several other sectors, including agriculture, food, healthcare, pharmaceutical, and biotechnology (Allied Market Research, 2022). Nearly all products meant for human consumption have to be subjected to laboratory testing to establish their safety, which indicates the pivotal role played by this sector.

The Analytical Laboratories sector constitutes one of the fastest growing sectors worldwide. Globally, the market value of this sector is projected to grow from $ 833.52 million in 2021 to $ 1652.72 million by 2027, which represents a compound annual growth rate (CAGR) of 12.14 percent (Allied Market Research, 2022). The growth of this sector is projected to occur across various regions globally. For instance, in the Americas, projections indicate that market size of the Analytical Laboratories sector is expected to reach $ 595.56 million by 2027, up from $ 305.57 million in 2021, translating a CAGR of 11.76% (Allied Market Research, 2022). Similar growth projections are expected in the Asia Pacific region with the market size of this sector expected to reach an estimated $ 460.76 million by 2027, from $ 223.84 million in 2021, which represents a CAGR of 12.78 percent. Likewise, the estimated market size for the Analytical Laboratory sector in Europe, Middle East and Africa by 2027 is $ 601.38 million, an increase from $ 304.11 million in 2021, which represents a CAGR of 12.03 percent (Allied Market Research, 2022). These estimations show that the sector is poised for immense growth in the near future.

Several factors are contributing to the growth of the Analytical Laboratories sector globally. These factors include governments' initiatives aimed at strengthening Analytical testing capabilities; the growing number of approvals for clinical trials and drugs; the growing demand for specialized analytical testing services due to increased development of new products; and increasing investments in innovation by market players. Africa is one the key regions where the Analytical Laboratories sector has the potential for considerable growth due to the numerous emerging economies, such as Nigeria, Egypt, South Africa, and Kenya just to name a few (Allied Market Research, 2022). The governments of these economies are focusing on strengthening analytical testing capabilities in order to achieve their goals of enhancing public health.

As noted earlier, innovation adoption is one of the factors contributing to growth in the Analytical Laboratories sector. Innovation comprises of activities undertaken by organizations with the goal of innovating and introducing new services and products, or improving the production process (Gupta et al., 2017). Innovation is differentiated from typical organizational activities since it is not oriented to produce immediate profit; instead, it carries an uncertain return on investment (ROI) and greater risk. Nevertheless, the business benefits of innovation are well-documented in the literature. Innovation has been positively associated with improved productivity measures such as profitability. Additionally, innovation adoption improves the innovative capacity of firms,

which is in turn linked to competitive advantage (Oguguo et al., 2020). Through innovation, companies can create products, processes, or services that competitors can find difficult to imitate (Gupta et al., 2017). Additionally, innovation can help organizations stay ahead of the curve by anticipating trends or customer demands. In the Analytical Laboratories services sector, innovation has been linked to improvements in the efficiency and design of processes for analytical testing (Konieczka & Namiesnik, 2018). Through innovation adoption, the efficiency (turnaround time for results), accuracy and sensitivity of analytical testing processes and methods can be improved, which can lead to significant cost savings for testing laboratory companies.

The choice of analytical laboratories as the context of this study also emanates from the Kenyan government's keen interest in enhancing the country's laboratory testing capacity, which is in line with its goals of improving biosafety standards, quality assurance systems, and appropriate specimen handling. The laboratory strengthening efforts are integral in ensuring Kenya's health security (Hunsperger et al., 2019). While the determinants of innovation have been studied extensively, there seems to scant studies on the same focusing specifically on the analytical laboratories sector.

1.1.1 Innovation Adoption

Various conceptualizations of innovation adoption exist in the literature. Lei et al. (2020) provided a generalized conceptualization of innovation adoption as a firm's ability to develop and implement unique and new concepts, products, services, business models and processes that support the financial viability and mission of an organization. According to Kiveu et al. (2019), adoption innovation has also been defined as the process of generating, developing and adapting new ideas by an organization. Ngundi and Namada (2022) defined innovation adoption as trying something different compared to what an organization was doing previously. Additionally, adoption has been conceptualized as the decision to utilize an innovation (novel idea) (Shibia, 2022).

Industry-specific conceptualizations of innovation adoption have also been provided in the literature. For instance, in manufacturing, Lai (2017) defined innovation adoption as the implementation of a significantly improved or new production method, such as making significant changes in software, equipment or techniques, with the aim of improving the current production

capability. Innovation adoption has also been conceptualized as the implementation of a new methodology or process that will enhance the efficiency and productivity of the manufacturing business (Benhabib et al., 2021). In the service sector, innovation adoption denotes the implementation of changes that alter how services are delivered, lead to the introduction of novel services, and create value for customers (Rosca et al. (2017). For this study, innovation adoption was defined as the ability to implement and sustain new and unique testing techniques and equipment (Lei et al., 2020).

1.1.2 Determinants of Innovation Adoption

Numerous determinants of innovation adoption have been uncovered in the literature, which include perceived innovation characteristics (such as benefits, compatibility, trialability, observability and uncertainty of the innovation), adopter/firm characteristics (such as organizational strategic posture, innovativeness, structure and size), environmental influences (competitive pressures and network externalities), social network (network participation and interconnectedness), and marketing efforts of the supplier (risk education, communication, and targeting), and industry characteristics (competition, entry barriers, buyers and suppliers, and availability of substitutes in the market) (Tomizawa et al., 2020). For this study, the three determinants that were examined are macroenvironment-level, industry-level and firm-level determinants. These determinants have been used in other studies (Aghion et al., 2018; Gupta et al., 2018). The rationale for selecting these determinants stems from the disagreement in existing literature regarding how macroenvironment-level, industry-level and firm-level determinants influence innovation adoption, which leads to a lack of clarity regarding the relationship between these determinants and innovation adoption.

Macroenvironment determinants are related to the overall economy, such as economic growth, regulatory environment, and sustainability standards, which might potentially impact innovation in firms (Argente et al., 2018; Tomizawa et al., 2020; Zhong, 2018). Varied effects of macroenvironment determinants on innovation adoption have been reported in the literature. Some studies have reported a bi-directional relationship between firm innovation and economic growth (Rosca et al., 2017; Shao et al., 2020). By contrast, Jiang and Fu (2021) reported a negative effect of economic development on organizational innovation – booming economy disincentivizes firms to be innovative. Similar contradictions have also been reported in sustainability standards and

regulatory compliance. Compliance with regulations has also been reported as a driver for firm-level innovation (Tomizawa et al., 2020). However, García-Sánchez et al. (2020) reported that sustainability standards and compliance can be detrimental to innovation by diverting costs from innovative projects towards ensuring compliance. For this study, the indicators that were used to measure macroenvironment level determinants were economic growth, regulatory environment and sustainability standards (Dechezleprêtre & Sato, 2017; Shao et al., 2020)

Industry level determinants refer to variables relating to the characteristics derived from an industry, such as the intensity of competition, buyer power, entry barriers and threats of substitutes (Bouncken et al., 2018; Nam et al., 2019; Papa et al., 2020). These determinants are based on Michael Porter's five forces and have an influence on the extent to which firms in an industry embrace innovation (Nam et al., 2019). Varied effects of competition, defined as the number of competitors in an industry, have been reported in extant studies. A high competition intensity compels firms to be more innovative for them to gain competitive advantage; however, in industries with few players and low competition intensity, firms are reluctant to pursue innovation aggressively (Nam et al., 2019). By contrast, some studies report an insignificant effect of competition on firm innovation (Canare & Francisco, 2021; Heredia et al., 2017). Similar contradictions also exist in other industry-level determinants – new entrants, buyer and supplier power, and threat of substitutes. In industries where entry barriers are strong, Lee (2019) observed that innovation often tends to be low compared to industries where entry barriers are minimal. However, Canare & Francisco (2021) reported that new entrants can increase competition leading to a shrunk market share; thus, making innovation costly. In an industry with a high buyer power, firms are incentivized to invest in quality improvement; therefore, are more likely to innovate in order to retain customers (Calvano & Polo, 2021). Chen (2019) and Kim et al. (2015), nevertheless, reported that buyer power has an insignificant impact on suppliers' innovation. In industries where the threat of substitutes is high, innovation is high (Gilbert, 2022; Kim et al., 2015). According to Calvano and Polo (2021), a high power of suppliers drives up innovation in industries. These contradictions indicate a lack of clarity regarding the relationship between these industry-level determinants and innovation adoption. The indicators for industry level determinants that were used in this study were intensity of competition, buyer power, supplier power, entry barriers, and threat of substitutes (Chen, 2019; Kin et al., 2015).

Firm level determinants refer to aspects that an organization's management, to a significant extent, has control over. Firm-level determinants have been conceptualized in terms of size, product diversification, age of firm, financial capabilities, and human capabilities (skill sets) (Choi & Lee, 2018; Guo et al., 2018; Regasa et al., 2021). Inconsistent findings exist in the literature with respect to the effects of firm-level determinants on innovation adoption by organizations. Rammer et al. (2022) reported that smaller firms are more innovative due to higher flexibility, compared to larger firms that are more rigid and rely on legacy processes and systems. On the contrary, large firms have more resources to pursue innovation projects compared to small firms that are usually constrained in terms of resources (Shibia, 2022). Similar disagreements also exist in the literature regarding other firm-level determinants including age and capabilities. While older firms have capabilities and resources, they tend to be rigid and leverage legacy systems and processes, which in turn hinders radical innovation (Lysek, 2019). At the same time, younger firms are flexible but lack the capabilities and resources needed to be innovative (Chirico et al., 2022) older firms are more likely to have the resources needed for pursuing innovation (Rammer et al., 2022). From the literature, there is a lack of clarity between firm characteristics and innovation adoption, which underscores the need for additional studies to better understand the relationships between these determinants and innovation adoption. The indicators for firm-level determinants that were used in this study are firm size, product diversification, firm age, financial capabilities, human capabilities, and innovation strategy (Choi & Lee, 2018; Knott & Vieregger, 2020).

1.1.3 Analytical Laboratories in Kenya

In Kenya, there are at least 50 analytical laboratories accredited by Kenya Accreditation Service (KENAS). Notable variations exist in the characteristics of firms in the analytical laboratories sector in Kenya in terms of size, service diversification, and ownership (foreign/local and public/private). Companies in this sector comprise of both private and public entities although private firms constitute the majority. Additionally, players in analytical laboratories services in Kenya also vary in terms of service type offered, testing type, and end-users served. The scope of services offered by these firms include water testing, food testing, livestock feed testing, environmental testing, agriculture testing, and geo-technical testing.

In terms of industry level determinants, the analytical laboratories sector in Kenya can be best described using high level of competition, high buyer power, high entry barriers, moderate threat

of substitutes, and high supplier power (KENAS, 2022). There are more than 50 analytical labs operating in the Kenyan market targeting the few B2B clients, which leads to a high buyer power. Entry barriers are high due to the significant capital investments required; as a result, new entrants are few. The threat of substitutes in this industry stems from clients building their own testing capabilities. The high supplier power stems from the few equipment suppliers in this sector.

With respect to the macroenvironment determinants, analytical laboratories in Kenya currently operate in a period of economic downturn. The regulatory environment for these laboratories is characterized by strict regulations and standards that determine the accreditation of these labs (Shao et al., 2020). Like other firms in other sectors, analytical laboratories need to comply with numerous environmental and sustainability laws, such as the Environmental Management and Coordination Act, the Climate Change Act, and the Clean Energy Act. Moreover, technological trends, like automation, are improving the efficiency of processes in analytical laboratories, such as reducing human errors during manual sample preparation and processing and increasing sample throughput. Technological innovation has led to increased accuracy and reproducibility in the analytical laboratories sector (Rood, 2018).

1.2 Statement of the Problem

The adoption of innovation in Kenya is generally low in numerous sectors, including analytical laboratories (State Department of Planning, 2021). This is a problem not only for analytical laboratories but also their customers. In the analytical laboratories sector, most firms are using old testing processes and methods that are expensive, which is hindering small analytical laboratories to afford testing (Hunsperger et al., 2019; Muvugabigwi et al., 2018). Old testing processes and methods also introduce inefficiencies due to long turnaround times, leading to delayed results (Benhabib et al., 2021). In addition, the low uptake of innovation is making analytical laboratories less competitive, hindering their growth, and risking their closure due to the utilization of old and less accurate testing processes and methods (Gupta et al., 2018; Omari et al., 2019). As a result, customers of analytical labs in Kenya are more likely to ship their samples abroad to countries that have better testing capabilities, resulting in a loss of revenues, stunted growth, reduced competitiveness and increased risk of failure for analytical labs in Kenya. For customers of analytical labs, delayed testing results can affect the time to market products, which in turn leads to increased warehousing costs (Agoti et al., 2021; Brown & Badrick, 2023). The delayed time-

to-market products can affect the competitiveness of firms that submit their products for testing. Whereas innovation is linked to firm productivity and competitiveness, low innovative capacity in Kenyan firms is a significant policy concern (KNIA, 2022). While the analytical laboratories sector is poised for growth, low innovation adoption poses a significant hurdle to the achievement of the projected growth.

While innovation adoption has been studied extensively, disagreement, contextual, conceptual, and methodological gaps have been identified in the existing literature regarding the determinants that influence innovation adoption. Using a case study design with 59 products and services from developed and industrialized countries, Rosca et al. (2017) reported a bi-directional relationship between economic development and firm-level innovation adoption. However, Jiang and Fu (2022), using panel data from Brazil, Russia, India, and China, and South Africa (BRICS) countries showed a negative effect of economic development on organizational innovation – booming economy disincentivizes firms to be innovative. Similar contradictions also exist in industry-level and firm-level determinants. In the German medical and machinery sectors, Bouncken et al. (2018) reported an insignificant effect of competition on innovation adoption. However, Nam et al. (2019) demonstrated that a high competition intensity compels firms to be more innovative for them to gain competitive advantage; however, in industries with few players and low competition intensity, firms are reluctant to pursue innovation aggressively. Similarly, inconsistencies exist with respect to firm-level characteristics, such as age and size. Rammer et al. (2022) reported that smaller firms are more innovative due to higher flexibility, compared to larger firms that are more rigid and rely on legacy processes and systems. On the contrary, large firms have more resources to pursue innovation projects compared to small firms that are usually constrained in terms of resources (Shibia, 2022). The disagreement in the literature indicates a lack of clarity regarding the effects of macroenvironment, industry-level and firm-level determinants on innovation adoption, which underlies the need for further research.

Additionally, contextual gaps also exist in the literature. Most innovation studies in Kenya are in the manufacturing and banking sectors (Ngugi & Karina, 2013; Ngundi & Namada, 2022; Simiyu, 2013). Therefore, this study sought to examine the determinants of innovation adoption in the analytical laboratories sector in Kenya.

1.4 Overall Objective of the Study

The aim of this research is to examine the determinants of innovation adoption by analytical laboratories in Kenya.

1.4.1 Specific Objectives of the Study

i. To examine the effect of firm level determinants on innovation adoption by analytical laboratories in Kenya.
ii. To investigate the effect of industry level determinants on innovation adoption by analytical laboratories in Kenya.
iii. To assess the effect of macroenvironment level determinants on innovation adoption by analytical labs in Kenya.

1.5 Research Questions

This research attempted to answer the following questions:

i. What is the effect of firm level determinants on innovation adoption by analytical laboratories in Kenya?
ii. What is the effect of industry level determinants on innovation adoption by analytical laboratories in Kenya?
iii. What is the effect of macroenvironment level determinants on innovation adoption by analytical laboratories in Kenya?

1.6 Scope of the Research

The scope of this research was to investigate the determinants of innovation adoption by analytical labs in Kenya. The focus of this study was innovation adoption, which was defined as the ability to develop and implement unique and new concepts, products, services, business models and processes that support the financial viability and mission of an organization (Lei et al., 2020). This study examined the adoption of innovation in the general sense rather than focusing on a specific type of innovation. Therefore, the dependent variable was innovation adoption. The independent variables include firm-level determinants, industry-level, and macroenvironment-level determinants. The firm-level determinants that were examined include size, product diversification, age of firm, financial capabilities, human capabilities (skill sets), and open and closed innovation strategies. The industry-level determinants that were studied are the intensity of

competition, buyer power, supplier power, entry barriers, threats of substitutes. The macroenvironment determinants that were examined in this study are economic growth, regulatory environment, sustainability standards, and technological change. This study was delimited to the analytical laboratories sector in Kenya. Other laboratory sectors, such as clinical laboratories, were not included in this research. The rationale for focusing on analytical labs is because it is an under-studied subsector, especially with respect to innovation. Geographically, this study was delimited to analytical lab firms with operations in Kenya. The theoretical scope for this study was limited to the technology acceptance model and the open versus closed innovation model. The methodological scope for this research entailed the use of the quantitative approach, especially the descriptive cross-sectional research design, to investigate the associations between the dependent and independent variables. The study was conducted within three months – from January to March 2024 – after getting the necessary approvals.

1.7 Significance of the Study

The findings of this study might benefit policy makers, practitioners (managers of analytical labs), and scholars. For policymakers and regulators, the findings obtained from this research might help in developing appropriate policies to increase innovation in analytical labs. Based on the findings, recommendations might be made regarding the appropriate institutional systems that can be adopted to encourage analytical labs to adopt and increase their innovative capacity. Also, policymakers will be able to determine the specific aspects contributing to poor innovation, which can help inform the development of targeted policies. For managers and owners of analytical labs, the findings from this research provided insights regarding the strategies that can be adopted to increase innovation in the analytical laboratories sector. Based on the findings, recommendations were made regarding the appropriate organizational strategies, in terms of accessing external finance capital and product diversification, which can be adopted to enhance innovation. For scholars, the findings of this research helped expand the existing literature regarding innovation in the analytical laboratory sector. The findings from this research also constituted the basis for additional research to better understand innovation in the analytical laboratory sector as well as other industries in Kenya.

1.9 Chapter Summary

This chapter has presented an introduction to the overall topic of the research including its background and a brief description of the variables in relation to the analytical laboratories sector – innovation, firm-level, industry level and macroenvironment determinants. In addition, this chapter described the statement of the problem, objectives of the research, research questions, and the scope and significance of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of existing literature on the determinants of innovation adoption. The chapter commences by outlining the theoretical foundation of the study. Next, an empirical review is conducted that focuses on the effects of firm-level, industry and macroenvironment determinants on innovation adoption. A critique of existing literature is presented together with a summary of the research gaps used to justify the need for this study. Lastly, a conceptual framework outlining the variables, their operationalization, and relationships between them is presented.

2.2 Theoretical Review

This section discusses theories that anchor this research. The main theory is the diffusion of innovation theory. Secondary theories that provide the theoretical basis for this research are the technology acceptance model and the open versus closed innovation model.

2.2.1 Technology Acceptance Model

Davis (1985) introduced TAM as a model to explain the determinants of acceptance of technological innovations, which in turn influences their adoption. According to TAM, the adoption of technology is influenced by two factors including perceived usefulness and perceived ease of use (Davis, 1985). Perceived usefulness refers to the belief that adopting a technology or innovation will result in performance improvements whereas perceived ease of use denotes the extent to which the potential user or adopter believes that the adoption will be effortless and without complexities (Fedorko et al., 2018). TAM posits that perceived usefulness and perceived ease of use influence the intent to adopt technology, which in turn influences actual adoption behavior. A technology or innovation is more likely to be adopted if users perceive it to be useful and easy to use.

TAM also posits that the concepts of perceived usefulness and perceived ease of use are influenced by external variables. The external variables that influence perceived usefulness and ease of use

are relevant to the present study in terms of informing the variables that influence adoption of innovation (Lai, 2017). Some of these external variables adapted from TAM for this study are firm-level, industry-level and macro-environment determinants. Organizational, or adopter characteristics, such as size, structure and innovativeness, influence the perceived usefulness and ease of use, which in turn can determine the adoption decision. The size of an organization has an influence on the tendency to adopt new ideas (Taherdoost, 2018). Larger organizations, because of centralized structures, are less likely to adopt innovations compared to smaller organizations that are flexible. Large organizations have established themselves; thus, can be expected to perceive lower value in new, innovative ideas. Capital might be another organizational characteristic that influences adoption. Organizations with higher capital are expected to have a higher likelihood of innovation adoption since they face minimal challenges of adopting innovation; thus, their perceived ease of use is high (Lai, 2017). Organizations with smaller capital reserves might find adoption challenging due to resource limitations. Age is also another organizational characteristic that influences adoption. Older organizations with established processes tend to be rigid and resistant to chance; therefore, perceive lower usefulness of innovations (Lai, 2017). Younger organizations, on the other hand, are expected to be innovative and constantly try and adopt new ideas because they are still undergoing a learning phase. Other organizational characteristics that influence adoption are risk and organizational structure. In the business environment, competitive pressures and the favorability of government policies can influence adoption (Lai, 2017). Other external environment variables, like the competitive environment and the macro-environment are expected to incentivize or discourage firms from adopting innovations (Taherdoost, 2018). Overall, the independent variables for this study were adapted from the external variables in TAM that influence the adoption of innovation.

TAM has a number of strengths including accurately predicting the intension of adopting innovation (Taherdoost, 2018). This theory has also been validated extensively in research. In addition, TAM is also appropriate for explaining institutional adoption of innovation (Guo et al., 2018). However, a limitation of this theory is that it does not capture the contextual and cultural variations in innovation adoption (Taherdoost, 2018).

2.2.2 Open versus Closed Innovation Model

Chesbrough (2006) developed this theory in 2003 to present two contrasting approaches that firms can use to pursue innovation – open and closed. In open innovation, firms collaborate with external partners, including customers, academic institutions, and other firms, with the goal of pooling resources and knowledge (Chesbrough, 2006). Open innovation is based on the flow of intellectual property, ideas and knowledge across the boundaries of an organization (Radicic & Alkaraan, 2022). This approach to innovation is grounded on collaboration between the firm and external partners, such as customers, suppliers, research institutes, universities, and sometimes competitors (Hameed et al., 2018). Open innovation makes use of external sources of disruptive thinking and creativity to develop new business models, services, or products to drive organizational growth. Open innovation offers numerous benefits for firms including accessing a huge pool of external expertise and ideas that can significantly increase the problem-solving capabilities of an organization. Through collaboration with external partners, a firm is capable of tapping into diverse perspectives that can lead to the innovation solutions that might be impossible to accomplish using internal resources only (Hameed et al., 2018). Open innovation also reduces R&D costs for firms. External collaboration makes R&D projects more efficient and effective. Additionally, open innovation reduces risk by spreading it across several parties, which reduces the financial burden associated with innovation.

Conversely, closed innovation is dependent on internal resources and knowledge, such as R&D, to develop proprietary solutions that are protected using intellectual property rights in order to remain competitive. Closed innovation is the traditional approach to R&D in which firms manage innovation processes internally to develop and commercialize new innovation. A key advantage associated with closed innovation is that it enables firms to protect their intellectual property (Radicic & Alkaraan, 2022). Through a closed approach, a firm can exercise more control over its trade secrets and innovation, which in turn lowers the risk of theft of intellectual property by competitors. Closed innovation can allow firms to strategically allocate resources and customize innovation to fit their objectives and strategy (Hameed et al., 2018). Moreover, closed innovation is effective in encouraging internal competitiveness amongst employees, which drives them to formulate creative and unique solutions.

A strength of the open versus closed innovation model accurately depicts the nature of innovation nowadays, especially amidst globalization and the changing business environment where firms have to open up their innovation management. Research studies have also validated the constructs of this theory (Bigliardi et al., 2020). While this theory describes the innovation process, it does not capture the determinants of innovation (Saura et al., 2023). The open versus closed innovation model informed the current study by forming the basis for the approach adopted by firms to manage their innovation processes, which is an important firm-level variable to be examined in this study. As a result, this theory was useful in characterizing the profile of innovation adopters in the analytical laboratories sector in Kenya. The variables of firm-level and industry level determinants were adapted from the open versus closed innovation model.

2.3 Empirical Literature Review

This section reviews existing studies with respect to the objectives of this study. A critical synthesis and analysis of themes in extant literature is presented. The scope of the literature review is on relationships between innovation adoption and firm-level, industry-level, and macroenvironment-level determinants.

2.3.1 Firm-level Determinants and Innovation Adoption

Firm level determinants refer to characteristics that an organization's management, to a significant extent, has control over. Firm-level determinants have been conceptualized in terms of size, product diversification, age of firm, financial capabilities, and human capabilities (skill sets) (Choi & Lee, 2018; Guo et al., 2018; Regasa et al., 2021). The relationship between these firm-level determinants and innovation adoption is discussed in the following subsections.

Size is also an important firm-level characteristic that affects the adoption of innovation by firms. In the literature, firm size has mostly been described using the number of employees (Bouncken et al., 2018). Firm size has been reported to positively influence the adoption of innovation (Chirico et al., 2022; Naranjo-Valencia et al., 2017). Using the number of employees as the proxy for firm size, Naranjo-Valencia et al. (2017) provided evidence indicating a positive relationship between firm size and innovation behavior, suggesting that larger firms have a higher likelihood of pursuing innovation compared to small firms. The positive relationship between firm size (measured using the number of employees) and the innovation adoption was also demonstrated by Chirico et al.

(2022) in family-owned firms in Spain. In a sample consisting of firms selected from the German commercial and industrial machinery and computer equipment sectors, Bouncken et al. (2018) reported that firm size has a positive impact on innovation adoption, which was attributed to strategic alliances amongst large firms and the high intensity of R&D. Knott and Vieregger (2020) also observed that large firms have a higher likelihood of pursuing innovation than small firms, which occurs due to the increased R&D spending and productivity. Based on a sample derived from South Korean firms, Choi and Lee (2018) found a significant positive association between firm size and innovation adoption and new R&D. The overall inference that can be made from the existing literature is that large companies have innovative advantages over small firms; as a result, large firms are more likely to pursue innovation than small firms.

Another important firm-level characteristic that can have an impact on the adoption of innovation is product diversification. Evidence from manufacturing firms in China show the negative impact of product diversification on innovation intensity defined in terms of the number of innovations, which occurs mainly via R&D expenditures (Guo et al., 2018). Guo et al. (2018) reported that firms pursuing a product differentiation strategy by continually improving its existing products had higher R&D spending compared to those pursuing product diversification and cost leadership strategies; as a result, these firms had a higher innovation intensity. A study conducted using a sample of Chinese private firms revealed that firms with a diverse product portfolio are likely to spend a smaller fraction of their total expenditures on R&D compared to those that offer a single product and focus on continually improving and differentiating itself in the market (Leung & Sharma, 2021). These results show that innovation intensity reduces as product/service diversification increases. Similarly, Shibia (2022) reported that product diversification had a negative impact on R&D investment on Kenyan manufacturing firms. Firms with a more diverse product R&D portfolio were less likely to have undertaken R&D investment decisions like providing employees with formal training or giving them time to develop new processes or products, which in turn lowers their innovation intensity and output. The outcome is that a more diverse product/service portfolio was associated with a reduced innovation output. Similarly, in an interview with managers of Swedish firms, Lysek (2019) reported that horizontal diversification served to disincentivize innovation. These managers viewed horizontal product diversification as a better and less risky strategy to pursue than innovation. Overall, results from these studies show

that product diversification seems to have a negative influence on innovation investments and output. Conversely, product differentiation appears to be a driver of innovation.

Age is also another organizational characteristic that influences innovation. Older organizations with established process tend to be rigid and resistant to change; as a result, there are less likely to pursue innovation (Lai, 2017). Younger organizations, on the other hand, are expected to be innovative and constantly try new ideas because they are still undergoing a learning phase (Lai, 2017). Chirico et al. (2022) reported a negative association between innovation adoption and firm age measured using years of existence of a firm. Chirico et al. (2022) argued that older firms are less likely to pursue innovative projects because of the reliance on legacy products or services that have already been proven in the market. On the other hand, Naranjo-Valencia et al. (2017), using a sample of Spanish companies, Naranjo-Valencia et al. (2017) reported a positive correlation between innovation adoption and age of firms, meaning older firms were more likely to be innovative than younger firms. Similarly, in Germany, Bouncken et al. (2018) reported a positive association between the age of firms and innovation adoption. From these findings, the relationship between age and radical innovation is unclear.

Financial capability constitutes another organizational characteristic that influences innovation in firms. Organizations with more financial resources are expected to have a higher likelihood of pursuing innovation projects adoption since they face minimal challenges when it comes to financing innovation projects (Lai, 2017). Bhattacharya et al. (2021) further observed a positive relationship between firms' capital flows (equity or debt) innovation output – this relationship was mediated RD budget allocations. This finding suggests a link between R&D budget and the financial capability of a firm, defined as the ability of an organization to raise and deploy capital. Organizations with smaller capital reserves might find pursuing innovation challenging due to resource limitations as well as the uncertainty and risk of innovating (Xu & Chen, 2020). Some financial performance metrics, such as solvency and liquidity, have been reported to be positively associated with innovation output in firms (Chirico et al., 2022).

Human capabilities/resources represent another factor that affects innovation in organization. Human capabilities refer to the knowledge and skills that employees have. The positive link between human capabilities in organizations and innovative behavior is well-documented in the literature. For instance, Nasiri et al. (2020) reported a positive association between digital related

human capabilities/skills and knowledge and the adoption of digital innovations in SMEs in Finland. Moreover, practices to enhance human capabilities, such as employee retention and training and development, improve the innovative capacity of firms (the capacity of a firm to introduce new ideas, products, and processes) (Papa et al., 2020).

The innovation strategy adopted by an organization also influences the adoption of innovation (Lu et al., 2021). Open innovation practices, such as crowdsourcing ideas, co-creation, and development with partners, integrating external knowledge from suppliers, and collaborating with competitors and universities, have been studied in terms of their effectiveness in enhancing innovation performance. Radicic and Alkaraan (2022) studied the effectiveness of open innovation strategies in SMEs, especially coupled open and inbound innovation strategies. Inbound open innovation involves integrating external stakeholders into a firm's innovation process, such as collaborating with startups or universities, crowdsourcing, and technology scouting. Coupled open innovation is characterized by firms working together through joint development and ventures. Radicic and Alkaraan (2022) reported that these open innovation strategies are effective in enhancing the innovative performance of firms with respect to new product development. The positive impact of open innovation strategies was also reported by Lu et al. (2021), who reported a positive relationship between open innovation and innovation performance of Chinese SMEs.

Closed innovation practices, including R&D departments and using employees, influence the innovation performance of firms. For instance, Hameed et al. (2018) reported that the R&D department and internal innovation were significant determinants of Malaysian SMEs innovation performance in terms of new process development. Similar finding supporting the positive effects of closed innovation practices on innovation performance was provided by Edquist et al. (2018), who showed that firms with R&D teams had better innovation performance than those lacking R&D teams.

2.3.2 Industry-level Determinants and Innovation Adoption

Industry level determinants comprise of variables relating to the characteristics derived from an industry, such as the intensity of competition, buyer power, entry barriers and threats of substitutes (Bouncken et al., 2018; Nam et al., 2019; Papa et al., 2020). These determinants are based on Michael Porter's five forces and have an influence on the extent to which firms in an industry

embrace innovation (Nam et al., 2019). These determinants are discussed in detail in the following subsections.

The intensity of competition is a key industry factor, which is defined as the number of rival firms operating in the same industry and the ability of these firms to undercut their rivals in the market (Zawislak et al., 2018). Innovation is considered one of the ways through which firms can gain competitive advantage. A high competition intensity compels firms to be more innovative for them to gain competitive advantage. However, in industries with few players and low competition intensity, firms are reluctant to pursue innovation aggressively (Nam et al., 2019). Coccia (2017) identified competitive forces as a significant driver of innovation, especially in the pharmaceutical industry when it comes to the development of cancer drugs. Coccia (2017) observed that innovation in the pharmaceutical industry is primarily driven by the need to gain a competitive edge in terms of being the first to introduce a drug in the market. In the competitive and dynamic pharmaceutical market, Coccia (2017) reported that leading players tend to be innovative-based and prioritize developing new target therapies. Thus, Coccia (2017) suggested a link between innovation and industry competition, and that firms rely on innovation as a way of gaining competitive advantage in markets. The positive impact of industry competition on firm-level innovation was also demonstrated by Aghion et al. (2018), who reported that increased competition resulted in a significant increase in R&D investments, which was used as a proxy for measuring innovation.

Buyer power refers to the significance of each customer and their ability to negotiate better deals from suppliers. Buyer power can take the form of a pull innovation, wherein firms become innovative in response to the problems or needs of customers (Bruijl, 2018). In an industry with a high buyer power, firms are incentivized to invest in quality improvement; therefore, are more likely to innovate in order to retain customers (Calvano & Polo, 2021). The impact of buyer power on firm innovation was illustrated in a study conducted by Krolikowski and Yuan (2017), who examined the effect of customer-supplier relationships on firm level innovation in United States' firms. Their findings showed customer concentration as well as bargaining power have a significant influence on supplier's process and product innovation in terms of patents and R&D-to-assets ratio. In particular, Krolikowski and Yuan (2017) reported that a concentrated customer base incentivizes suppliers to increase their R&D investments and become more innovative.

The power of suppliers is an important industry attribute that might influence innovation (Gilbert, 2022). The power of suppliers refers to the extent to which suppliers can influence the cost and the availability of inputs and resources. According to Calvano and Polo (2021), a high power of suppliers drives up innovation in industries. The significant influence of supplier power in firm innovation was also confirmed by Kim et al. (2018), who investigated the impact of supply chain relationships on firm innovation in Taiwan. The results showed that concentrated suppliers coupled with high switching costs drove firms to be more innovative. Additionally, firms increased their innovative capability as a strategy to mitigate uncertainties and risks in the supply chain. Similarly, Caballero-Morales (2021) observed that firms operating in industries where suppliers are few and large tend to be more innovative in comparison to those having many small suppliers where switching costs are low.

The threat posed by new entrants refers to the ease with which a new competitor can enter a company. In industries where entry barriers are strong, Lee (2019) observed that innovation often tends to be low compared to industries where entry barriers are minimal. This is because existing firms are not incentivized to increase their innovation in order to protect their market from new entrants. If barriers are minimal however, competition increases by the entry of new players, which incentivizes existing firms to be innovative. Similar insights were observed by Block et al. (2019), who reported that during the early stages of an industry when entry barriers are low and there is high uncertainty, small and young firms are more innovative. The opposite occurs in the later stages of a mature industry where entry barriers are high, wherein industry level innovation diminishes.

The threat of substitutes refers to the degree to which substitutes exist in the market that customers can use to replace a company's product/service offerings. In industries where the threat of substitutes is high, innovation is high (Block et al., 2019). In systematic review, Talwar et al. (2020) reported that organizations resistance to technological innovation is higher if the perceived threat of substitutes with comparable performance is low. Bruijl (2018) also identified the threat of substitutes as a driver for innovation.

2.3.3 Macroenvironment Determinants and Innovation Adoption

Macroenvironment determinants are related to the overall economy, which have been conceptualized in terms of economic growth, regulatory environment, and sustainability standards, which might potentially impact innovation in firms (Argente et al., 2018; Tomizawa et al., 2020; Zhong, 2018). The state of the economy is one of the determinants that drives firm-level innovation. According to Kendiukhov and Tvaronaviciene (2017), during periods of economic boom, firms tend to be more innovative in order to meet rising consumer demands and needs. Conversely, during economic recessions, innovation might decrease due to a reduction in consumer demand. At the same time, firms can become innovative in order to survive the harsh economic realities, such as innovating processes in order to cut costs (Tomizawa et al., 2020). Additionally, Argente et al. (2018) observed that more product development occurs during economic boom than during economic recession. Empirical evidence shows a bi-directional relationship between economic firm innovation and economic growth. Innovation drives economic growth (Zhong, 2018). At the same time, economic growth incentivizes firms to increase their innovative activities.

The regulatory environment also constitutes a key element of the macroenvironment that can drive firm innovation. Evidence from existing research points to a positive impact of regulations on increasing firm innovation. For instance, Shao et al. (2020) conducted a systematic review to assess the effect of environmental regulations on firm innovation. The results from their study indicated those environmental regulations had a positive impact on firm innovation behavior. In the same vein, Dechezleprêtre and Sato (2017) provided empirical evidence to show that regulations induce firm innovation. These studies suggest that the regulatory environment is an important factor that influences innovation.

The move towards sustainable business processes is increasing; as a result, businesses are innovating their processes and products to be environment friendly, not only for compliance reasons but to appeal to sustainability conscious consumers (Rosca et al., 2017). Sustainability standards and laws compel businesses to look for ways achieving environment-friendly processes, which in turn drives innovation activity in firms. Compliance with regulations has also been reported as a driver for firm-level innovation (Tomizawa et al., 2020). Altenburg and Pegels (2017)

reported that the green transformation has been a key driver of firm innovation, especially with respect to the development of eco-friendly products and services.

2.4 Research Gaps

Whereas innovation adoption has been studied extensively, disagreement, contextual, conceptual and methodological gaps have been identified in the existing literature regarding the determinants of innovation adoption. Inconsistencies exist in the literature with respect to the effect of firm-level and macro-environment on innovation adoption. For instance, contradictory findings exist with regard to the effect of firm age and size on innovation adoption. Younger firms are more likely to be innovative; however, they are constrained by resources (Chirico et al., 2022; Lai, 2017). While older firms have the resources to pursue innovation adoption, they are rigid and rely on proven strategies and products (Choi & Lee, 2018). Similar contradictions exist on industry level and macroenvironment determinants. For example, Bouncken et al. (2018) reported an insignificant effect of competition on innovation adoption while Nam et al. (2019) demonstrated that a high competition intensity compels firms to be more innovative for them to gain competitive advantage. The disagreement in the literature indicates a lack of clarity regarding the effects of macroenvironment, industry-level and firm-level determinants on innovation adoption, which underlies the need for further research.

Additionally, the contextual gap identified in the literature is the scant literature on the determinants of innovation in the analytical laboratories sector in the Kenyan context. The analytical laboratories sector is unique since it is a B2B sector; however, most studies have been conducted on B2C sectors like banking and manufacturing. The B2B sector offers a unique and different context from B2C sectors. In B2B sectors, the focus is in building business relationships. In B2C, however, there is more transactional focus. As a result, there is a need to examine if innovation determinants reported in the B2C context can be replicated in the B2B sectors and in the Kenyan context. Table 2.2 presents a summary of the research gaps.

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Table 2.1 Summary of Research Gaps

Author	Title	Methodology	Finding	Research Gaps	Focus of the Current Study
Naranjo-Valencia et al. (2017)	Organizational culture and radical innovation: Does innovative behavior mediate this relationship?	Descriptive survey	Age and firm size had an influence on the adoption of innovation	Contextual and disagreement gaps	This study assessed innovation adoption in the Kenyan context
Chirico et al. (2022)	Radical innovation in (multi)family-owned firms	Descriptive survey	Size had an influence on the adoption of innovation in family-owned firms	Contextual and disagreement gaps	This study assessed innovation adoption in the Kenyan context
Chung and Kang (2019)	Characteristics of chief technology officers and radical innovation	Descriptive survey	Firm size and age also affect the extent of radical innovation	Contextual and disagreement gaps	This study assessed innovation adoption in the Kenyan context
Bouncken et al. (2018)	Coopetition in new product development alliances: advantages and tensions for incremental and radical innovation	Descriptive survey	Firm size and size have a positive impact on radical innovation.	Contextual and disagreement gaps	This study assessed innovation adoption in the Kenyan context
Knott and Vieregger (2020)	Reconciling the firm size and innovation puzzle	Descriptive survey	Firm size has a positive impact on incremental innovation	Contextual and disagreement gaps	This study assessed innovation adoption in the Kenyan context

Choi and Lee (2018)	Firm size and compositions of R&D expenditures: evidence from a panel of R&D performing manufacturing firms	Panel data research design	Firm size has a positive impact on new and incremental innovation	Contextual, methodological and disagreement gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design
Guo et al. (2018)	Manufacturing R&D investment efficiency and financing constraints: evidence from China	Panel data research design	Product diversification is negatively associated with innovation intensity	Contextual and methodological gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design
Lysek (2019)	Disguising diversification for innovation	Qualitative grounded theory	Product diversification is negatively associated with innovation output and intensity while product differentiation positively impacts innovation	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using descriptive cross-sectional research design The present study also looked at other determinants including macro-environment and industry-level determinants
Lai (2017)	The literature review of technology adoption models and theories for	Systematic review	Age and firm size have an impact on the innovation behavior of firms	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using descriptive cross-sectional research design

	the novelty technology				The present study also looked at other determinants including macro-environment and industry-level determinants
Xu & Chen (2020)	Exploring the innovation efficiency of new energy vehicle enterprises in China	Panel data analysis	Financial resources were associated with innovation output	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design The present study also looked at other determinants including macro-environment and industry-level determinants
Nasiri et al. (2023)	Shaping digital innovation via digital-related capabilities	Descriptive survey	A positive association between human capabilities and digital innovation in SMEs was reported	Contextual and conceptual gap	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants
Papa et al. (2020)	Improving innovation performance through knowledge acquisition: the moderating role of employee retention and	Descriptive survey	A positive association between human capabilities and firm's innovation capacity was reported	Contextual and conceptual gap	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants

	human resource management practices				
Radicic and Alkaraan (2020)	Relative effectiveness of open innovation strategies in single and complex SME innovators	Descriptive survey	Open innovation practices enhance innovation effectiveness	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants
Lu et al. (2021)	Effects of open innovation strategies on innovation performance of SMEs: evidence from China	Descriptive survey	A positive association exists between open innovation strategy and innovation performance	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants
Hameed et al. (2018)	Determinants of Firm's open innovation performance and the role of R & D department: An empirical evidence from Malaysian SME's	Descriptive survey	Closed innovation practices including R&D and internal innovation had a positive impact on innovation performance	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants

Aghion et al. (2018)	The causal effects of competition on innovation: Experimental evidence	Panel data analysis	Industry competition was found to have a positive impact on innovation in terms of R&D investments	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants
Calvano & Polo (2021)	Market power, competition and innovation in digital markets: A survey	Descriptive survey	Buyer power and supplier power drive up innovation	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context The present study looked at other determinants including macro-environment and industry-level determinants
Krolikowski and Yuan (2017)	Friend or foe: Customer-supplier relationships and innovation	Panel data analysis	Buyer power increases supplier's innovative behavior	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design
Kim et al. (2018)	Strategic orientations, joint learning, and innovation generation in international customer-supplier relationships	Descriptive survey	Supplier power was a determinant of firm level innovation	Contextual and conceptual gaps	The present study also looked at other determinants including macro-environment and industry-level determinants

Caballero-Morales (2021)	Innovation as recovery strategy for SMEs in emerging economies during the COVID-19 pandemic	Descriptive survey	Innovation is higher in industries where suppliers are powerful	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design
Block et al. (2019)	The Schumpeterian entrepreneur: a review of the empirical evidence on the antecedents, behaviour and consequences of innovative entrepreneurship	Systematic review	Low entry barriers increase innovation	Contextual and conceptual gaps	The present study also looked at other determinants including macro-environment and industry-level determinants
Talwar et al. (2020)	Consumers' resistance to digital innovations: A systematic review and framework development	Panel data analysis	Resistance to digital innovation in organizations is high if the perceived threat of substitutes is low	Contextual and conceptual gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design

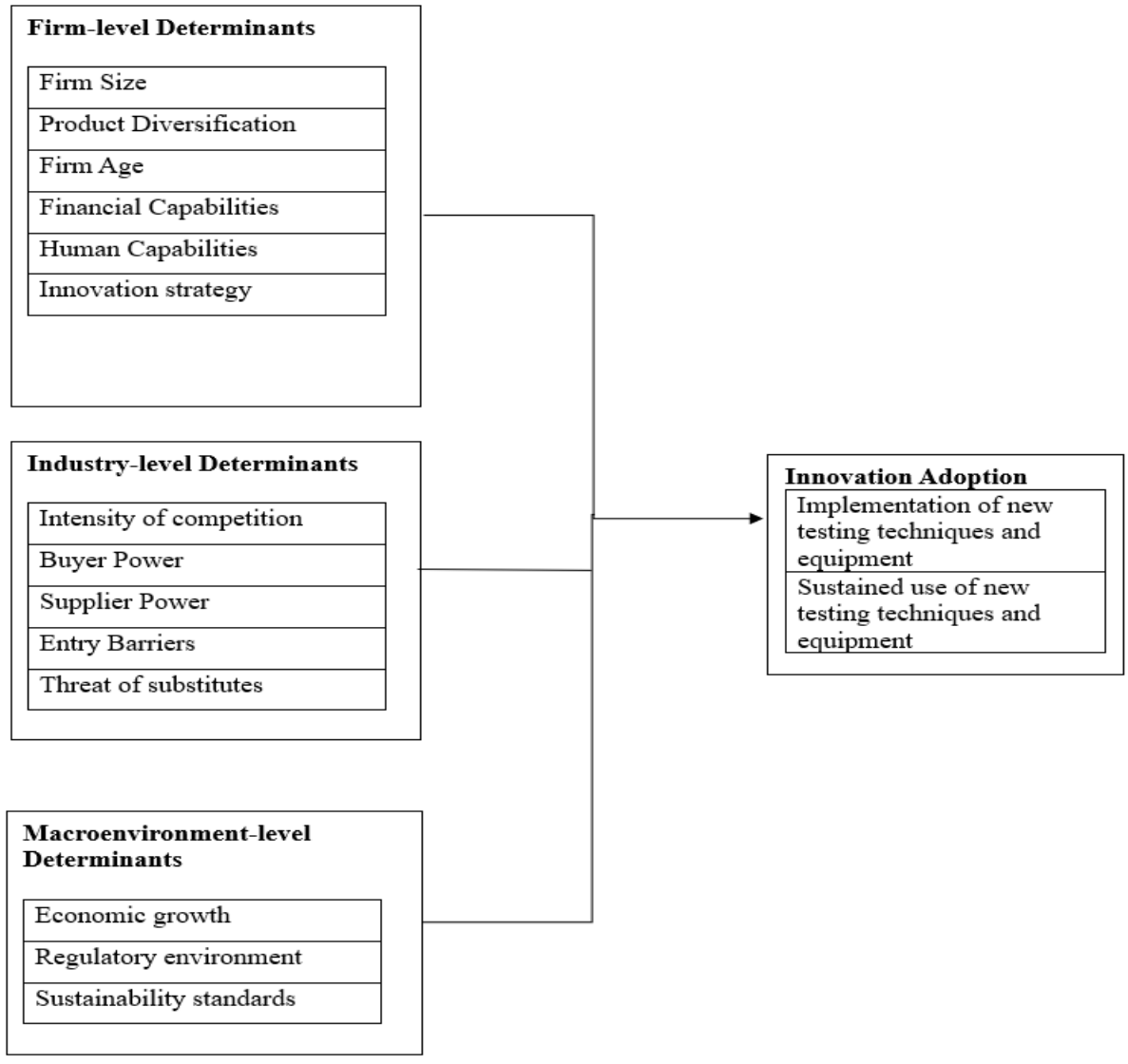
Bruijl (2018)	The relevance of Porter's five forces in today's innovative and changing business environment	Descriptive survey	Threat of substitutes was reported to be a driver of innovation	Contextual and conceptual gaps	The present study also looked at other determinants including macro-environment and industry-level determinants
Kendiukhov and Tvaronaviciene (2017)	Managing innovations in sustainable economic growth	Panel data analysis	Firm innovation differs during economic recession and boom	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design
Argente et al., (2018).	Innovation and product reallocation in the great recession	Panel data analysis	New product development was higher during economic boom than during recession	Contextual, conceptual and methodological gaps	The present study also looked at other determinants including macro-environment and industry-level determinants
Shao et al. (2020)	Environmental regulation and enterprise innovation: a review.	Systematic review	Regulations can drive up innovation	Contextual, conceptual and methodological gaps	This study assessed innovation adoption in the Kenyan context using a descriptive cross-sectional research design

Source: Researcher (2024)

2.5 Conceptual Framework

The conceptual framework for this study is presented in Figure 2.1. This framework shows the hypothesized relationships between variables. Innovation adoption is the dependent variable, which was assessed in terms of implementing and sustaining innovation. Firm level, industry level and macroenvironment-level determinants are the independent variables.

Figure 2.1 Conceptual framework



Source: Researcher (2024)

Table 2.2 Operationalization of Variables

Variable	Variable Definition	Variable Indicator	Scale of Measurement	Supporting Literature	Supporting Theories
Independent Variables					
Firm-level determinants	Factors that an organization's management, to a significant extent, has control over	Firm, size, product diversification, firm age, financial capabilities, human capabilities, closed innovation strategy and open innovation strategy	Ordinal – five-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high)	Bouncken et al. (2018), Guo et al. (2018), Lai (2017), Xu & Chen (2020), Nasiri et al. (2020) and Hameed et al. (2018)	TAM and Open versus Closed Innovation Model
Industry level determinants	Variables relating to the characteristic or derived from an industry	Intensity of competition, buyer power, supplier power, entry barriers and threat of substitutes	Ordinal – five-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high)	Nam et al. (2019), Calvano and Polo (2021), Kim et al. (2018), Lee et al. (2019) and Block et al. (2019)	TAM and Open versus Closed Innovation Model
Macroeconomic level determinants	Factors that are related to the overall economy	Economic growth, regulatory environment, and sustainability standards	Ordinal – five-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high)	Kendiukhov and Tvaronaviciene (2017), Dechezleprêtre and Sato (2017), and Altenburg and Pegels (2017	TAM and Open versus Closed Innovation Model
Dependent Variable					
Adoption of innovation	The ability to develop and implement unique and new concepts, products, services, business models and processes that support the financial viability and mission of an organization	Implementation of new testing equipment and techniques Sustained use of new testing equipment and techniques	Ordinal – five-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high)	Naranjo-Valencia et al. (2017)	TAM and Open versus Closed Innovation Model

Source: Researcher (2024)

2.6 Chapter Summary

In this chapter, existing literature on the determinants of adoption of innovation has been reviewed. The theoretical and empirical review have also been discussed. The summary of research gaps and a conceptual framework have been provided.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology that was used for data collection and analysis. The rationales for the methodological decisions are discussed in this chapter. The specific elements of the research methodology covered in this chapter are the research philosophy, design, population and sampling, data collection and analysis, steps to ensure research quality, and ethical issues to be considered during the research.

3.2 Research Philosophy

Research philosophy refers to the assumptions and beliefs regarding how valid knowledge should be developed. Research philosophy is an important aspect of methodology since it guides the entire methodological process including how data should be gathered and analyzed. The first research philosophy considered for this research was positivism, which assumes that phenomena can be examined objectively and that a researcher should not incorporate their values or biases into the study. positivism calls for the use of empirical methods in order to objectively predict and explain phenomena (Stokes, 2017). The rationale for adopting the positivism philosophy for this research is because of the need to produce objective findings that can be generalized to the analytical laboratories sector in Kenya. The research questions for the current study are framed to assess relationships between variables, which can only be done using empirical methods; hence, the positivism philosophy provided a suitable guiding paradigm for the current study.

Other research philosophies, including interpretivism, realism, and pragmaticism, were considered for use in this research but were found unsuitable. Interpretivism philosophy is based on the assumption that reality is subjective; thus, can be understood by exploring the meanings, opinions, narratives and thoughts of people. Interpretivism was deemed unsuitable because it does not generate findings that can be generalized to an entire industry; instead, it is suited for in-depth investigations using small samples (Stokes, 2017). Realism assumes that while reality is objective, it should be interpreted in light of the historical context by considering the past and future. The current study does not examine the phenomenon of innovation with regard to past and future

trends; thus, realism is not an appropriate philosophy to guide the present research. Pragmatism assumes that the relevance of research is measured by the degree to which the findings are useful in informing actions to solve practical problems. The present study is primarily observational rather than action research (Stokes, 2017). Overall, positivism was the suitable philosophy for this research due to the need to generate generalizable findings that can be applied to the broader analytical laboratories sector in terms of the adoption of innovation.

3.3 Research Design

The cross-sectional descriptive design was adopted for the current research. This design is used in studies that seek to examine the relationships between variables (Bell et al., 2022). The choice of the descriptive design is aligned with the objectives of the current study that seeks to examine the relationships between innovation adoption, and firm-level, industry level and macroenvironment level determinants. The unit of analysis was the analytical laboratory firm. Cross-sectional descriptive design has been adopted in similar studies on innovation (Ngugi & Karina, 2013; Ngundi & Namada, 2022)

3.4 Population of the Study

The population for this study comprised of the 50 analytical laboratories accredited by the Kenya National Accreditation Service (KENAS) (KENAS, 2022). Respondents were selected from these analytical laboratories.

3.5 Sample Design and Technique

A census approach was utilized in this study. This approach involves collecting data from all units in the population (Bell et al., 2022). The reason for adopting a census approach is due to the small size of the study population that consists of only 50 analytical laboratories in the country. Recruiting respondents was performed using judgement sampling. In this sampling strategy, respondents are selected based on whether or not they meet a criterion needed to help the researcher meet the study objectives. For this study, the criterion for eligibility was working in a managerial position in the analytical labs in Kenya. Judgmental sampling was employed because it is cost-effective and can be employed to access a large pool of participants (Bell et al., 2022). From each analytical laboratory, the target is to sample two respondents working in diverse positions

including general managers, senior analysts, analysts, business development and marketing managers, quality managers/officers, finance managers, head of R&D and human resource managers, which brings the total sample size to 100 respondents from all the analytical laboratories in the country. These key personnel are relevant for this study because they are in a position to make organizational decisions and carry out key activities; hence, are better suited to provide useful insights regarding innovation.

3.6 Data Collection Method

This study collected primary data from respondents. The data collection tool for this study was the questionnaire due to its convenience and effectiveness for collecting data from a large sample pool (Bell et al., 2022). The questionnaire consisted of three sections. Section A collected information on respondent's demographic information. Section B collected information on determinants while section C collected information on innovation adoption.

Data was collected by distributing questionnaires to the various branches of analytical laboratories based in Nairobi using a drop and pick approach. An electronic version of the questionnaire was sent to prospective respondents via email who preferred taking part in the survey electronically. The contacts of lead persons of these laboratories are publicly available at the KENAS website. The researcher called and asked for permission prior to distributing questionnaires. Trained research assistants were used in order to increase the response rate.

3.7 Research Quality

3.7.1 Reliability

Reliability is the dependability of the research, that is, the degree to which it can yield similar results repeatedly (Bell et al., 2022). Reliability of the data collection instrument was calculated after collecting data, which was computed for the entire question as well as the sub-scales for the variables (Oakshott, 2020). An internal consistency coefficient of at least 0.7 was considered acceptable (Oakshott, 2020). Table 3.1 shows the reliability coefficients for the variables in the questionnaire.

Variable	Components	Cronbach's Alpha Coefficient	Number of Items	Interpretation
Firm-level determinants	Firm, size, product diversification, firm age, financial capabilities, human capabilities, closed innovation strategy and open innovation strategy	0.779	13	Reliable
Industry level determinants	Intensity of competition, buyer power, supplier power, entry barriers and threat of substitutes	0.767	11	Reliable
Macroenvironment level determinants	Economic growth, regulatory environment, and sustainability standards	0.773	6	Reliable
Innovation adoption	Implementation of new testing equipment and techniques Sustained use of new testing equipment and techniques	0.776	2	Reliable

Source: Researcher (2024)

3.7.2 Validity

Validity is the degree of accuracy of the findings of a study, which can be achieved by ensuring instruments measure what they are supposed to measure. Various steps were taken to improve the validity of this study (Oakshott, 2020). First, pilot research was performed with a sample of 30

participants consisting of managers from analytical laboratories sector, with the goal of assessing if the questionnaire items are clearly and easily understood by respondents (Oakshott, 2020). Respondents in the pilot study were from five analytical labs. Pilot study respondents were excluded from the final analysis. The findings of the pilot study showed that the questionnaire items were clear and understood by respondents. Additionally, the questionnaire was developed with the guidance of a supervisor at Strathmore University.

3.8 Data Analysis

SPSS was used to process and analyze the collected data. Descriptive statistics, including means, standard deviations and frequency were utilized for summarizing and describing variables as well as demographic information for respondents. For hypothesis testing, inferential statistics, especially simple and multiple linear regression analyses were employed to assess the relationships between innovation adoption and firm-level, industry level and macro-economic level determinants. Simple linear regression was used to assess the relationships between individual independent variables and the dependent variable. The multiple linear regression equation below was used.

$$IA = \beta_0 + \beta_1 FLD + \beta_2 ILD + \beta_3 \text{MED} + \in$$

Where,

- IA = Innovation Adoption
- FLD = Firm level determinants
- ILD = Industry level determinants
- MED = Macroenvironment determinants

3.9 Ethical Considerations

A number of ethical issues were considered in this research including voluntary participation, confidentiality, privacy, and ethical approval. Participation in this research was on a voluntary basis, which means that informed consent was obtained before respondents take part in the survey. Participants were also informed of their right to stop participation at any point without any penalty (Hair et al., 2019). Confidentiality was realized by not obtaining any information from respondents that could be used to reveal their identities, like their names, telephone number and addresses. Privacy was achieved by not disclosing the data collected to third parties (Bell et al., 2022).

Moreover, ethical approval was sought from SU-ISERC as well as NACOSTI prior to collecting any data.

3.10 Chapter Summary

This chapter has described the research methodology that was used for data collection and analysis. The rationales for the methodological decisions have also been discussed in this chapter. The specific elements addressed in this chapter are the research philosophy, design, population and sampling, data collection and analysis, steps to ensure research quality, and ethical issues that were considered during the research.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the findings of the research with respect to the objectives of the study. The findings of both descriptive and inferential analysis are presented.

4.2 Response Rate

The response ate helps to establish the validity of the study. A higher response rate suggests that the sample is less biased and more representative. On the contrary, a lower response rate might suggest a biased and potentially unrepresentative sample that could skew the findings. For this study, the researcher targeted 100 respondents – two from each of the 50 analytical laboratories. The researcher was able to collect 88 complete questionnaires from all the 50 analytical laboratories in the country, which represents a response rate of 88%. This response rate was considered appropriate for further analysis. Hair et al. (2019) reports that a response rate of at least 60% is sufficient to generalize the findings.

Table 4.1: Response Rate

Category	**Frequency**	**Percentage**
Issued	100	100%
Returned	88	88%
Not returned	12	12%

Source: Researcher (2024)

4.3 Demographic Information of Respondents

This section presents the demographic profile information collected from respondents in this study, including their age. Gender, experience and position in the organization. This demographic information provide context for the data. Table 4.2 presents a summary of respondents' demographic information.

Table 4.2: Respondents' Demographic Information

		Frequency	Percent
Age category	18-25	6	6.8%
	26-35	31	35.2%

	36-45	36	40.9%
	46-55	15	17.0%
	56-65	0	0.0%
	66 and above	0	0.0%
	Total	88	100.0%
Gender	Male	26	29.5%
	Female	62	70.5%
	Total	88	100.0%
Experience in Years	0-5 years	26	29.5%
	6-10 years	22	25.0%
	11-15 years	28	31.8%
	16-20 years	3	3.4%
	21 years and above	9	10.2%
	Total	88	100.0%
Position in the Company	Owner	0	0.0%
	Director	1	1.1%
	General manager	3	3.4%
	Technical director	0	0.0%
	Head of department/unit	19	21.6%
	Quality control office	10	11.4%
	Business development officer	2	2.3%
	Senior analyst	42	47.7%
	Lab manager	11	12.5%
	Total	88	100.0%

Source: Researcher (2024)

The findings showed that the majority of the respondents were aged 36-45 years (40.9%). Those aged 26-35 years constituted 35.5% of the respondents. Seventeen (17) percent of the respondents were aged 46-55 years while only 6.8% were aged 18-25 years. There were no respondents aged above 56 years,

In terms of gender, the majority of the respondents were female (70.5%) while 29.5% were male. This shows that the sample was predominantly female. Regarding experience, the majority of the respondents indicated an experience of 11-15 years (31.8%), followed by 0-5 years (29.5%), 6-10 years (25%), 21 years and above (10.2%), and lastly 16-20 years (3.4%). With respect to the position of respondents at the company, the majority were senior analysts (47.7%), followed by heads of departments/units (21.6%), lab managers (12.5%), quality control officers (11.4%),

business development officers (2.3%) and directors (1.1%). No owners of analytical laboratories participated in the survey.

4.4 Descriptive Analysis

This section presents a descriptive analysis of the individual statements in the questionnaire relating to the variables being studied.

4.4.1 Descriptive Statistics on Firm-level Determinants

The first objective of this study was to examine the influence of firm-level determinants on innovation adoption by analytical laboratories in Kenya. The firm-level determinants that were examined in this study included firm size, product diversification, firm age, financial capabilities, human capabilities, open innovation strategy, and closed innovation strategy. These determinants were measured using a five-point Likert scale that ranges from one to five. Table 4.3 shows the descriptive statistics for the responses for firm-level determinants.

Table 4.3: Descriptive statistics for Firm-level Determinants

	N	Mean	Standard Deviation
Firm Size	88	2.95	1.715
Number of services/products offered by your firm	88	3.47	1.446
My firm continually works towards developing new products and services rather than continually improving existing ones	88	3.40	1.130
Number of your years your firm has been in operation	88	4.50	1.093
The budget that the firm allocates towards research and development is adequate	88	2.82	1.209
The company generates adequate profits, which enables it adopt new testing techniques and equipment	88	3.40	1.109
Employee are adequately trained and developed in the use of new testing techniques and equipment	88	3.81	1.113
Employees at the company have adequate skills and knowledge to use new testing equipment and techniques	88	3.72	1.114

The company collaborates with external partners such as universities and research institutes to develop new testing techniques and equipment	88	3.11	1.149
The company engaged in joint development with other firms involved in the development of new testing equipment and techniques	88	3.17	1.157
The company collaborates with customers and suppliers – obtaining their ideas and feedback on how to improve analytical testing	88	3.82	1.130
There is an inhouse research and development team at the firm that focuses on improving testing techniques and equipment	88	3.16	1.249
There are internal innovation teams at the company focused on enhancing testing capabilities	88	3.20	1.166
Overall Score for Firm Level Determinants	**88**	**3.4248**	**.64104**

Source: Researcher (2024)

The descriptive statistics revealed that most of the firms surveyed were medium sized (Mean = 2.95, Standard Deviation = 1.715). The number of products/services offered by the companies was reported to be moderate (Mean = 3.47, Standard Deviation = 1.446). The findings also indicate that respondents agreed that their firm continually works towards developing new products and services rather than continually improving existing ones (Mean = 3.4, Standard Deviation = 1.130). In terms of the age of the firm, there was agreement that most firms had existed for 16-20 years (Mean = 4.5, Standard Deviation = 1.093). Respondents disagreed that their firms had adequate budgetary allocation towards research and development (Mean = 2.82, Standard Deviation = 1.209). Respondents also agreed that their company generates adequate profits that make it easy to adopt new testing techniques and equipment (Mean = 3.4, Standard Deviation = 1.109). Respondents were in agreement that employees at their firm are adequately trained and developed to use new testing techniques and equipment (Mean = 3.81, Standard Deviation = 1.113). Additionally, respondents agreed that employees at the company have adequate skills and knowledge to use new testing equipment and techniques (Mean = 3.72, Standard Deviation = 1.114). There was agreement among respondents that their company collaborates with external partners to develop new testing techniques and equipment (Mean = 3.11, Standard deviation = 1.149). Moreover, there was agreement that the firm engaged in joint development with other firms involved in the development of new testing equipment and techniques (Mean = 3.17, Standard Deviation = 1.157). Respondents agreed that their company collaborates with customers and

suppliers (Mean = 3.82, Standard Deviation = 1.130). Respondents also agreed that their firm has an inhouse research and development team that focuses on improving testing techniques and equipment (Mean = 3.16, Standard Deviation = 1.249). Additionally, respondents were in agreement that their firms have an internal innovation team that focuses on enhancing their testing capabilities (M = 3.20, Standard Deviation = 1.166). The overall score for firm-level determinants was 3.4248 (Standard Deviation = 0.64104).

4.4.2 Descriptive Statistics on Industry Level Determinants

The second objective of this study was to examine the influence of industry level determinants on innovation adoption by analytical laboratories in Kenya. The industry-level determinants that were examined in this study were intensity of competition, buyer power, supplier power, entry barriers and threat of substitutes. These determinants were measured using a five-point Likert scale that ranges from one to five. Table 4.4 shows the descriptive statistics for the responses for industry-level determinants.

Table 4.4 Descriptive Statistics on Industry Level Determinants

	N	Mean	Standard Deviation
The number of competitors is high, which means that companies have to implement new testing techniques and equipment to remain competitive	88	3.88	1.153
Our competitors have the ability to cut our market share if we do not adopt new testing methods	88	3.90	1.104
We have a few customers, which means that firm has to implement new testing techniques to retain them	88	2.87	1.182
Our customers are able to negotiate for better deals and terms if we offer them innovative testing services	88	3.45	1.124
The company can easily access testing equipment and technologies (R)	88	2.22	1.119
Testing technologies and equipment are cheap to acquire (R)	88	4.15	.851
The cost of switching testing equipment is low (R)	88	4.11	.863
Entering the analytical testing industry does not need substantial capital (R)	88	4.27	.867

There are few restrictive legal requirements for new businesses in the analytical testing industry (R)	88	3.45	1.193
Our customers can easily switch to our competitors who offer better testing capabilities	88	3.58	1.152
Our customers can develop their own testing capabilities	88	2.89	1.139
Overall Score for Industry Level Determinants	**88**	**3.5248**	**.46594**

Source: Researcher (2024)

Note: Items labelled (R) are reverse-scored.

The descriptive statistics showed that respondents agreed that the number of competitors is high, which compels their firm to implement new testing techniques in order to remain competitive (Mean = 3.88, Standard Deviation = 1.153). Respondents also agreed that their competitors have the ability to undercut their market share if they do not adopt new testing methods (Mean = 3.90, Standard Deviation = 1.104). These findings suggest high intensity of competition in the analytical laboratories sector. Respondents also agreed that they have few customers, which means that their firms have to implement new testing techniques to retain them (M = 2.87, Standard Deviation = 1.182). Respondents also agreed that their customers are able to negotiate for better deals and terms if they offer them innovative testing services (Mean = 3.45, Standard Deviation = 1.124). These results suggest a high buyer power in the analytical laboratories that encourage these firms to adopt innovation.

The descriptive statistics also indicated that respondents disagreed that the firm can easily access testing equipment and technologies (Mean = 2.22, Standard Deviation = 1.119). The respondents disagreed that testing equipment and technologies are cheap to acquire (Mean = 4.15, Standard Deviation = 0.851). Respondents also disagreed that the cost of switching testing equipment is low (Mean = 4.11, Standard Deviation = 0.863). These results suggest a high supplier power in the analytical laboratories sector.

The descriptive statistics also indicated that respondents disagreed that entering the analytical testing industry does not require substantial capital (Mean = 4.27, Standard Deviation = 0.867).

Respondents were neutral that there are few restrictive legal requirements for new businesses in the industry (Mean = 3.45, Standard Deviation = 1.193)

The findings also showed that respondents agreed that their customers can easily switch to their competitors who offer better testing capabilities (Mean = 3.58, Standard Deviation = 1.152). Respondents also agreed that their customers can develop their own testing capabilities (Mean = 2.89, Standard Deviation = 1.139). The overall score for industry level determinants was 3.5248 (Standard Deviation = 0.46594).

4.4.3 Descriptive Statistics on Macroenvironment Level Determinants

The third objective of this study was to examine the influence of macroenvironment level determinants on innovation adoption by analytical laboratories in Kenya. The macroenvironment level determinants that were examined in this study were economic growth, regulatory environment, and sustainability standards. These determinants were measured using a five-point Likert scale that ranges from one to five. Table 4.5 shows the descriptive statistics for the responses for firm-level determinants.

Table 4.5: Descriptive Statistics on Macroenvironment Level Determinants

	N	Mean	Standard Deviation
When the economy is performing well, the firm is capable of implementing new testing techniques and equipment in order to meet the demands of customers	88	3.98	.830
When the economy is performing poorly, the firm has to implement new testing techniques and equipment to survive	88	3.17	1.106
Industry regulations compel us to look for better ways of performing analytical testing	88	3.74	1.000
Industry standards compels the firm to continually search for ways of improving its testing capabilities	88	3.99	.851
Compliance with Sustainability requirements compels the firm to constantly look for ways of improving its testing capabilities	86	3.84	.852
Compliance with environmental regulations requires the company to implement new testing technologies and techniques	87	3.74	.933
Overall Score for Macroenvironment Level Determinants	**88**	**3.7417**	**.64611**

Source: Researcher (2024)

The descriptive statistics show that respondents agreed that their firms implemented new testing techniques and equipment when the economy is performing well in order to meet the demands of customers (Mean = 3.98, Standard Deviation = 0.830). They also agreed that the firm has to implement new testing techniques and equipment when the economy is performing poorly in order to survive (Mean = 3.17, Standard Deviation). These statistics suggest the influence of the economic environment on innovation adoption.

There was agreement among respondents that industry regulations compel their firms to look for better ways of performing analytical testing (Mean = 3.74, Standard Deviation = 1.000). In the same way, respondents were in agreement that industry standards compel their firms to constantly search for ways of improving their testing capabilities (Mean = 3.99, Standard Deviation = 0.851). These findings suggest the potential influence of industry standards on the adoption of innovation by analytical laboratories in Kenya.

The respondents also agreed that compliance with Sustainability requirements compels the firm to constantly look for ways of improving its testing capabilities (Mean = 3.84, Standard Deviation = 0.852). Moreover, there was agreement that compliance with environmental regulations requires the company to implement new testing technologies and techniques (Mean = 3.74, Standard Deviation = 0.933). These results suggest that sustainability requirements potentially influence the adoption of innovation. The overall score for macro-environment level determinants was 3.7417 (Standard Deviation = 0.64611), which suggests that respondents agreed that macroenvironment determinants influence the adoption of innovation.

4.4.4 Descriptive Statistics on Innovation Adoption

The dependent variable for this study was innovation adoption by analytical laboratories in Kenya. The indicators used for innovation adoption were the implementation of new testing equipment and techniques and sustained use of new testing equipment and techniques. These indicators were measured using a five-point Likert scale that ranges from one to five. Table 4.6 shows the descriptive statistics for the responses for firm-level determinants.

Table 4.6: Descriptive Statistics on Innovation Adoption

Descriptive Statistics			
	N	Mean	Standard Deviation
Our company regularly implements new testing equipment and techniques	88	3.52	1.104
Our company continually strives to implement new equipment and testing techniques	88	3.74	1.067
Overall Score for Innovation Adoption	88	3.6307	.98113

Source: Researcher (2024)

The descriptive statistics indicated that respondents agreed that their companies regularly implement new testing equipment and technologies (Mean = 3.52, Standard Deviation = 1.104). The results also showed that respondents agreed that their companies continually strived to implement new equipment and testing techniques (Mean = 3.74, Standard Deviation = 1.067). The overall score for innovation adoption was 3.6307 (Standard Deviation = 0.98113). These results suggest that respondents agreed that their firms adopted innovative testing equipment and techniques.

4.5 Inferential Analysis

Inferential statistics is concerned with making approximations, estimates, generalizations and inferences using data collected from the sample (Bell et al., 2022). Correlation and regressions were the inferential statistics used in this study, which are discussed in the following sections.

4.5.1 Correlation Analysis Results

Correlation analysis is used to determine if a significant relationship exists between two variables. It shows the direction and strength of the relationship between the variables and can be used for forecasting future observations (Bell et al., 2022). The findings of the correlation analysis are shown in Table 4.7.

Table 4.7: Correlations

		Firm Level Determinants	Industry Level Determinants	Macro-environment Level Determinants	Innovation Adoption
Firm Level Determinants	Pearson Correlation	1			
	Sig. (2-tailed)				
Industry Level Determinants	Pearson Correlation	.178	1		
	Sig. (2-tailed)	.098			
Macroenvironment Level Determinants	Pearson Correlation	.441**	.534**	1	
	Sig. (2-tailed)	.000	.000		
Innovation Adoption	Pearson Correlation	.502**	.277**	.475**	1
	Sig. (2-tailed)	.000	.009	.000	

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

Source: Researcher (2024)

Significant associations exist between the variables of this study. A moderate significant positive correlation was found between firm level determinants and innovation adoption (r = 0.502, p = 0.00). This shows that a higher score for firm level determinants is associated with a higher adoption of innovation in analytical laboratories. A weak significant positive correlation was found between industry level determinants and innovation adoption (r = 0.277, p = 0.009), which suggests that a higher score for industry level determinants was associated with a high adoption of innovation in analytical laboratories in the country. A significant moderate positive correlation was found between macro-environment determinants and the adoption of innovation (r = 0.475, r = 0.00). This suggests that a higher score of macroenvironment factors was associated with a higher adoption of innovation.

In addition, inter-relationships were found amongst the independent variables. The results show that a weak positive relationship between firm-level determinants and industry level determinants; however, this relationship was not statistically significant (r = 0.178, p > 0.05). A significant moderate positive relationship was found between macro-environment determinants and firm level determinants (r = 0.441, p = 0.00). A similar significant moderate positive association was found

between macroenvironment determinants and industry level determinants (r = 0.534, p = 0.00). These findings show that the independent variables are independent.

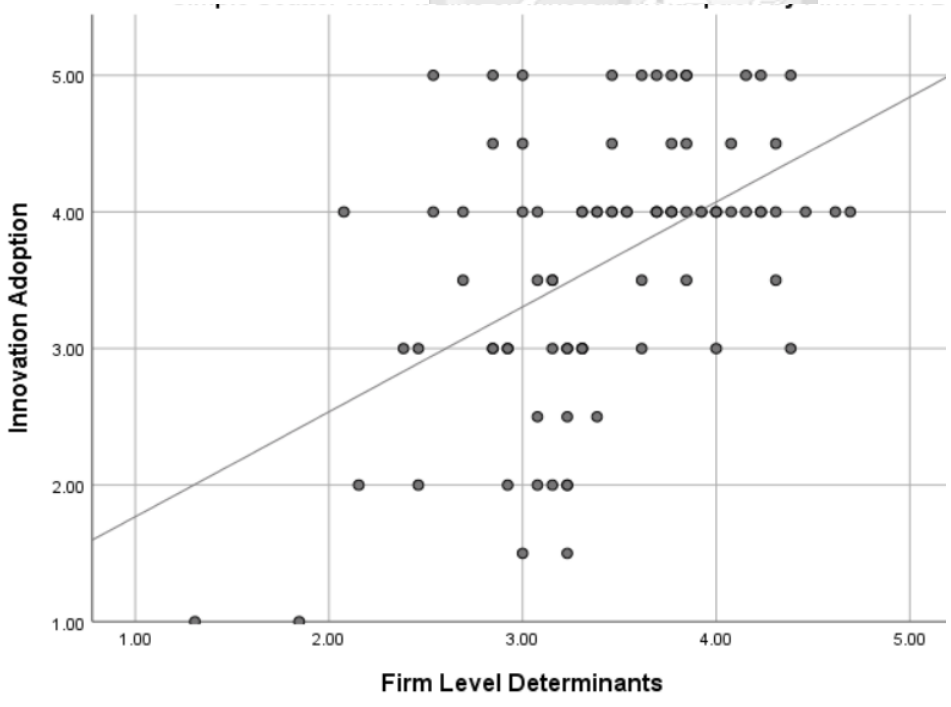
4.5.2 Regression Analysis

Regression was carried to model the relationship between the independent and dependent variables. This section presents the diagnostics for regression to determine if the collected data met the required assumptions for analysis. Next the regression analysis is conducted between each independent and dependent variable separately and then between the independent and dependent variables in one model.

4.5.2.1 Diagnostics for Regression

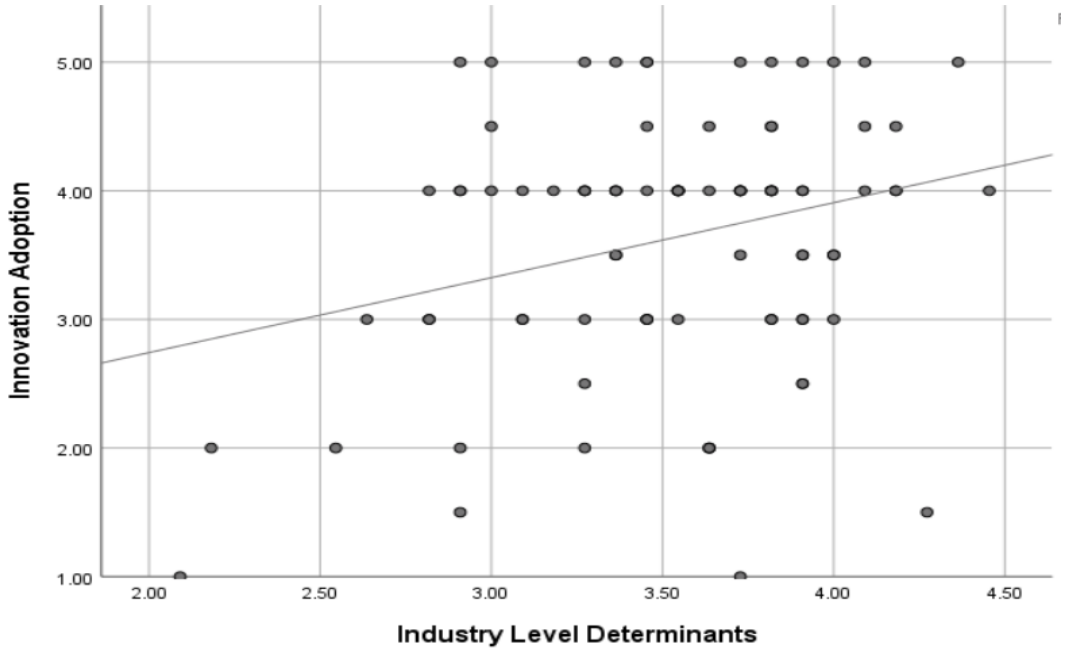
The first assumption needed for regression is that a linear relationship should exist between each of the independent variables and the dependent variable. This can be established by creating scatter plots and visually inspecting them to establish linearity. A visual inspection of the scatter plots affirms the linear relationship between the variables as indicated in Figures 4.1-4.3.

Figure 4.1: Scatter Plot – Innovation Adoption by Firm Level Determinants



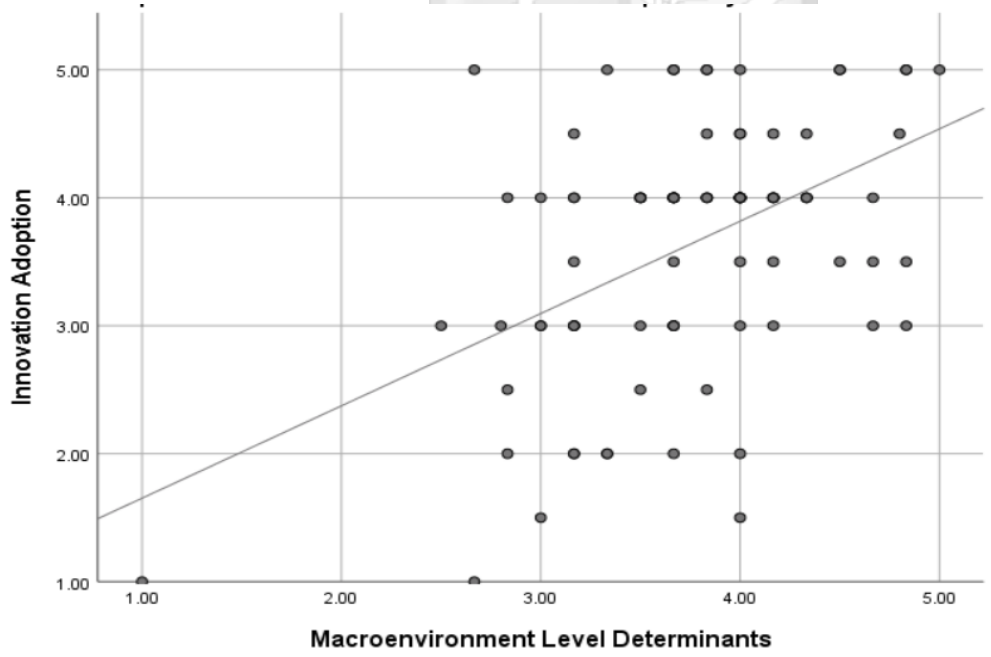
Source: Researcher (2024)

Figure 4.2: Scatter Plot – Innovation Adoption by Industry Level Determinants



Source: Researcher (2024)

Figure 4.3: Scatter Plot – Innovation Adoption by Macroenvironment Level Determinants



Source: Researcher (2024)

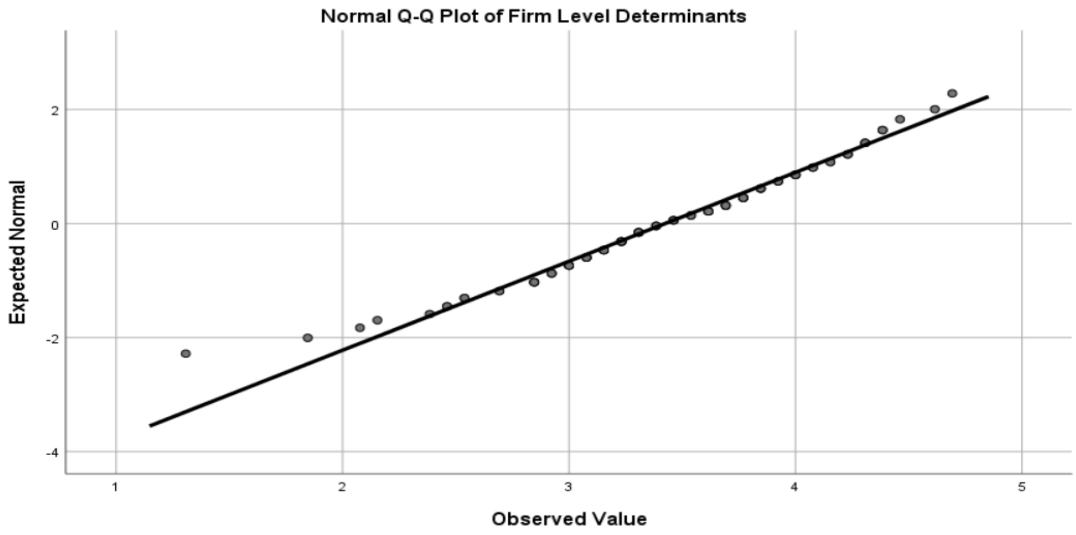
The second important assumption that must be met for regression to be performed is normality. Variables should be distributed normally, which can be tested using the Shapiro-Wilk test such that a significance value that is greater than 0.05 indicates that the data is normal. Additionally, normal Q-Q plots can be used to assess the normality of data visually. In a normally distributed data, points are close to the diagonal line, as shown in Figures 4.4-4.7.

Table 4.8: Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Firm Level Determinants	.059	88	.200	.980	88	.189
Industry Level Determinants	.100	88	.030	.967	88	.125
Macroenvironment Level Determinants	.113	88	.008	.950	88	.202
Innovation Adoption	.238	88	.000	.909	88	.177

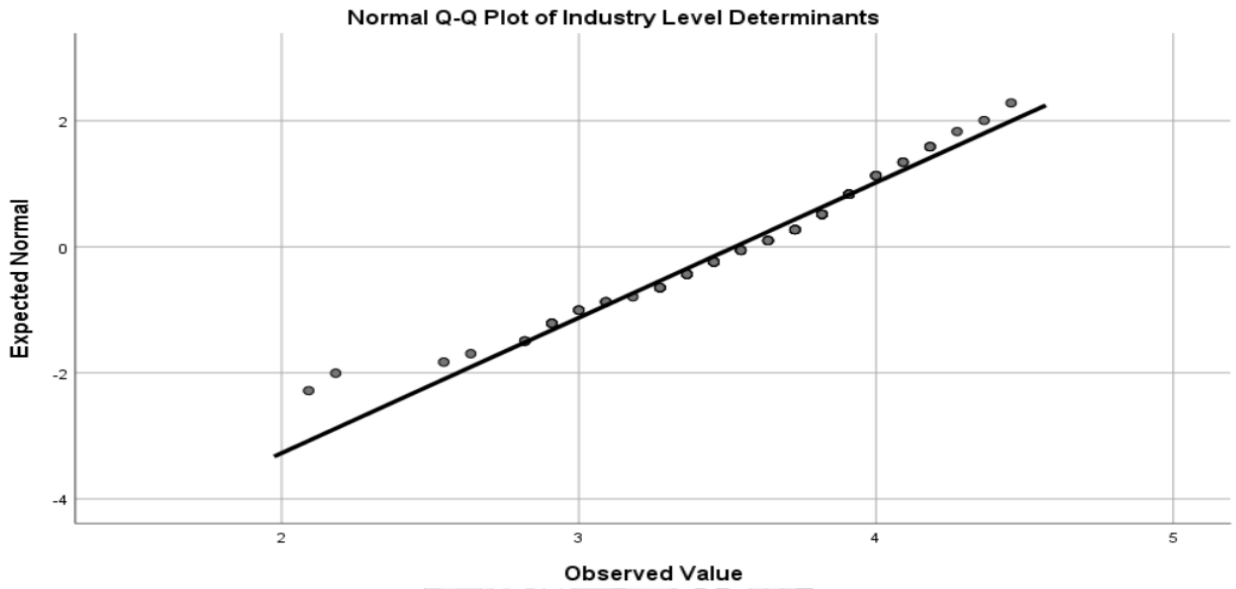
Source: Researcher (2024)

Figure 4.4: Normal Q-Q Plot for Firm-level Determinants



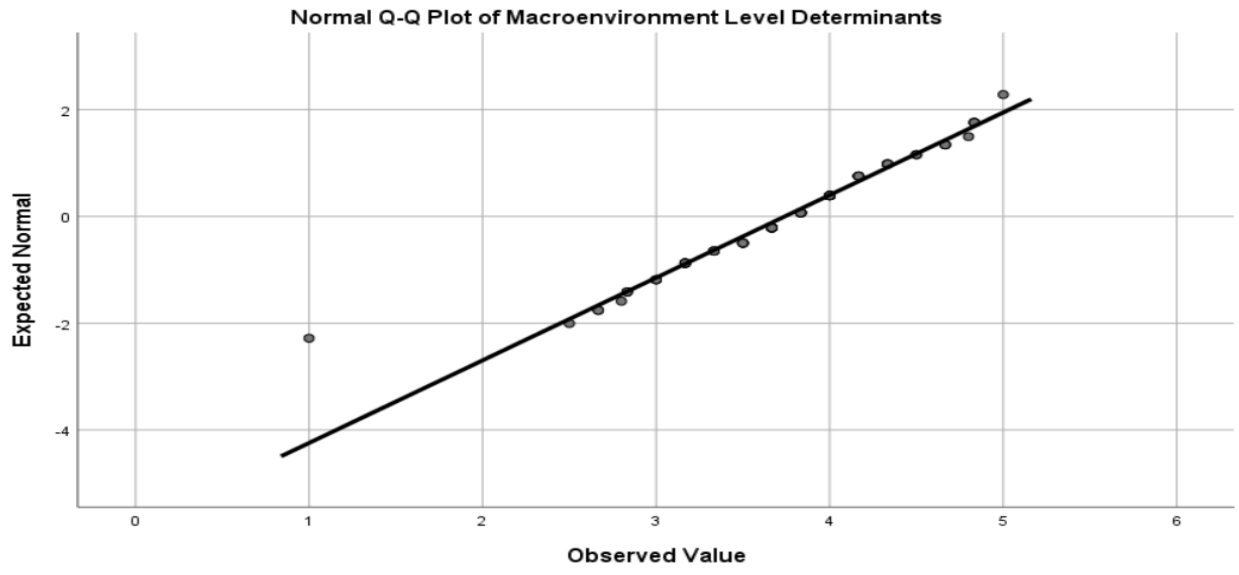
Source: Researcher (2024)

Figure 4.5: Normal Q-Q plots for Industry Level Determinants



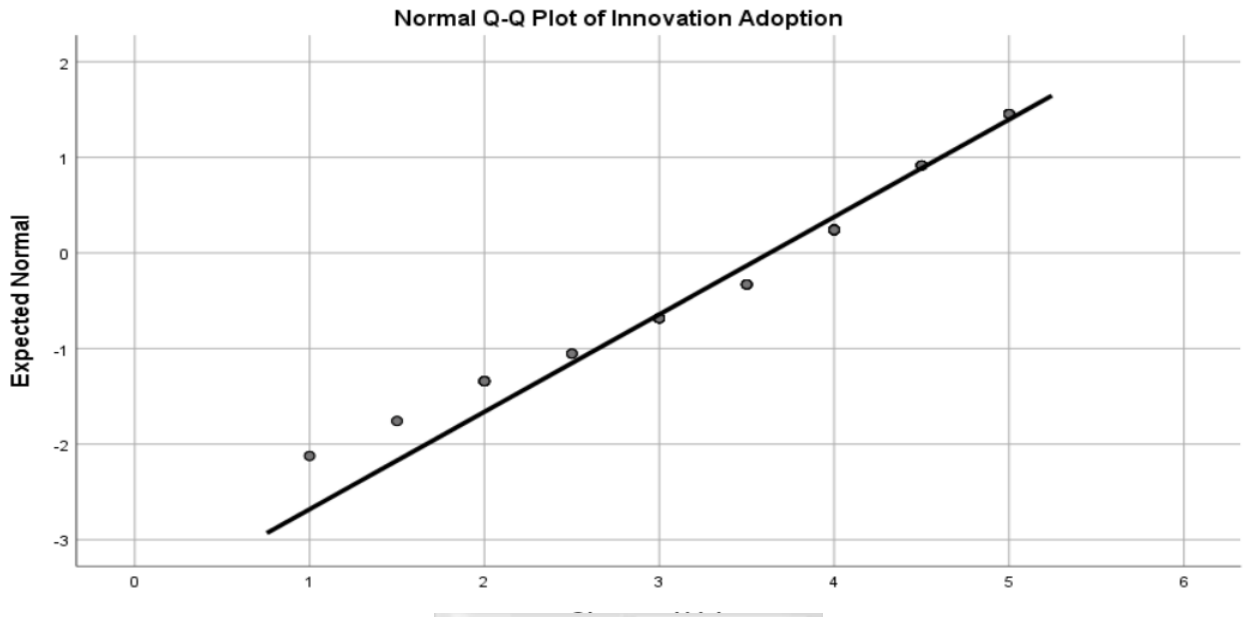
Source: Researcher (2024)

Figure 4.6: Normal Q-Q plot for Macroenvironment Determinants



Source: Researcher (2024)

Figure 4.7: Normal Q-Q plots for Innovation Adoption



Source: Researcher (2024)

Another important assumption that must be met for regression analysis is the independence of observations. This assumption holds that participants should be independent of each other in the analysis, which means that they are only counted once rather than using repeated measures. There is no statistical way of testing for independence of observations; instead, it is an issue of the study design. In this research, each participant was surveyed once. Overall, the data met all the diagnostic tests required for performing regression analysis. Therefore, further analysis was conducted.

4.5.2.2 Regression between Firm Level Determinants and Innovation Adoption

A regression analysis was conducted to examine the relationship between firm level determinants and the innovation adoption in analytical laboratories. Table 4.9 presents a summary of the regression findings.

Table 4.9: Regression Summary for Firm Level Determinants and Innovation Adoption

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.502[a]	.252	.243	.85355

Predictors: (Constant), Firm Level Determinants
Dependent Variable: Innovation Adoption

Source: Researcher (2024)

The regression results indicated an R square of 0.252, which suggests that firm level determinants explain 25.2% of the change in innovation adoption in analytical laboratories with the remaining 74.8% attributed to other factors that were not accounted for in the model. Table 4.10 presents the analysis of variance results.

Table 4.10: ANOVA Summary – Firm level determinants and Innovation Adoption

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.093	1	21.093	28.952	.000
	Residual	62.655	86	.729		
	Total	83.747	87			

Dependent Variable: Innovation Adoption
Predictors: (Constant), Firm Level Determinants

Source: Researcher (2024)

The ANOVA results shown in Table 4.10 indicate that the F-statistic value was 28.952 with a p-value of 0.000 ($F(1, 86) = 28.952$, $p < 0.05$). This indicates that the model was significant in explaining the association between firm level determinants and innovation adoption in analytical laboratories in Kenya. Regression coefficient results are shown in Table 4.11.

Table 4.11: Regression Coefficient – Firm level determinants and Innovation Adoption

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.000	.497		2.011	.047
	Firm Level Determinants	.768	.143	.502	5.381	.000

a. Dependent Variable: Innovation Adoption

Source: Researcher (2024)

$$y = 1.0 + 0.768x_1$$

The regression coefficients reveal a positive and significant relationship between firm level determinants and the innovation adoption (β= 0.768, p value- < 0.05). This shows that for unit change in firm level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.768.

4.5.2.3 Regression between Industry Level Determinants and Innovation Adoption

A regression analysis was conducted to examine the relationship between industry level determinants and the innovation adoption in analytical laboratories. Table 4.12 presents a summary of the regression findings.

Table 4.12: Regression Summary for Industry Level Determinants and Innovation Adoption

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.277[a]	.077	.066	.94825

Dependent Variable: Innovation Adoption
Predictors: (Constant), Industry Level Determinants

Source: Researcher (2024)

The regression results indicated an R square of 0.077, which suggests that industry level determinants explain 7.7% of the change in innovation adoption in analytical laboratories with the remaining 92.3% attributed to other factors that were not accounted for in the model. Table 4.13 presents the analysis of variance results.

Table 4.13: ANOVA Summary – Industry level determinants and Innovation Adoption

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.418	1	6.418	28.952	.009
	Residual	77.329	86	.729		
	Total	83.747	87			

a. Dependent Variable: Innovation Adoption
b. Predictors: (Constant), Industry Level Determinants

Source: Researcher (2024)

The ANOVA results shown in Table 4.14 indicate that the F-statistic value was 7.138 with a p-value of 0.000 (F (1, 86) = 7.138, p < 0.05). This indicates that the model was significant in explaining the association between industry level determinants and innovation adoption in analytical laboratories in Kenya. Regression coefficient results are shown in Table 4.14.

Table 4.14: Regression Coefficient – Industry level determinants and Innovation Adoption

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.576	.776		2.032	.045
	Industry Level Determinants	.583	.218	.277	2.672	.009

a. Dependent Variable: Innovation Adoption

Source: Researcher (2024)

$$y = 1.576 + 0.583x_2$$

The regression coefficients reveal a positive and significant relationship between industry level determinants and the innovation adoption (β= 0.583, p value- < 0.05). This shows that for unit change in industry level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.583.

4.5.2.4 Regression Between Macroenvironment Determinants and Innovation Adoption

A regression analysis was conducted to examine the relationship between macroenvironment level determinants and the innovation adoption in analytical laboratories. Table 4.15 presents a summary of the regression findings.

Table 4.15: Regression Summary for Macroenvironment Level Determinants and Innovation Adoption

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.475	.226	.217	.86831

Dependent Variable: Innovation Adoption
Predictors: (Constant), Macroenvironment Level Determinants

Source: Researcher (2024)

The regression results indicated an R square of 0.226, which suggests that macroenvironment level determinants explain 22.6% of the change in innovation adoption in analytical laboratories with the remaining 77.4% attributed to other factors that were not accounted for in the model. Table 4.16 presents the analysis of variance results.

Table 4.16: ANOVA Summary – Macroenvironment level determinants and Innovation Adoption

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.907	1	18.907	25.076	.000
	Residual	64.840	86	.729		
	Total	83.747	87			

a. Dependent Variable: Innovation Adoption
b. Predictors: (Constant), Macroenvironment Level Determinants

Source: Researcher (2024)

The ANOVA results shown in Table 4.16 indicate that the F-statistic value was 25.076 with a p-value of 0.000 ($F(1, 86) = 25.076$, $p < 0.05$). This indicates that the model was significant in explaining the association between macroenvironment level determinants and innovation adoption in analytical laboratories in Kenya. Regression coefficient results are shown in Table 4.17.

Table 4.17: Regression Coefficient – Macroenvironment level determinants and Innovation Adoption

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.931	.547		1.702	.092
	Industry Level Determinants	.722	.144	.475	5.008	.000

a. Dependent Variable: Innovation Adoption

Source: Researcher (2024)

$$y = 0.722x_3$$

The regression coefficients reveal a positive and significant relationship between industry level determinants and the innovation adoption ($\beta = 0.722$, p value- < 0.05). This shows that for unit change in macroenvironment level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.722.

4.5.2.5 Multiple Regression Analysis

Regression analysis was used to determine the relationship between the dependent variable (innovation adoption) and the independent variables (firm level determinants, industry level determinants and macro environment level determinants). Table 4.18 presents a summary of the regression findings.

Table 4.18: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.578	.335	.311	.81449

Dependent Variable: Innovation Adoption
Predictors: (Constant), Firm Level Determinants, Industry Level Determinants, and Macroenvironment Level Determinants

Source: Researcher (2024)

The findings in Table 4.18 indicate an R-square value of 0.335, which suggests that 33.5% of the variance in the dependent variable (innovation adoption) can be explained using the independent variables included in the model (Firm Level Determinants, Industry Level Determinants and Macroenvironment Level Determinants). The R-square value suggests that the model has a good fit – an R-square of at least 0.25 is considered acceptable (Bell et al., 2022). The remaining 66.5% of the variance in innovation adoption in analytical laboratories in Kenya can be explained by other factors that were not factored in the current regression model. In sum, the regression model indicates that firm level determinants, industry level determinants and macro-environment determinants are strong predictors of innovation adoption in analytical laboratories in Kenya. Table 4.19 shows the analysis of variance results.

Table 4.19: ANOVA Summary for the Regression Model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28.022	3	9.341	14.080	.000
	Residual	55.725	84	.663		
	Total	83.747	87			

a. Dependent Variable: Innovation Adoption

b. Predictors: (Constant), Firm Level Determinants, Industry Level Determinants, Macroenvironment Level Determinants

Source: Researcher (2024)

The ANOVA results shown in Table 4.16 indicate that the F-statistic value was 14.080 with a p-value of 0.000 ($F(3, 84) = 14.080$, $p < 0.05$). This indicates that the model was significant in explaining the association between dependent variable and the predictors. Regression coefficient results are shown in Table 4.20. Collinearity diagnostics indicated that multicollinearity is not a problem in the model, which was used using variance inflation factor (VIF). According to Hair et al. (2019), a VIF value of 1-5 shows moderate correlation between the predictor variables, which does not need further attention. VIF values that are >5 show severe correlation between predictor variables included in the model, which can make the p-values and the estimated coefficients unreliable. The finding in Table 4.20 shows that the VIF values for all predictor variables are within the range of 1-5.

Table 4.20: Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.346	.756		-.458	.648		
	Firm Level Determinants	.562	.152	.367	3.694	.000	.801	1.248
	Industry Level Determinants	.130	.222	.062	.586	.023	.710	1.408
	Macroenvironment Level Determinants	.425	.176	.280	2.420	.018	.591	1.692

a. Dependent Variable: Innovation Adoption

Source: Researcher (2024)

Therefore, the regression model became:

$$y = 0.562x_1 + 0.130x_2 + 0.425x_3$$

Where

y = Innovation Adoption

x_1 = Firm Level Determinants

x_2 = Industry Level Determinants

x_3 = Macroenvironment Level Determinants

The findings in Table 4.20 shows multiple regression coefficients examining the associations between the predictors (firm level determinants, industry level determinants and macro-environment determinants) and innovation adoption in analytical laboratories in Kenya. The results revealed a constant value of -0.346, however, it was not statistically significant ($p > 0.05$); hence, was excluded from the final model.

The findings also indicated a significant positive relationship between firm level determinants and innovation adoption in analytical laboratories in Kenya ($\beta = 0.562$, $p < 0.05$). This shows that for unit change in firm level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.562. This finding suggests that enhancing firm-level determinants can improve the adoption of innovation in analytical laboratories.

The findings also demonstrated a significant positive relationship between industry level determinants and innovation adoption in analytical laboratories in Kenya ($\beta = 0.130$, $p < 0.05$). This shows that for unit change in industry level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.130. This finding suggests that enhancing industry level determinants can improve the adoption of innovation in analytical laboratories.

The findings also reported a significant positive relationship between macroenvironment level determinants and innovation adoption in analytical laboratories in Kenya ($\beta = 0.425$, $p < 0.05$). This shows that for unit change in macroenvironment level determinants, there will be an expected unit change in innovation adoption by analytical laboratories in Kenya by 0.425. This finding suggests that enhancing macroenvironment determinants can enhance the adoption of innovation in analytical laboratories.

4.6 Chapter Summary

This chapter had presented the findings of this study. A response rate of 88% was achieved. The correlation analysis showed that firm-level determinants, industry level determinants and macroenvironment determinants were positively related to innovation adoption in analytical laboratories in Kenya. The regression model was a good fit with predictors explaining 33.5% of the variation in the dependent variable. The regression model also indicated significant positive relationships between innovation adoption, and firm level determinants, industry level determinants and macroenvironment determinants.

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes and discusses the major findings of this study. This chapter also discusses the policy, managerial and theoretical recommendations. In addition, a discussion of the study's limitations is provided as well as the recommendations for future studies.

5.2 Discussion of Findings

This section discusses the findings of the study with respect to the specific objectives of this study.

5.2.1 Firm-level Determinants and Innovation Adoption

The first objective of this study sought to examine the influence of firm-level determinants on innovation adoption in analytical laboratories in Kenya. The firm-level determinants that were studied included firm size, product diversification, firm age, financial capabilities, human capabilities and innovation strategy. The findings from this study showed that firm-level factors have a significant positive influence on innovation adoption in analytical laboratories in Kenya as evidenced by a positive regression coefficient ($\beta = 0.562$, $p < 0.05$). These results suggest that firm-level determinants had a positive effect on innovation adoption. These findings imply that innovation adoption was higher in large firms, those with high product diversification, those that focus on continually developing new products/services rather than improving existing ones, older firms, those with high financial and human capabilities, and those pursuing open and closed innovation strategies. This finding validates the propositions of TAM and Open versus Closed Innovation Model. Based on TAM, organizational, or adopter characteristics, such as size, structure and innovativeness, influence the perceived usefulness and ease of use, which in turn can determine the adoption decision.

The positive influence of firm-level determinants reported in this study is also consistent with past studies. Naranjo-Valencia et al. (2017) provided evidence indicating a positive relationship between firm size and innovation behavior, suggesting that larger firms have a higher likelihood of pursuing innovation compared to small firms. Guo et al. (2018) reported that firms pursuing a product differentiation strategy by continually improving its existing products had higher R&D spending compared to those pursuing product diversification and cost leadership strategies; as a

result, these firms had a higher innovation intensity. Bouncken et al. (2018) reported a positive association between the age of firms and innovation adoption. Bhattacharya et al. (2021) further observed a positive relationship between firms' capital flows (equity or debt) innovation output – this relationship was mediated RD budget allocations. Nasiri et al. (2020) reported a positive association between digital related human capabilities/skills and knowledge and the adoption of digital innovations in SMEs. The positive impact of open innovation strategies was also reported by Lu et al. (2021), who reported a positive relationship between open innovation and innovation performance. The findings of the present study are consistent with findings in past studies.

5.2.2 Industry-level Determinants and Innovation Adoption

The second objective of the study was to examine the influence of industry-level determinants on innovation adoption in analytical laboratories in Kenya. The industry level determinants that were examined in this study included intensity of competition, buyer power, supplier power, entry barriers, and threat of substitutes. The findings suggested that high innovation adoption was associated with high intensity of competition, high buyer power, high supplier power, high threat of substitutes and low entry barriers as shown by a positive regression coefficient ($\beta = 0.130$, $p < 0.05$). These findings indicate that industry-level determinants positively influenced innovation adoption. These results indicate that industry level determinants had a positive effect on innovation adoption. These findings are consistent with the Open versus Innovation Theory, which holds that firms can pursue innovation by collaborating with external partners, such as customers and suppliers (Bigliardi et al., 2020).

The findings of this study showing the positive influence of industry-level determinants on innovation adoption is consistent with the findings of past research studies. Aghion et al. (2018) reported that increased competition resulted in a significant increase in R&D investments, which was used as a proxy for measuring innovation. Krolikowski and Yuan (2017) reported that a concentrated customer base incentivizes suppliers to increase their R&D investments and become more innovative. Caballero-Morales (2021) observed that firms operating in industries where suppliers are few and large tend to be more innovative in comparison to those having many small suppliers where switching costs are low. In industries where entry barriers are strong, Lee (2019) observed that innovation often tends to be low compared to industries where entry barriers are minimal. Bruijl (2018) also identified the threat of substitutes as a driver for innovation. Overall,

the findings of this study support the significant influence of industry level determinants on innovation adoption.

5.2.3 Macroenvironment Determinants and Innovation Adoption

The third objective of this study was to examine the influence of macroenvironment determinants on innovation adoption in analytical laboratories in Kenya. The macroenvironment determinants that were examined in this study included economic growth, regulatory environment and sustainability standards, which were found to have a positive influence on innovation adoption in analytical laboratories as evidenced by a positive regression coefficient ($\beta = 0.425$, $p < 0.05$), suggesting the positive effect of macro-environment determinants on innovation adoption. This finding validates TAM, which posits that external variables can affect the adoption of innovation.

The findings of this study were also similar to past studies on innovation adoption. Argente et al. (2018) observed that more innovative product development occurs during economic boom than during economic recession. Zhong (2018) reported a bi-directional relationship between economic firm innovation and economic growth; hence, innovation drives economic growth and vice versa. Shao et al. (2020) revealed environmental regulations had a positive impact on firm innovation behavior. In the same vein, Dechezleprêtre and Sato (2017) provided empirical evidence to show that regulations induce firm innovation. Sustainability standards and laws compel businesses to look for ways achieving environment-friendly processes, which in turn drives innovation activity in firms. Compliance with regulations has also been reported as a driver for firm-level innovation (Tomizawa et al., 2020). Altenburg and Pegels (2017) reported that the green transformation has been a key driver of firm innovation, especially with respect to the development of eco-friendly products and services. Overall, the findings from the present study and prior literature suggest that the macroenvironment is an important factor that influences innovation

5.3 Conclusions

The findings of this study showed that firm level, industry level and macroenvironment determinants had a significant positive influence on innovation adoption in analytical laboratories in Kenya. First, the findings suggested that firm level determinants have a positive influence on innovation adoption in analytical laboratories in Kenya. These findings imply that innovation adoption was higher in large firms, those with high product diversification, those that focus on

continually developing new products/services rather than improving existing ones, older firms, those with high financial and human capabilities, and those pursuing open and closed innovation strategies. This finding suggests that enhancing firm-level determinants can improve the adoption of innovation in analytical laboratories

Secondly, the results showed that industry level determinants have a positive influence on innovation adoption in analytical laboratories in Kenya. The findings suggested that high innovation adoption was associated with high intensity of competition, high buyer power, high supplier power, high threat of substitutes and low entry barriers. This finding suggests that enhancing industry level determinants can improve the adoption of innovation in analytical laboratories.

Lastly, the results showed that macro-environment determinants have a positive influence on innovation adoption in analytical laboratories in Kenya. Economic growth, regulatory environment and sustainability standards were found to have a positive influence on innovation adoption in analytical laboratories. This finding suggests that enhancing macroenvironment determinants can enhance the adoption of innovation in analytical laboratories.

5.4 Recommendations

5.4.1 Policy Recommendations

The findings from the study provide valuable insights that can help policymakers formulate policies to improve innovation adoption in analytical laboratories. First, the study shows that industry regulations, as part of the macroenvironment, compels analytical laboratories to become innovative. Therefore, the recommendation for policymakers is to strengthen strengthen the macro-environment by implementing industry regulations and standards for analytical laboratories as a strategy for encouraging innovation. Policymakers need to increase industry standards as a way of compelling analytical laboratories to compel analytical firms to become innovative. Industry standards refer to voluntary standards that can be used to establish requirements for practices, products and operations in the sector. For instance, policymakers can encourage analytical laboratories in the country to consider adopting ISO standards. Formulating sustainability standards and environmental regulations can also help analytical laboratories to become innovative. Formulation of industry standards and regulations alone is not enough, there

is need to ensure compliance. This study has shown that compliance compels analytical laboratories to constantly look for ways of improving their processes and implementing new testing technologies and techniques.

5.4.2 Managerial Recommendations

The findings of this study also have important managerial implications, especially with respect to strategies that can be adopted to strengthen firm-level and industry-level determinants of innovation. First, managers of analytical laboratories in Kenya should embrace innovation as a competitive strategy. The findings show that the industry is extremely competitive and has few customers who are capable of developing their own testing capabilities and can switch easily; as a result, these companies need to be innovative to remain competitive. Secondly, managers of analytical laboratories need to enhance their firm-level determinants by increasing their internal capacity for innovation, which can be achieved through increasing their financial and human capacity for innovation. Additionally, analytical laboratories need to constantly monitor innovation in their competitors as well as changes in the regulatory and economic environment and respond appropriately using innovation.

5.4.3 Theoretical Recommendations

This study contributes to the TAM theory by supporting the influence of firm-level, industry-level and macro-environment determinants on the adoption of innovation. The findings from this theory can be used to extend and refine TAM by outlining additional external variables that might influence innovation adoption. In addition, the findings from this study also lend support to the open versus closed innovation by highlighting the important role played by internal innovation teams and research and development as well as external partnerships in fostering innovation. The findings support open innovation strategy - this approach to innovation is grounded on collaboration between the firm and external partners, such as customers, suppliers, research institutes, universities, and sometimes competitors. The findings also support the closed innovation model, which is dependent on internal resources and knowledge, such as R&D, to develop proprietary solutions that are protected using intellectual property rights in order to remain competitive. Thus, pursuing a dual approach to innovation that incorporates both open and closed innovation strategies can maximize the innovative capacity of analytical laboratories in Kenya.

This study also adds to the existing body of knowledge by examining the influence of firm level, industry level, and macroenvironment determinants on innovation adoption. This study provided findings that supported the findings of previous studies on innovation adoption. The study covered factors in analytical laboratories' internal and external environment to provide a better understanding of how these companies can drive innovation adoption.

5.5 Study Limitations and Suggestions for Further Research

This study had methodological limitations associated with the use of the descriptive cross-sectional research design. This design cannot be used to establish cause and effect associations. In addition, respondents might give socially desirable answers and may not be truthful. As a result, future studies can consider using other designs, such as causal comparative designs using secondary data to compare innovation adoption across firms in order to establish cause and effect relationships.

Another limitation of this study is that it focused only on analytical laboratories. As a result, future research could consider exploring innovation adoption in the entire laboratories sector by studying the diagnostic laboratory service sector, and medical and clinical laboratories sectors.

Future research studies could explore innovation adoption in other sectors in Kenya, such as financial services and manufacturing, which are extremely dependent on innovation for effectiveness. Another limitation of this study is that the dependent variables (firm level, industry level and macro-environment level determinants) only explained 33.5% of the variance in innovation in analytical laboratories. As a result, there is a need to study other factors that were not accounted for in this study. Future studies can use an expanded model that also accounts for socio-economic, cultural and technological factors. Additionally, future studies can also consider using a qualitative approach to provide in-depth contextual data on the determinants of innovation in analytical laboratories.

5.6 Chapter Summary

This chapter has concluded the research by discussing the major findings and presenting the contribution of the research to practice and research. The limitations of the study have also been discussed as well as the suggestions for future research.

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APPENDICES

Appendix I: Letter of Introduction

You are being invited to take part in a research study titled, "Determinants of Innovation Adoption by Analytical Laboratories in Kenya." This research is being conducted by Dan Robert Okwaro of Strathmore University, (Email address: dan.okwaro@strathmore.edu, Phone Number: 0723785181)

The aim of this research is to examine the determinants of adoption of innovation by analytical laboratories in Kenya. Your participation will help towards a better understanding of how analytical laboratories can become innovative. You are free to contact the researcher at the provided email address or phone number to discuss any detail regarding the study. You must be at least 18 years old to participate.

If you agree to participate, you will be required to fill in a questionnaire for about 10-15 minutes. You will provide information about your demographic details, such as age, gender and your position at the company. You will also provide information on characteristics of your company, industry and the macro-economic environment in which your company operates. You will not receive any compensation.

Your decision to participate is completely voluntary. You are not required to answer all the questions and will not be penalized if you choose to cease participation or refuse to answer any or all the questions.

If you have any questions regarding the research, contact the researcher, Dan Robert Okwaro at 0723785181 or send an email to dan.okwaro@strathmore.edu

Appendix II: Ethical Approval and NACOSTI Research License

Strathmore UNIVERSITY

29th January 2024

Mr Okwaro Dan,
dan.okwaro@strathmore.edu

Dear Mr Okwaro,

RE: Determinants of Innovation Adoption by Analytical Laboratories in Kenya

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU-masters** research proposal. Your application reference number is **SU-ISERC1987/24.** The approval period is from **29th January 2024 to 28th January 2025.**
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

STRATHMORE UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICAL REVIEW COMMITTEE
(SU-ISERC)
30-Jan-2024
Email:ethicsreview@strathmore.edu
P.O BOX 59857-00200
NAIROBI-KENYA

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **745470**

Date of Issue: **07/February/2024**

RESEARCH LICENSE

This is to Certify that Mr.. DAN ROBERT OKWARO 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: DETERMINNATS OF INNOVATION ADOPTION BY ANALYTICAL LABORATORIES IN KENYA for the period ending : 07/February/2025.

License No: **NACOSTI/P/24/32917**

745470

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

Appendix III: Research Questionnaire

Section A: Basic demographic Information (Please tick/mark your answer in the corresponding box)

1. Please state you age category.

18-25	
26-35	
36-45	
46-55	
56-65	
66 and above	

2. Please state your gender

Male	
Female	

3. Please indicate your experience in years working for your company.

0-5 years	
6-10 years	
11-15 years	
16-20 years	
21 + years	

4. Please state your position in the company

Owner	
Director	
General manager	
Technical director	
Head of department/unit	
Quality control office	
Business development officer	
Senior analyst	
Lab manager	

Section B: Firm-level Determinants

Firm Size

5. Please indicate size of your company in terms of the number of employees (Please tick/mark your answer in the corresponding box)

Small (10-49 employees)	
Medium (50-249 employees)	
Large (250+ employees)	

Product diversification

6. Please indicate the level of service/product diversification in your firm. Product diversification refers to the number of services/products offered by your firm). (Please tick appropriate box)

1 – very low (less than 10 services/products)	
2 – low (11-20 products/services)	
3 – moderate (21-30 products/services)	
4 – high (31-40 products/services	
5 – very high (more than 40 products/services	

7. To what extent do you agree with the following statement: my firm continually works towards developing new products and services rather than continually improving existing ones. (please mark the appropriate box)

Strongly disagree	
disagree	
Neither	
Agree	
Strongly agree	

Firm age

8. Please indicate the number of your years your firm has been in operation (Please mark the appropriate box)

1	0-5 years	
2	6-10 years	

3	11-15 years	
4	16-10 years	
5	21+ years	

Financial Capabilities

To what extent do you agree with the following statements about the financial capability of your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
9. The budget that the firm allocates towards research and development is adequate					
10. The company generates adequate profits, which enables it adopt new testing techniques and equipment					

Human Capabilities

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
11. Employee are adequately trained and developed in the use of new testing techniques and equipment					
12. Employees at the company have adequate skills and knowledge to use new testing equipment and techniques					

Open Innovation strategy

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
13. The company collaborates with external partners such as universities and research institutes to develop new testing techniques and equipment					
14. The company engaged in joint development with other firms involved in the development of new testing equipment and techniques					
15. The company collaborates with customers and suppliers – obtaining their ideas and feedback on how to improve analytical testing					

Closed Innovation Strategy

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
16. There is an inhouse research and development team at the firm that focuses on improving testing techniques and equipment					
17. There are internal innovation teams at the company focused on enhancing testing capabilities					

Section C: Industry Level Determinants

Intensity of Competition

To what extent do you agree with the following statements about your industry. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
18. The number of competitors is high, which means that companies have to implement new testing techniques and equipment to remain competitive					
19. Our competitors have the ability to cut our market share if we do not adopt new testing methods					

Buyer Power

To what extent do you agree with the following statements about your customers. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
20. We have a few customers, which means that firm has to implement new testing techniques to retain them					
21. Our customers are able to negotiate for better deals and terms if we offer them innovative testing services					

Supplier Power

To what extent do you agree with the following statements about your suppliers. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
22. The company can easily access testing equipment and technologies					
23. Testing technologies and equipment are cheap to acquire					
24. The cost of switching testing equipment is low					

Entry Barriers

To what extent do you agree with the following statements about your industry. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
25. Entering the analytical testing industry does not need substantial capital					
26. There are few restrictive legal requirements for new businesses in the analytical testing industry					

Threats of Substitutes

To what extent do you agree with the following statements about your customers. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
27. Our customers can easily switch to our competitors who offer better testing capabilities					
28. Our customers can develop their own testing capabilities					

Section D: Macroenvironment Determinants

Economic Growth

To what extent do you agree with the following statements about your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
29.When the economy is performing well, the firm is capable of implementing new testing techniques and equipment in order to meet the demands of customers					
30. When the economy is performing poorly, the firm has to implement new testing techniques and equipment to survive					

Regulatory Environment

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
32. Industry regulations compel us to look for better ways of performing analytical testing					
33. Industry standards compels the firm to continually search for ways of improving its testing capabilities					

Sustainability standards

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
34. Compliance with Sustainability requirements compels the firm to constantly look for ways of improving its testing capabilities					
35. Compliance with environmental regulations requires the company to implement new testing technologies and techniques					

Section 5: Innovation Adoption

To what extent do you agree with the following statements about innovation in your firm. (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

	1	2	3	4	5
36. Our company regularly implements new testing equipment and techniques					
34. Our company continually strives to implement new equipment and testing techniques					

Appendix IV: List of Analytical Laboratories in Kenya

1. Analabs Limited
2. SGS Kenya Limited
3. EUROLAB Services Ltd
4. Aquatreat Solutions Ltd
5. CSI International Ltd
6. Lab Works (Ea) Ltd
7. Angie Aqua Solutions Ltd
8. Aqualytic Laboratories Ltd
9. Spectralab Analytical Services Ltd
10. Lake Victoria South Water Service Board
11. Precision Experts Limited Laboratory
12. Bureau Veritas Laboratory
13. GMP Services Ltd
14. Ecoserv Consultants Laboratory
15. Ivory Consult Ltd
16. Aquatech Industries Ltd
17. Eldoret Water and Sanitation Company Ltd
18. Intertek Testing Services (EA) PTY Ltd
19. Saosa Tea Factory Laboratory James Finlay (Kenya) Limited
20. Nakuru Water and Sewerage Company Ltd
21. Crop Nutrition Laboratory Services Ltd
22. University of Nairobi Institute of Nuclear Science and Technology
23. Catholic Diocese of Nakuru Water Programme Laboratory
24. Quality Assurance Systems Ltd
25. Polucon Services (Kenya) Ltd
26. Universal Corporation Limited
27. Achelab Laboratory Services
28. Interfield Food Testing Laboratories (IFTL)
29. Nutri Lab & Consulting
30. GTB Scanlab Limited

31. Lab Works East Africa
32. Bureau Burundais De Normalisation Et Controle De La Qualite (BBN)
33. Universal Superintendence Co. Limited
34. Gokhan Technical Services Limited
35. Masterspace Solutions (K) Limited
36. Geo-Technical Equipment Africa Limited
37. Soleil Solutions Africa Limited
38. Interdigicert Kenya Limited
39. Amotech Africa Limited
40. Advanced Helios Process Solutions (AHPS) Limited
41. Sigma Inspectorate East Africa Limited
42. Gallant Scientific Limited
43. Azania Physical Laboratory Limited
44. Absolute Scales Limited
45. New Sonic Quality Inspectors Limited
46. Biologic Calibration Solutions Limited
47. ESTEC Limited
48. Wondernut International EPZ Limited
49. CUC & Inspections Kenya Limited
50. Merchant Technical Services Limited