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# Influence of technology on operational performance of pharmaceutical firms in Kenya.

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# INFLUENCE OF TECHNOLOGY ON OPERATIONAL PERFORMANCE OF PHARMACEUTICAL FIRMS IN KENYA

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## DECLARATION

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 thesis/dissertation (use as appropriate) contains no material previously published or written by another person except where due reference is made in the thesis/dissertation itself.



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The thesis/dissertation of [Name of Candidate] was reviewed and approved for examination by the following:

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## DEDICATION

I dedicate this research project to my family for their support, as well as stakeholders in the Pharmaceutical industry who supported with valuable information and guidance:

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| | |
|---|---|
| APA | American Psychology Association |
| APS | Advanced Planning System |
| E – CTD | Electronic Common Technical Document |
| EDI | Electronic Data Interchange |
| GPS | Global Positioning System |
| ICT | Information Communication Technology |
| IT | Information Technology |
| KAPI | Kenya Association of Pharmaceutical Industries |
| KEMSA | Kenya Medical Supplies Authority |
| MCC | Medicines Control Council |
| MDs | Metabolic Diseases |
| MNCs | Multi-National Corporations |
| NACOSTI | National Council of Science, Technology and Innovation |
| OTC | Over the Counter |
| PPB | Pharmacy and Poisons Board |
| QBD | Quality by Design |
| QMS | Quality Management Systems |
| RFID | Frequency Identification |
| RFID | Radio Frequency Identification |
| SCM | Supply Chan Management |
| SPSS | Statistical Package for Social Sciences |
| TMS | Transport Management System |
| USD | United States Dollars |
| WHO | World Health Organisation |
| WMS | Warehouse Management System |

## ABSTRACT

This study sought to examine the extent to which technology influences operational performance of pharmaceutical firms in Kenya. The objectives for this study were to test the relationship between; level of technology, supply chain technology, marketing technology and quality control technology and operational performance of pharmaceuticals firms in Kenya. The study was anchored on Diffusion of Innovation Model and Technology Acceptance Model (TAM). There are 50 registered pharmaceutical firms operating in Nairobi and unit of analysis were all persons who were working in four departments; Supply Chain, Marketing, Quality control and Operations in those firms. The study adopted cross-sectional survey design which supported identification of 200 respondents by use of purposive random sampling technique. Questionnaires were used to collect data from Operations Manager, Supply Chain Manager, Marketing Manager and Quality control Manager from the Pharmaceutical firms in Nairobi. The quality of this study was guaranteed by testing validity and reliability of the questionnaire. Data was analysed using computer supported software Statistical Package for Social Sciences (SPSS) to generate means, correlation and regression coefficients. The findings on level of technology revealed that with mean of 3.54, the level of technology was considered high. Also, with an overall mean of 3.21, the findings indicated that technology was intensively used in all stages of supply chain mainly in planning, implementation and reporting. Preliminary tests of assumptions were run; linearity tests, normality tests, multicollinearity tests and homoscedasticity tests and the results provided a basis for running parametric inferential statistics. The results of persons correlation coefficient indicate that there is a significant positive correlation between supply chain technology, marketing technology and quality control technology and operation performance whereas; a significant positive correlation between marketing technology with operation performance positive significant correlation between quality control technology and operation performance. Multiple regression analysis was run to test if the technology usage significantly predicts operation performance of pharmaceutical firms. The results of the regression indicated that the three predictors, supply chain, marketing and quality control explained 31.6% of operation performance could be explained by a unit change in supply technology on marketing technology the model established that 35.5% operation performance could be influenced by a unit change in marketing technology and finally, 38.2% of quality control technology would influence operation performance. Overall, the consistency of regression coefficients on the predictors in the model suggest that these variables are important factors influencing operation performance and therefore proving the usefulness of enhancing operational performance of pharmaceutical firm through the use of technology in departments like supply chain, quality control and marketing department for general improvement of operational efficiency and effectiveness.

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background to the Study

Technology is increasingly becoming a strategy of improving performance of an organisation. Thompson, Strickland and Gamble (2007), observed that good strategy making builds a market position that is strong enough to make organization up its performance despite competition. Through adoption of Radio Frequency Identification (RFID) technology, a company can effectively monitor every product both at the production line and in the supply line. RFID chips are placed on all items which helps employees to quickly detect any anomalies in an order. It is an innovative way of correcting a problem before it ruins the entire supply chain.

In transportation, modern technology includes the ingenious on-board truck scales which allow for seamless operations when access to platform scales is not available. The scales measure payload weight and the trucks gross weight and enhance productivity by ensuring a truck carries the maximum weight right from the point of loading while also saving time and money. Orembo (2013) found that on-board truck scales have also been adopted as a safety guarantee to ensure operators within a warehouse for instance only carry the allowed weight on their lifts. Computerized supplies management is the future of the business. Williams (2006) stated that use of computerized shipping and tracking software systems helps to integrate all operations from one panel and it enhances customer experience and reduces errors in the entire process.

Social Media Revolution is an ingenious way to open more channels and remain in touch in real-time with all stakeholders in the supply chain. It is easy to respond to questions, report in real-time about incidences in the supply chain, report price changes, and also enhance visibility of the company. The usage of Information Technology (IT) in organizations across the supply chain has become a determinant of competitive advantage for many corporations. IT plays an enabler role in Supply Chan Management (SCM), by addressing a range of different point and enterprise solutions in a variety of supply chain settings (Venkatraman & Henderson, 1998). Emerging IT trends like software agents, RFID, web services, virtual supply chains, electronic commerce, and decision support systems, further underscore the importance of IT in global firms' competition.

Some pharmaceutical industries are already using innovative marketing technologies which include webinars, video conferencing and streaming of international medical conferences to train local doctors and other health practitioners on new / innovative practices. This facilitates dissemination of the latest industry trends and provision of fast and cost-efficient marketing tool. Technology application is thus leveraged to train and build capacity for a high number of doctors as opposed to having a few senior doctors travel to developed world at high costs to attend the training. Technology has also been used to great effect to combat stock outs and anticipated demand for drugs to ensure constant and consistent supply year-round (Onyango, 2016).

Omwansa (2012) observed that supplier integration software used by established drug retail stores directly feed information from the retail tills directly to the production units that ensure needed meds are available on demand. Dis- chem used by large pharmaceuticals in South Africa has reduced lead times as well as better stock units management through the information platform between customers and suppliers is constantly updating and monitoring the entire supply chain and enhancing overall performance.

Other than use of technology in operations of pharmaceutical firms, technology is also applied by regulatory bodies of the pharmaceutical industry. For example, in Zimbabwe, Uganda, and Zambia, technology is used by respective pharmaceutical regulatory bodies (WHO, 2017). The regulatory services include license renewals, payments, clinical trials, students' registration, trade, inspection, and verification of professionals has now moved online. The automation has reduced delays in service delivery and increased the capacity to transform pharmaceutical practice. The automation has also boosted revenue collection and improved industry surveillance mechanisms, (PPB, 2017). Payments can be easily done through electronic money transfer services. The new technology-based services have enabled the regulatory bodies in Zimbabwe, Uganda, and Zambia join Medicines Control Council of South African (MCC). MCC is the only pharmaceutical regulatory authorities in the continent which receive submissions of drug registration dossiers online, commonly referred to as Electronic Common Technical Document (E - CTD).

In Kenya, health and ICT are slowly becoming more interconnected with the country proving a front-runner in innovative ICT solutions. Kenya is the only African country with a

comprehensive e-Health strategy and a ranked global power with a multi-billion United States Dollars (USD) turnover of mobile money (MPesa) payments that is increasingly being linked to paying for healthcare services. In Kenya, the Pharmacy and Poisons Board (PPB) was the first fully automated national drug regulatory authority in Africa in 2015, automating clinical trial registry process among other services. This certifies Kenya as a regional center of regulatory excellence for pharmaco-vigilance, a platform that tracks and reports adverse effects licensed drugs may have on patients. The PPB provides a list of all registered pharmacists online to help Kenyans easily identify qualifications of people superintending over pharmacies. While not full proof, the system has gone a long way in improving adherence and operational standards within the industry, (PPB, 2017). This coupled with Global Positioning System (GPS) enabled devices for enhanced drug and facility inspection have all served to increase transparency and efficiency at the regulator.

Pharmaceutical firms in Kenya can be divided into three main segments namely; manufacturers, distributors and retailers. All these play a major role in supporting the country's health sector, which is estimated to have about 4,557 health facilities countrywide according to the Ministry of Health (2016). The industry has major Multi-national pharmaceutical companies present through locally incorporated affiliates, technical representative offices and local technical agents. It also has local manufacturers and local importers of drugs as its membership all of whom then distribute their products through appointed distributors. Pharmaceutical products in Kenya are distributed through pharmacies, chemists, health facilities and shops. There are about 700 registered wholesale and 3000 retail dealers in Kenya, manned by registered pharmacists and pharmaceutical technologists, a number that continues to increase as more players enter the sector, (PPB, 2017).

A 2015 Business Monitor report on pharmaceutical manufacturing in Kenya states that the country hosts the largest pharmaceutical industrial base in East Africa. In Kenya, the pharmaceutical industry compounds and packages medicines, repackages formulated drugs and processes bulk drugs into doses using predominantly imported active ingredients and excipients. The bulk of locally manufactured preparations are non-sterile, Over the Counter (OTC) products. WHO (2014) noted that the Kenyan market for pharmaceuticals reached $558.5 million in 2014

with the total turnover for the local production standing it at $103 million. The value addition from the pharmaceutical sector generated around $62 million, an amount that has steadily risen since. The industry generally operates under the Ministry of Health however its members are in a lobby; The Kenya Association of Pharmaceutical Industries (KAPI) established in the 1960's by a group of Research and Development (R&D) based pharmaceutical companies to promote high standards in the pharmaceutical industry. The Association draws its membership from large MNCs with local affiliates. KAPI's mission is to promote an ethical, innovative and responsible health care industry. Of concern now is how the pharmaceutical sector can play its role efficiently and effectively.

Another key player in the country's pharmaceutical industry is the Kenya Pharmacy and Poisons Board which is the regulatory body under which the pharmaceutical firms in the country operate. Its mission is to protect the health of the public by regulating the profession of pharmacy and ensuring quality, safety and efficacy of medical products and health technologies in the country. The board's main role is regulatory oversight of all players in the pharmaceutical industry (PPB, 2017). The third key player in the country's pharmaceutical industry is Kenya Medical Supplies Authority (KEMSA) which was established as a state corporation with the mandate to procure, warehouse and distribute medical commodities to Kenya's Health facilities. KEMSA works to support the National Health Strategic Plan and the Kenya Health Package for Health in providing public health facilities with the right quantity and quality of drugs and medical supplies at the best market value, (KEMSA, 2007). KEMSA is the largest purchaser of drugs manufactured both locally and imported, in the country buying about 30% of the drugs in the Kenyan market through an open-tender system and distributing them to government medical institutions.

The relationships between pharmaceutical firms, regulatory body and medical supply agency are important in promoting quality health care in the country. In this regard, supply and provision pharmaceutical products to consumers should be guaranteed by role of regulatory body. As technology promotes operational efficiency and effectiveness, technology thus becomes the link in regulation or control, supply and marketing in pharmaceutical firms in Kenya. However, it remains unclear how technology influences the operational efficiency of pharmaceutical firms in

Kenya. This study therefore sought to investigate the influence of technology on the operational performance of pharmaceutical firms in Kenya.

### 1.1.1 Technology: Concept of independent variable

Technology is the application of skills, competencies or mechanization for the purpose of enhancing efficiency and production quality while saving time and money (Orembo, 2013). Orembo explains technology as an application of scientific knowledge for practical purpose especially in industry with the purpose of enhancing efficiency in productivity. Technology may have tangible or intangible properties or both. Technological applications aim at facilitating task performance and speed-up in operations for more productivity in timelines. Technological innovations range from newly fabricated machinery, Information Communication Technology (ICT) systems which are tangible to intangible skills and competencies of human resources. Tangible technology applications improve quality, save time /speedup the flow of information or delivery of goods and services in firms. Vivarelli (2015) cites other benefits of business technology to include enhanced organizational efficiency in tracking supply chain in business relationships.

According to Atalay, Anafarta and Sarvan (2013), technology and technological innovations have completely changed the business landscape; technological innovation is widely regarded as one of the most important sources of sustainable competitive advantage in an increasingly changing business environment. Its application leads to product and process improvements, makes continuous advances that help firms to survive, allow firms to grow faster, become efficient and ultimately become more profitable than non-innovators. Kotler (2000) observed that firms which fail to innovate put themselves at great risk of failure. In the pharmaceutical industry, technology is purported to be the basis of the industry since the industry's very existence stems from the need to provide essential drugs to combat disease and improve general health and wellbeing. To achieve this, the industry relies heavily on technology to discover and improve new medicines over the years.

Kotler (2001) postulates that globalization and rapid technological advancement have immensely transformed the way companies do business worldwide; spurred innovation and development in various sectors, and driven the world economic changes. Due to globalization, customers' needs

and requirements have been changed and developed. Customers need the relevant product, in the right place, at the right time with high quality and affordable cost. Saleh (2015) observed that any organization seeking to compete in this recent hyper-market should match itself with the customers' requirements. The pharmaceutical sector is complex and has many different interested parties including the manufacturers themselves, national regulators, government ministries, wholesalers among others, (UNIDO, 2010). To fully optimize its productivity implies embracing the industry as an asset to economic and social development which needs concerted action across the stakeholders. The pharmaceutical sector is complex with diverse stakeholders' interests ranging from manufacturers themselves, national regulators, government ministries, wholesalers who require technological coordination (UNIDO, 2010).

### 1.1.2 Operational Performance

Operational performance is a measure of a firm's performance against standards of effectiveness, efficiency and environmental responsibility which may include cycle time, productivity, waste reduction and regulatory compliance. It may be said to be a group of standards and benchmarks that are adopted and used by organizations to achieve competitive advantage, customer satisfaction, and maximum level of profitability. Operational efficiency is an essential component of organizational performance. Abdolvand, Albadvi and Ferdowsi (2012), in terms of outputs based on quality of services and products, speed of product and service delivery, flexibility, and dependability. Operational performance may also be said to be the sum total of all an entity's routine processes and activities, and the undertaking of these activities which can range from financial to being non-financial. Kalpan and Norton (2001) came up with a performance measure framework which gives organizations a balanced view of performance; under four perspectives; financial, customer, growth, and internal processes. In the pharmaceutical industry, operational performance may be derived as a function of cost reduction, revenue growth, ease of access of new products/ speed of launches and general product lead times.

### 1.1.3 Pharmaceutical Industry

The global pharmaceutical industry has continuously grown over the years and emerged as one of the fastest growing industries in the world. Its market worth is over US$1,200 billion a year, a figure that was expected to rise continually by the World Health Organisation (WHO) in a 2015

report. Controlling over one-third of this market, with sales over US$400 billion a year and profit margins of about 30%, are the 10 largest drug companies in the world, with six based in the United States and four in Europe. Production and consumption within the industry is unevenly distributed around the world with the developed countries being the leading producers and consumers of pharmaceuticals. While they bear the heaviest disease burden, developing regions like Asia, Africa, Australia and Latin America with a share of nearly 85% of world population, only accounted for 21% of global pharmaceutical consumption in 2010 (IMS Health Market Prognosis, 2011). This was mainly due to the high cost associated with quality medication and other resultant factors that have worked in tandem to further exclude the poor from quality healthcare.

Globally there is continual pressure on healthcare systems as players and governments with diminishing resources try to ensure affordable healthcare for all. UNIDO (2016) noted a global increase in Non-Communicable Diseases (NCDs) like Cancer, Diabetes and Hypertension not to mention more rare forms of illnesses e.g Multiple Sclerosis all of which are expensive to manage and as a result there is increasing strain on healthcare systems globally. Globally, firms view technology adoption as a means of improving their performance. Innovative technology is a major continuous management strategy undertaken by firms to increase efficiency, effectiveness and impact of the firms. Kotler (2000) observes that firms which fail to innovate put themselves at great risk of failure.

Developing countries have an even bigger challenge with double disease burden where NCDs are on the rise while the burden of communicable diseases likes Malaria, Cholera etc still persistent. This is further compounded by poorly funded healthcare systems resulting in huge pricing pressures for pharmaceutical industry players that have to try to deliver on their mandate of service delivery while remaining as viable businesses. Within Africa South Africa has the most developed pharmaceutical industry with high specs on quality, regulatory processes and efficient supply chain systems right to the point of usage by patients/ consumers? This is partly driven by years of technology transfer by most international players who set hubs there to support production and operations as they expand into other parts of Africa.

In East Africa, Kenya is the front runner with, and most advanced compared to its neighbours (Uganda, Tanzania, Burundi, Sudan, Ethiopia, and Rwanda). The pharmaceutical industry in Kenya plays a major role in supporting the health sector by providing medication for treatment and prevention of various diseases. This not only aids in management of diseases but also promotes good health of the citizenry to enable them to participate actively in the economics of nation building. To effectively play this role, the industry should support research-based production, marketing, promotion and availability of quality medication at the right place, time and quantities (Business Daily, 2017).

Good quality medicine are still very expensive in this part of the world. With growing demand and poor enforcement of regulations coupled with unethical practices there's a rise in proliferation of unregulated or "grey" medicines. These are pharmaceutical products brought into the market through irregular channels without undergoing the necessary regulatory scrutiny to conformity as stipulated by Pharmacy and Poisons Board. Such products pose dangers to the patients using them since their efficacy and quality remains questionable. However due to their relatively lower prices, many consumers end up opting for them judging by relative costs based on limited incomes as well.

The government of Kenya needs to provide incentives to encourage local production of affordable medicine particularly for simple molecules in a bid to drive growth of local manufacturing and exports to the regional market. It also needs to protect the interests of research based Multi-National Corporations (MNCs) which are key players in the pharmaceutical industry globally particularly on Research and Development of new drugs. Multinational corporations lead in supplying innovative molecules, latest interventional products available in the developed markets, patented medicines, new technologies and act as incubation hubs for latest pharmaceutical inventions all of which eventually feed the generic manufacturers (MOH, 2013).This delicate balancing act must be done deliberately by government if the potential inherent in the pharmaceutical industry is to be fully optimized. Technology is a buzz word adopted by many as they strive to be competitive and this study will establish whether its just glamour or indeed a critical support with operational efficiency to improve competitiveness.

### 1.2 Problem Statement

As a developing nation, Kenya still suffers from a huge burden of communicable diseases (T.B, Malaria, Cholera, and HIV among others). Current statistics show an increasing trend of Non-

Communicable Diseases (NCD's), like Diabetes, Cancer and Hypertension. This situation is described as "double disease burden" with both Communicable diseases as well as NCD's. This is a big strain on the healthcare system that's inherently underfunded. With a high disease burden and inadequate healthcare financing, the result is immense pricing pressure for quality medication. To improve on medication pricing, the pharmaceutical industry needs to increase competitiveness by allowing as many players with quality brands as possible in the market and the use of technology in process improvement and enhancing operational effectiveness and efficiency has been proposed by pharmaceutical industries in (Kenya (MOH, 2013).

Marketing on average consumes one-third of total sales revenue of pharmaceutical products, this doubles the amount spent on research and development. This was mainly attributed to pressure to maintain sales which led to an inherent conflict of interest between the public selection and rational use of drugs. —Pharmaceutical companies incur huge costs associated with transcontinental travel by Physicians for the sole purpose of knowledge transfer. The push for sales and more profits has also compromised the quality controls. Whereas research and quality control should be given necessary priorities, pharmaceutical industries spend less on innovation but more on marketing to make more sales (WHO, 2013). The industry should explore means of leveraging on technology to facilitate the same knowledge transfer at cheaper costs. This would inevitably reduce the costs of investments and hence some price relief.

Therefore, the role of technology in operational performance of pharmaceutical firms can be ascertained and confirmed by empirical studies. However, empirical evidence that will ensure pharmaceutical firms in Kenya increasingly adopt technology in operational activities remain inadequate. For example, use of technology had significant influence in supply chain of Postal Kenya (Jepkoech, 2012). Also, technology improves marketing in retail outlets (Munyasi, 2015; Ndubai, 2013) and distribution firms (Ngumau, 2016). On quality, technology was found to increase efficacy (Sigei, 2014), enforcement of regulatory framework (Kiragu, 2014) and financial performance (Mutua, 2014). The empirical evidence available does not exhaustively indicate that use of technologies in pharmaceutical firms improves operational efficiency in supply chain, marketing and quality control. It is with reference to the above issues that this

study sought to explore whether technology can be deployed to improve pharmaceutical firm performance.

### 1.3 Research Objectives

The overall objective of this study was to determine the influence of technology on the operational performance of pharmaceutical firms in Kenya. The study was guided by the following specific objectives:

i. To establish the level of technology used by pharmaceutical firms in Kenya.
ii. To determine the influence of supply chain technology on the operational performance of pharmaceutical firms in Kenya.
iii. To determine the influence of marketing technology on the operational performance of pharmaceutical firms in Kenya.
iv. To determine the influence of quality control technology on the operational performance of pharmaceuticals firms in Kenya.

### 1.4 Research Questions

This study attempted to answer the following research questions:

i. What are the levels of technology used by pharmaceutical firms in Kenya?
ii. To what extent has supply chain technology influenced operational performance of pharmaceutical firms in Kenya?
iii. To what extent does marketing technology influence the operational performance of pharmaceutical firms in Kenya?
iv. To what extent has quality control technology influence the operational performance of pharmaceutical firms in Kenya.

### 1.5 Significance of the Study

This study focused on pharmaceutical industry that directly touches on management of human health. Pharmaceutical industry is pivotal disease management and achievement of good health. The study will therefore be of benefit to pharmaceutical industry players as they seek to address the challenges of operational optimization. The findings on this study may inform way to optimize processes and improve efficiency across the pharmaceutical industry. The study will also be useful for future scholars who may be interested in this area of study as they can use the

study findings and recommendations as a basis for their research and to this end, it will have added to the wider body of knowledge and academic research.

### 1.6 Scope of the Study

The delimitation of this study was confined to pharmaceutical manufacturers in Kenya. Going by the latest registration they are 50 in total and this represents the total number of registered manufacturers (PPB Renewal 2019). Within each of the companies the study targeted a respondent from each of the following four departments: Supply Chain, Regulatory, Quality control and Operations. The concentration of their operational bases is in Nairobi County hence the study was confined to Nairobi County. The aim of the study was to establish the level of usage of technology by these firms and more specifically the influence of marketing, supply chain and quality control technologies on operational performance. The study was conducted between April and May 2019, and respondents provided information through a questionnaire administer via drop and pick.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews literature on relevant past researchers and pertinent documents and working papers on influence of technology and perceived operational efficiency in pharmaceutical firms. The first section presents theoretical review while the second section provides empirical review which anchors the gap on which the study is focused. The review arrangement is consistent with independent variables used in the study. The last section of the chapter presents the conceptual framework.

## 2.2 Theoretical framework

This study adopted two theoretical frameworks: Diffusion of Innovation Model (DOI) and Technology Acceptance Model (TAM). DOI was used to explain the phases in which technology diffuses into organization and finally adopted to support operations (supply, marketing, quality). TAM was also used to explain acceptance behaviour of organizations that adopt technologies to improve operations.

### 2.2.1 Diffusion of Innovation Theory

This study adopted the Diffusion of Innovation model. The Diffusion of Innovation (DOI) theory was introduced by Rogers in 1962 and states that 'diffusion is the process of conveying innovation for a period to members of a society using certain channels. Rogers (2003) describes the series of phases through which an individual or firms go through in technology adoption. These are: the knowledge phase, persuasion phase, decision phase, implementation phase, and confirmation phase. Notions on the technology's characteristics like compatibility, its relative advantage, complexity, observability, and trialability impact the adoption process.

The knowledge phase is characterized by an individual learning about the existence of new technology and seeking information about it. At persuasion phase, the individual creates a negative or positive attitude towards the new technology, but such attitude does not always result in acceptance or rejection of the new technology. During the decision phase, the person chooses whether to take up and fully utilize the new innovation or to decline it. Implementation involves putting the new technology into practice, while at confirmation phase the individual seeks

approval for his/her decision (Oliveira & Martins, 2010). For the DOI model the individual, the structure of the organization and a firm's external characteristics are important backgrounds to innovation (Oliveira & Martins, 2010).

This model focuses on the driving force for the adoption of the technology. This implies that the motive or reason for adoption is based on expected outcomes of the technology in supporting businesses. According to this model, the decision made by people or organizations on whether to adopt a technology or not is heavily dependent on perceived influence of the technology. It is from such perceptions that there are categories of the people: early adopters, early majority, late majority and laggards. In this regard, early adopters become satisfied with the influence of the technology early enough as compared to the rest. Thus, if the technology offers quick solutions, it is easier to be adopted.

According to this theory, pharmaceutical firms level of usage of technology was based on various technological fit in their processes and the motivating factor pushed by factors like how technology enhance speed, convenience in service delivery, boost in sales and effectiveness. In supply chain technology, firms use technology to share information through electronic supply network interphase such as Manufacturing Resource Planning (MRP) which enhance on time availability of the right materials required based on customers feedback and trend analysis of orders. Additionally, according to this theory technology supports quality control, monitoring old stocks to be released first and reduced firm's losses as well as supporting marketing and increasing sales and revenue of the firms.

### 2.2.2 Technology Acceptance Model

Technology Acceptance Model (TAM) was developed by Fred Davis in 1989. The model states that adoption of any technology by firms or organization is significantly dependent on perceptions about usefulness and ease of use of the technologies. Davis (1989) defines perceived usefulness of technology as user's conviction that using the technology is beneficial in terms of improving worthiness, performance or wellbeing. Also, Davis (1989) defines perceived ease of use of the technology as user's conviction that using the technology will be free of effort. Based on the two definitions of perceived usefulness and ease of use of the technologies, the TAM indicates that the two factors define the behaviour of the user before adopting the technology. In

this regard, organizations that perceive technologies will improve overall performance end up adopting the technology. Also, organizations that perceive that any technology if applied will reduce costs and deployment of more resources eventually adopt such technology.

In this study, Technology Acceptance Model (TAM) was applied in this study by acknowledging that the driving force for any technology adoption based on the applicability and the subsequent rewards of that technology to a pharmaceutical firm. This indicates that pharmaceutical firms that perceive technologies to be useful will increase overall operational performance are likely to be adopted. This study therefore used this theory to measure the extent to which operational performance of pharmaceutical firms in Kenya is influenced by perceptions about usefulness as well as ease of using these technologies.

### 2.3 Empirical Review

This section describes the review of empirical studies on level of technologies used by Pharmaceutical firms. The section also provides a description on supply chain and operational performance, marketing technology and operational performance as well as quality control technology and operational performance.

#### 2.3.1 Level of Technologies used by Pharmaceutical Firms

Technology is revolutionizing the way Pharma industry conducts business globally. In Hungary, study done to investigate integration of knowledge management into information technology intelligence framework revealed that firms are utilising technology-based intelligence framework to improve integration of business intelligence initiatives. According to Boldeanu and Pugna (2012), the changes are affecting every level from Research and Development (R&D), interaction with Healthcare providers and patients to even healthcare systems in different markets. This indicates that with a cumbersome operational base, restrictive regulatory environment, cutthroat competition, pricing pressure and increasing bargaining power by both payers and consumers, Pharma companies are all struggling to keep up leveraging on technology. During the Research and development phase new technologies are being adopted into the drug development industry. This includes big data analysis to mine information from bodies of research.

In Pakistan, a study was done to determine the factors that affect readiness for business process in pharmaceutical firms. According to Abdolvand, Albadvi and Ferdowsi (2012), pharmaceutical companies are leveraging technology to go further and faster in monitoring patient safety. It also helps reduce costs and promote efficiencies by reducing manual input. To enhance marketing activities technology is used in segmentation and targeting of both healthcare providers as well as consumers for targeted communication approaches. This informs the choice of media used for communication or even more specifically product type vs prescription habits and patient types seen by respective specialist approaches. Customer Relationship Management (CRM) tools are also increasingly used to monitor performance of field teams to drive the desired customer coverage and reach leveraged to drive coverage as well as performance management of business development teams/ Field force (Drennan & McColl-Kennedy, 2003)

From the perspective of customers, a study was done in United States of America to determine the perception of patients on service delivery through technology. In the study, Porter (2010) opines thatwith literacy levels on the increase alongside access to information, patients are becoming more engaged in health issues. In the digital age, patients are much less dependent on their doctors for advice, increasingly able and willing to take greater control of their own health. They feel empowered by the vast amount of health information available online and on apps, and by the array of health and fitness wearables such as FitBit and Apple Watch. In one survey, more than 85 percent of patients said they were confident in their ability to take responsibility for their health and knew how to access online resources to help them do so. In addition, patients are becoming keener to evaluate different healthcare products and services given that they bear a growing proportion of the costs. To provide solutions to patients, Pharmaceutical companies must also engage digital with patients as they make such evaluations hence shifting the model of business.

Like the ebays and Amazons of the world, pharmaceutical business is moving towards online. In Africa, while the pace is not as fast as the developed countries, there is gradual growth in use of technology for operations in pharmaceutical firms. For example, in Nigeria the technologies are used in marketing (Melodi, Olufayo & Gbadamosi, 2012). As such Kenya already have an online Pharmacy (MYDAWA). Pharmaceutical companies are being pushed to adopt these as

distribution channels. With increasing focus on product quality and efficacy, technology is being used for batch tracking, temperature control and even pharmacovigilance. However, how the pharmaceuticals have adopted the technologies in Kenya remains unknown empirically hence this study.

### 2.3.2 Supply Chain Technology and Operational Performance

Supply chain is a logistical arrangement of goods and services in the market place. Kotler and Armstrong (2012) defined distribution channel as an array of interdependent organizations in the marketplace that help, through their activities, make any product or service readily available for the use or consumption of the consumer or a business user. Supply chain management may be defined as the overall management of this distribution channel. Due to the product sensitivity of the pharmaceutical industry, the supply chain becomes an integral pillar that must be closely monitored and directed to achieve optimal firm performance.

According to Gallaugher (2002), technological systems in the firm's supply chain can be broadly classified in three categories; Complex technological business systems, such as ERP (Enterprise Resource Planning) systems which are designed to cover and connect the entire company's operations. Focused technological solutions which comprise of the lower level of technological solutions that facilitate the optimization of certain business functions or that improve visibility along the channels and include Warehouse Management System (WMS), Advanced Planning System (APS) or Transport Management System (TMS) and technological tools that offer managerial solutions: such as Radio Frequency Identification (RFID), Electronic Data Interchange (or EDI) or the Internet.

In a desk review of the application of technology in the pharmaceutical supply chain in Europe, Vivarelli (2015) found that technological innovations deployed in the pharmaceutical industry in Europe had led to may be direct labor saving through increased efficiency and productivity with the most notable changes noted in the supply chain of drugs and other pharmaceutical products. It was noted that by adopting technology especially downstream, organizations were able to avoid any stock-outs or carriage of dead inventory since intelligent supply management software was able to effectively predict demand and ensure availability of inventory just in time. Product

flows from producers through wholesalers to retailers and ultimately the final buyer largely depends on systematic, strategic planning by a firm and sound management.

It was also noted that the immense potential inherent in automation of pharmaceutical supply chains especially linkage of distributors and parent company through electronic platforms that would provide updated demand data. This he opined had the potential to increase efficiency in the industry by up to 25% which he predicted would reflect directly on the balance sheet of concerned firms. The study however failed to factor other aspects of technology within the pharmaceutical industry and this gap is addressed by the current study. Further, being done in Europe meant its contextual realities may differ from those of the current study that will be done on pharmaceutical firms in Kenya.

In Africa, supply chain for pharmaceutical firms are not as robust as supply chains in developed countries. In a study on whether Africa should make its drugs, there are indications that sourcing pharmaceuticals products from other countries outside Africa lengthens the supply chain especially with regard to stringent trade polices (Conway, Holt & Sabow, 2018). In this study, there are recommendations that pharmaceutical firms should adopt technologies that will improve the supply chain operations where sourcing of the products can be done online. However, there are is no study that provides assessment on the extent to which the sourcing of pharmaceutical products has improved supply chain. This study therefore bridged this gap by investigating the effect of technology on supply chain.

Munyasi (2015) notes that the key objective of use of technology in supply chain management is integration across the different players which he argued would deliver many positive effects. Basing on comprehensive information sharing that is more accurate and faster, firms can get better demand forecasts that are based on precise information. Technology if properly deployed, he argued, not only serves to facilitate this process but further integrates the entire system, so that the process flow for demand and supply complements continuously. A smooth process flow ensures efficiency and productivity at its optimal which reflects on the overall firm performance. By applying digital technology, companies can significantly increase visibility into their supply chain operations and make better and faster decisions. Digitization allows companies to fully

integrate their supply chains and improve operational processes, making them more adaptive and responsive. As a result, planning accuracy, manufacturing efficiency and productivity, inventory levels, and service levels improve.

Jepkoech (2012) carried out a study on the effect of technology on supply chain performance using a case study of Postal Corporation of Kenya. The study noted that technology increased the agility of employees thereby improving the efficiency and effectiveness with which they completed tasks before them. The study further found that technology deployed in staff retraining improved the organizations reach to staff across the various stations and was key to enhancing service delivery. The study recommended the use of technology in demand projection to further reduce impediments to smooth flow of products and services within the firm's supply chain. The study was however limited to a specific organization and was fairly general in its discussion of technology on supply chain performance. It also focused mainly on the employee effects and not on the primary focus of the current study i.e. operational performance.

In another study, Munyasi (2015) examined the impact of technology adoption on pharmaceutical industry's distribution in Kenya. It was found that pharmaceutical companies that embraced new technologies had a competitive edge in sourcing and distribution of drugs due to the reduction in the costs associated with transportation, coordination and storage of products. The study further found a reduction in delivery turnaround timelines, reduction in data entry errors and enhanced accuracy in reporting and communication all of which served to improve overall efficiency not just within the supply chain but in the overall firm performance. The study however only concentrated on retail outlets and not the main pharmaceutical companies that this study seeks to study. The study only concentrated on the distribution systems and no other aspects of technology within the pharmaceutical industry in Kenya, a gap that the present study intended to address.

### 2.3.3 Marketing Technology and Operational Performance

Marketing technology has been increasingly adopted to support organizations reach out to more markets or consumers. According to Ngamau (2016), for businesses to remain viable, pharmaceutical firms will need to alter the marketing that focuses only on the product of the current model and create new strategies that recognize the importance and interdependence of

the payer, provider. This would underscore the pharmaceutical value chains thus providing a win-win situation for all interested parties benefiting from the complex and interactive processes within the chain. While there is steady demand for pharmaceutical products, the dynamics in the industry are so diverse and are constantly reshaping the marketplace. The demand for medicines is projected to grow rapidly over the coming years with governments focusing more on prevention rather than treatment; regulators are becoming more risk-averse and consumers better informed.

Rasmussen (2010) observed that key market segment for pharmaceutical companies has been the physician employed by the pharmaceutical firms. This aims at meetings between physicians and sales representatives to explain the advantages of a particular medication. Each new drug has been launched with a comprehensive and expensive global marketing campaign that involved the full range of marketing tools including media advertising, comprehensive information packs. These culminate into special events for doctors, conference presentations, and a dedicated sales force in this new model of partner firms. Increased investment in marketing and firm specific experience (Kor & Mahoney, 2005) also helps in building capability. However, the marketing budgets for most firms have progressively increased with the WHO (2016) attributing the high cost of medicines to the competitive nature of the industry that necessitates huge investments in marketing. Contemporary consumers are more educated, better informed, more technology savvy, have more purchasing power and hence, more demanding in the products and services they buy (Kotler & Keller, 2006).

Khedkar (2015) examined the effect of social media on customer satisfaction and loyalty in Indian pharmaceutical organizations. The study found that social media was increasingly becoming the marketing tool of choice for many companies across India since the customer ‘finds you.’ The study also found an increasingly important role played by consumers especially on social media platforms that was forcing many companies to improve their products and services since consumers were readily sharing both positive and negative experiences. The study recommended increased investment in social media as a marketing tool for any firm that sought to operate sustainably since it was proving to be an ever increasingly important marketing tool

that required great innovation but could hinge on technology and become very effective without being too expensive.

The study however was mainly empirical in nature as opposed to the current study that will employ both a theoretical framework as well as empirical research. Its societal and geographical context are distinctly different from Kenya as is the pharmaceutical industry in both countries, this could have a bearing on the findings of the current study. In Nigeria, Melodi, Olufayo and Gbadamosi (2012) conducted an appraisal of marketing technology in the banking sector using a study of four selected banks in Lagos State. They found that marketing technology had significant and positive impact on income generation capacity and profitability level of the studied banks. It not only increased their visibility but created interactive platforms for the banks to respond to customer needs faster. Their subsector of study was the banks which differ markedly with pharmaceutical industry and thus the current study will seek to find out whether the same applies in its subsector of interest.

Ndubai (2013), studied competitive marketing strategies in the retail sector of the pharmaceutical industry in Nairobi and found that strategies used included strategic choice of location, stocking other items like cosmetics, surgical and diagnostic items, attractive counter displays, staff uniforms and road signboards. His study projected that technology would increasingly become significant in the marketing of pharmaceuticals and he recommended that for a retail outlet to remain, viable, they would need to employ some form of technology in their marketing. The study however failed to focus on the projected operational gains that would come from embracing technology. It was also done on retail outlets and its findings though relevant may not fully apply to the parent firms under this study.

Ngumau (2016) studied the challenges facing the marketing of pharmaceutical products in Kenya and found that the pharmaceutical distribution companies have to deal with the lack of adequate product knowledge from the customers and their clients which make them vulnerable to counterfeits and grey medicines. The study also found that many distribution companies complained of underfunding from parent pharmaceutical firms in promotional activities. Regulatory hindrances were also noted with many distributors noting the strong regulatory

framework in drug promotion activities. The study however failed to address technology specifically as a marketing tool or its potential effects. The study focused only on distribution companies and not the parent pharmaceutical firms whose products the distributors push. The study also failed to address operational performance which is the key variable of the present study.

### 2.3.4 Quality Control Technology and Operational Performance

As part of a maturing industry, pharmaceutical companies are under significant pressure to both innovate and successfully manage increasingly complex operations, more stringent regulatory requirements and frequent consolidations (Guzman, 2010). Many are rethinking their Quality Management Systems (QMS), recognizing the imperatives to enhance agility and improve responsiveness to market needs without increasing quality-related costs or ultimately compromising product quality. While the benefits are clear, a misalignment between the QMS and a company's operational requirements can have downsides and drive costs. WHO (2016) notes that a lean and agile QMS will be a key source of competitive advantage if it has the ability to capture customer feedback and regulatory changes, build them into operations and rapidly launch new products to market. It should also offer a streamlined structure that enables both compliance and operational efficiency, even when faced with increased business complexity.

Recent pharma industry trends have had significant implications on the need for robust quality control. Technology advances have for example increased the diversity of products and processes. Products may have more elements (for example, the drug itself, software and a device), while traditional product lines (small and large molecules) have matured and new processes are increasingly more complex all of which has served to increase the need for greater prudence to ensure quality maintenance (Woodcock, 2010). Regulators are using technology to gain access to data and tools that enable more frequent and more in-depth audits with an end-to-end scope. This increased scrutiny demands more extensive sharing of information and a greater emphasis on its integrity. At the same time, advanced analytics are greatly enhancing the ability of regulators and industry players to process this information and derive new insights (KEMSA, 2016).

With emerging challenges like counterfeits and parallel imports, there is need to track batches, monitors temperatures to ensure stability of product and efficacy right to the end user. Traditionally, pharmaceutical companies have focused on the combination of approaches for quality control approaches. However, quality control is increasingly emerging as an important aspect of the industry and involves a broader platform to ensure quality by "bottom-up" approach. Larson, (2006) posits that 'Quality by Design' (QBD) is a customized and a latest version of quality management system in pharma sector. It covers "QBD" of pharma products by designing, development of formulation and various manufacturing processes to predefined product quality. Overall, a quality management system ensures that the products that reach the consumer are safe, efficacious & of high quality.

Regulatory Affairs falls squarely under quality control and plays a crucial role in the pharmaceutical industry and is involved in all stages of drug development and after drug approval and marketing. Malik (2016) notes that the drug development process is a lengthy, complex and extremely costly albeit necessary process. Pharmaceutical companies use all the data accumulated during discovery and development stages in order to register the drug and thus market the drug. Throughout the development stages, pharmaceutical companies must abide by an array of strict rules and guidelines in order to ensure safety and efficacy of the drug in humans. In this highly regulated environment, regulatory affairs play a critical role not only as the interface with health agencies and as a link between different departments in the company but also as the leading department to provide strategic advice on extremely difficult decisions through the life of a drug (WHO, 2013). Technology has proven a great asset in this endeavor and has been pivotal in the improvement of process efficiency and resource optimization.

Sigei (2014) studied total control and performance of multinational pharmaceutical firms in Nairobi and found a positive correlation between quality control standards and firm's performance. The study also found a positive relationship between the use of technology in quality control and overall efficacy of products. The study also identified the role technology in staff training on advanced quality control and recommended its use to make training more efficient and economical. The study however failed to address technology as a key variable in quality control a gap the present study seeks to bridge. The study also concentrated on

multinational firms and failed to consider the local firms thus probably failing to capture certain relevant aspects.

Kiragu (2014), studied government regulation and firm competitiveness in insurance and found that the government regulations affect the competitiveness in many ways and this is especially significant in life companies where return on investment have big impact on profitability and fund growth, thus requiring greater capital investment is restricting entry of firms while at the same time encouraging mergers and buyouts. It was noted on the study that technology was being successfully deployed to enforce the regulatory framework and this had a direct consequence of quality control on products. The study however focused on the insurance industry and not in pharmaceuticals. It also focused more on overall returns without giving much thought to operational efficiency which is a main focus of the current study.

In another 2014 study, Mutua studying quality management practices and financial performance of pharmaceuticals manufacturing firms in Kenya found that most pharmaceutical manufacturing firms that implemented technology backed quality management practices recorded high sales turnover leading to organizational performance. The study recommended that pharmaceutical manufacturing firms in Kenya should benchmark themselves with the best performing firms globally in order to map the quality management technology they deployed to improve overall performance. It however only concentrated on quality management practices in general with specific technological applications without regard for the deployment of technology in other spheres of the firm as done by the present study.

### 2.4 Chapter Summary and Knowledge Gaps

The reviewed studies generally indicate that technology continues to be a major determinant in improving operational performance of pharmaceutical firms. In developed countries, technology in pharmaceutical firms is used in research and development (Boldeanu and Pugna, 2012). Also, technology is used in monitoring safety of patients with regard to use of drugs (Abdolvand, Albadvi and Ferdowsi, 2012). In addition, technology is used to allow patients get control of their health by consulting pharmaceutical firms (Porter, 2010). However, while developing countries are in increasingly adopting technologies, the intentions of using technologies remains largely unexplored. For example, in Kenya while there is online provision of pharmaceutical

services, the extent to which such platforms support operational performance remains undetermined.

On supply chain and operational performance, the reviewed literature indicates that use of technology by pharmaceutical firms in developed countries increased efficiency and productivity of the firm. In Europe, use technology improved supply chain efficiency in the industry by up to 25% (Vivarelli, 2015). However, the study failed to factor other aspects of technology within the pharmaceutical industry and this gap is addressed by the current study. Comparatively, developing countries do not have robust supply chain of pharmaceutical firms and therefore recommendations for the firms to adopt technologies have been put in place (Conway, Holt & Sabow, 2018). However, the extent to which the sourcing of pharmaceutical products has improved supply chain has not been investigated. In other studies, while it was established that technologies improved supply chain, the studies did not focus on pharmaceutical firms (Jepkoech, 2012); focused on retail outlets and not main pharmaceutical manufacturers or packagers. This study therefore bridged this gap by investigating the effect of technology on supply chain with regard to main pharmaceutical manufacturers or packagers.

On marketing technology and operational performance, reviewed studies indicate that technologies are widely used in marketing in many countries across the world. For example, in India technology supports introducing pharmaceutical products to large population (Khedkar, 2015). In Kenya, there are limited studies on the extent to which technology supports pharmaceutical firms in marketing. For example, study by Ngumau (2016) failed to address technology specifically as a marketing tool or its potential effects. Thus, this study determined the extent to which technology affects marketing with regard to pharmaceutical firms.

On quality control technology and operational performance, the reviewed studies indicate that there are inadequate studies in Africa with regard to quality control in pharmaceutical firms through technology. The a few studies (Sigei, 2014; Mutua 2014) fail to address technology as a key variable in quality control. It is against this backdrop in lack of empirical evidence on influence of technology on operational performance that this study sought to bridge the stated gaps.

## 2.5 Conceptual Framework

Figure 2.1 describes the conceptual framework of this study.

**Independent Variable**

**Technology**

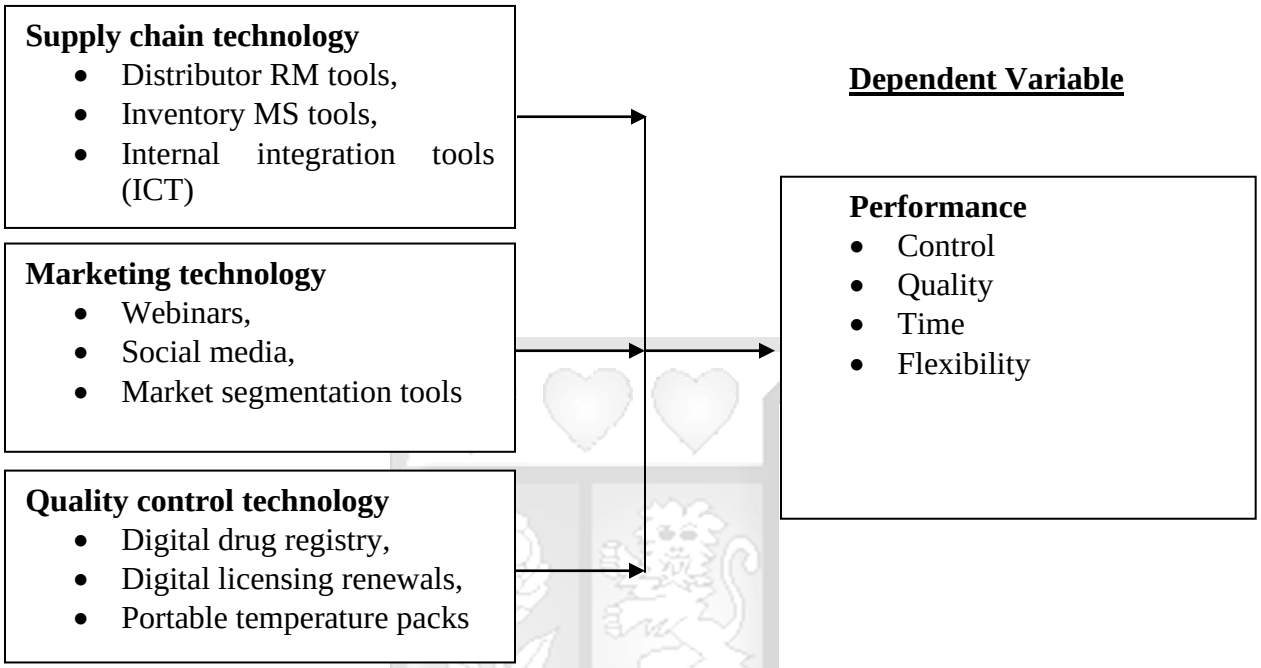


**Figure 2. 1: Conceptual framework**
**Source: Researcher (2019)**

The conceptual framework describes the relationship between independent and dependent variables. The independent variables are supply chain, marketing technology and quality control technology. The indicators for supply chain technology are distributor tools, inventory tools and internal integration tools. The indicators for marketing technology are webinars, social media and market segmentation tools. The indicators for quality control technology include digital drug registry, digital licensing renewals and portable temperature packs. The dependent variable is operational performance of the pharmaceutical firms. The indicators are control, quality, time and flexibility. The relationship indicates that increased positive influence of technology (supply chain, marketing and quality) increases operational performance of the pharmaceutical firms. The relationship also indicates that in case of negative influence in technology (supply chain, marketing and quality) decreases operational performance of the pharmaceutical firms.

## 2.6 Operationalization of Variables

The Table below describes the operationalization of variables. The Table illustrates operational definition of the study variables and how the variables will be measured. The supporting literature for each variable is also provided.

**Table 2. 1: Operationalization of Variables**

| Variable | Operation Definition | Measurement Indicators | Supporting literature Source |
|---|---|---|---|
| Supply chain technology | Supply chain technology is automated logistical arrangement of pharmaceutical services supporting manufacturers, distributors, retailers and consumers. | • Distributor RM tools,<br>• Inventory MS tools,<br>• Internal integration tools (ICT) | Vivarelli (2015); Munyasi (2015); Jepkoech (2012); |
| Marketing technology | Marketing technology is a set of automated processes and tools used by pharmaceutical firms to increase visibility of the firm as a brand in the market or products and services sold. | • Webinars,<br>• Social media,<br>• Market segmentation tools | Ngamau, (2016); Rasmussen (2010); WHO (2016); Khedkar (2015); Melodi, Olufayo and Gbadamosi (2012); Ndubai (2013); Ngumau (2016) |
| Quality control technology | Quality technology refers to set of automated tools and processes used by regulatory bodies and pharmaceutical firms to enforce standards and ensure compliance. | • Digital drug registry,<br>• Digital licensing renewals,<br>• Portable temperature packs | Malik (2016); WHO (2013); Sigei (2014); Kiragu (2014); |
| Operational performance | Operational performance technology refers to level of efficiency and effectiveness in pharmaceutical firms. | • Control<br>• Quality<br>• Time<br>• Flexibility | Munyasi (2015); Jepkoech (2012);Khedkar (2015); Ndubai (2013); Ngumau (2016); Sigei (2014); Kiragu (2014); |

# CHAPTER THREE
# METHODOLOGY

## 3.1 Introduction

This chapter presents the methodological approach that will be used for the study and specifically discusses the intended research design, target population, data collection procedure, data analysis procedure, reliability and validity of the instruments as well as addressing the ethical considerations that may arise from this study.

## 3.2 Research Design

The study adopted cross-sectional survey design to determine the influence of technology on operational performance of pharmaceutical firms in Kenya. This design ascertains and describes the characteristics of the variables of interest in a situation at a specific point in time (Kerlinger, 2000). Cross-sectional survey design is restricted to a fact finding and may result in the formation of important principle of knowledge and solutions to significant problems (Kothari, 2004). Similarly, it involves collection of data from large area by use of questionnaires to determine characteristics within the population (Kreswell, 2003). Thus, cross-sectional research design therefore supported identification of respondents by use of census and purposive random sampling technique as well as use of inferential data analysis.

## 3.3 Target Population

A population refers to an entire group of individuals, events or objects having a common observable characteristic about which a researcher is interested in (Sekaran, 2008). It describes the parameters whose characteristics the research will attempt to describe. It comprises of all potential participants that can make up the study group (Kumar, 2008). Kenya has 50 registered pharmaceutical manufacturing and distributing firms (Pharmacy and Poisons Board, 2019). Four managers in every firm. These managers were selected based on their areas, supply chain manager, marketing manager, quality control manager and the operation manager in each firm selected to form part of the target population giving us a total target respondents of 200.

## 3.4 Sample size and Sampling procedure

The study aimed to achieve a 95% confidence level and 5% margin of error. Given the small population of 50 firms, a census approach was adopted targeting all of the firms.

### 3.5 Data Collection Procedure

Primary data was collected from sample management executives in pharmaceutical firms in Kenya using questionnaires constructed in a five-point Likert scale. The questionnaires were administered through drop and pick up later method, and the data was collected within a period of one month. The questionnaire comprised of structured questions, made up of five sections namely section A: comprised of the demographic information, section B: Level of technology Section C: Supply Chain Technology, section D: marketing technology E: quality control technology F: operational performance. One research assistant was engaged in the data collection. The research assistant was given a brief orientation on the aim and objective of the study, the targeted population, sample and sampling procedure as well as the ethical issues in the study.

### 3.6 Research Quality

The quality of this study was guaranteed by testing validity and reliability of the questionnaire as follows:

#### 3.6.1 Validity

Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Joppe, 2000). Content validity was determined using the expert advice from my supervisors. A pilot test of five respondents randomly selected from the sample frame was done to test the reliability of the instrument. The five were then excluded from the final respondents to avoid contamination.

#### 3.6.2 Reliability

Reliability is the extent to which an instrument is predictable, stable, accurate and dependable to yield the same results every time it is administered. Reliability demonstrates that the study can be replicated. The study used a test retest for reliability which was then verified using Cronbach's alpha with a threshold of 0.7 to determine its reliability. 10 percent of the target population was used to conduct pilot test but these were managers who were from similar firms but were not to participate in the study like finance managers, credit management division unit and the directors of those firms.

**Table 3. 1:Reliability coefficient of variables**

| Variable | No of items | Respondents | Alpha | Comment |
|---|---|---|---|---|
| Operation performance | 11 | 20 | 0.825 | Reliable |
| Level of technology | 6 | 20 | 0.741 | Reliable |
| Supply chain technology | 10 | 20 | 0.882 | Reliable |
| Marketing technology | 11 | 20 | 0.912 | Reliable |
| Quality control technology | 7 | 20 | 0.931 | Reliable |

### 3.7 Data Analysis Procedures

The collected research data was edited and cleaned then coded, categorized and lastly keyed into for final data processing. Data was analysed using computer supported software Statistical Package for Social Sciences (SPSS). Means were obtained for each variable and regression analysis was done to provide correlation coefficients for determination of the influence of the technology on operational performance.

**Table 3. 2:**Data **Analysis Procedure**

| Objective | Measurement Indicators | Data analysis procedure |
|---|---|---|
| RO1. To establish level of technologies used by pharmaceutical firms in Kenya | Number of automated pharmaceutical processes and number of interphases. | Quantitative data of number of processes and interphases was coded, entered on SPSS, tabulated and expressed in form of means. |
| RO2. To assess the influence of supply chain technology on operational performance of pharmaceutical firms in Kenya | Distributor relationship management tools, Inventory management tools, Internal integration tools | Quantitative data on distributor relationship, management tools, inventory management tools and internal integration tools will be coded, entered on SPSS, tabulated and expressed in form of means. |

| Objective | Measurement Indicators | Data analysis procedure |
|---|---|---|
| RO3. To determine the influence of marketing technology on the operational performance of pharmaceutical firms in Kenya | Webinars, social media, Market segmentation tools, | Quantitative data on webinars, social media and market segmentation tools will be coded, entered on SPSS, tabulated and expressed in form of means. |
| RO4. To assess the influence of quality control technology on the operational performance of pharmaceutical firms in Kenya | Digital drug registry, digital licensing renewals, portable temperature packs | Quantitative data on digital drug registry, digital licensing renewals, portable temperature packs will be coded, entered into SPSS, tabulated and expressed in form of means. |
| RO5. To establish the operational performance of pharmaceutical firms. | Control, Quality, Time and Flexibility | Quantitative data on control, quality, time and flexibility will be coded, entered into SPSS, tabulated and expressed in form of means. |
| RO6 To determine joint influence of supply chain, marketing and quality assurance technology on operational performance of pharmaceutical firms in Kenya | | The means obtained on performance of pharmaceutical firms will be compared with means on supply chain, marketing and quality control. The comparison on means will yield Pearson correlation coefficients. Also, regression analysis will be done to obtain regression coefficient of independent variables (supply chain, marketing and quality control) regarding operational performance of pharmaceutical firms in Kenya. |

A regression model was generated showing operational efficiency and technology. The regression coefficients were assessed for statistical significance. The relationship between operational performance and technology was expected to follow a regression model of the nature below:

$Y=\alpha_0+ \alpha_1X_1+ \alpha_2X_2+ \alpha_3X_3+ \varepsilon$

Where;

Y= Operational performance

$\alpha$ = Intercept term

$X_1$=Supply chain technology

$X_2$= Marketing technology

$X_3$= Quality control technology

$\varepsilon$= Error term

### 3.8 Ethical Consideration

Ethical consideration involved obtaining permission to conduct the study from institutions and respondents as well using polite language. On approval, permission letters from Strathmore University was obtained. The letter was used to obtain research permit from National Council of Science, Technology and Innovation (NACOSTI). Permission letter from the University and research permit were used to obtain permission from pharmaceutical firms in Nairobi.

Respondents were also politely requested to participate in the study. According to Mugenda (2003), an ethical study is one that allows for freedom of purpose from the participant as well as protects their rights. This involved provision of a clause in the introduction section of the questionnaire that allowed respondents to willingly participate in the study or not. According to Creswell (2014), respondents should be informed of the nature and procedures of the study to allow the researcher to get consent. In this regard, the researcher ensured the confidentiality and anonymity of the participants by use of pseudonyms in the data gathered. After the completion of administration of questionnaires, respondents were given opportunity to review their responses and to make any changes to their previous statements.

The researcher also ensured ethical consideration by acknowledging authors and contributions of all literature used in the study. Respondents were not to be identified by their respective names and they were allowed to participate in the study voluntarily. Throughout all processes of data collection, objectivity was maintained where there was no misinterpretation of information. In addition, data collected was used for academic purposes only. Analysed data was only applied in the research report of this study.

# CHAPTER FOUR
# DATA ANALYSIS AND INTERPRETATION OF FINDINGS

## 4.1 Introduction

This chapter presents findings from the data analysis in line with the research objectives. The analysis is divided into four sections. Section 4.2 is the response rate, section 4.3 presents the background information and section 4.4 presents the analysis as per the research objectives. Section 4.5 presents the inferential statistics.

## 4.2 Response Rate

A population of 50 pharmaceutical firms was obtained and 200 questionnaires administered to 50 Operations Managers, Supply Chain Managers, Marketing Managers and Quality control Managers. However, only 178 questionnaires were successfully filled and returned representing 89% success rate in 45 pharmaceutical firms. The response rate was considered adequate for data analysis.

## 4.3 Background Information

The background information collected was on type of pharmaceutical firm, years in operation and firm's major functions. The findings are illustrated and presented as follows:

### 4.3.1 Respondents type

Analysis of respondents who participated in the study show that out of targeted 200 , only 178 completely filled the questionnaires and returned and that was what was used to develop the analysis. The results showed in table 4.1

**Table 4. 1:Respondents Response Rate**

| | **Frequency** | **Actual Response** | **Percentage** |
|---|---|---|---|
| Operation managers | 50 | 43 | 86% |
| Supply chain managers | 50 | 45 | 90% |
| **Marketing manager** | **50** | **44** | **88%** |
| **Quality control manager** | **50** | **46** | **92%** |
| **Total** | **200** | **178** | **89%** |

The findings in Table 4.1 shows response rate among the managers who participated in the study. Majority of responses were received from quality control managers (92%), supply chain

managers 90%, marketing managers 88% and operation managers had response rate of 86%. Overall response rate was 89%, with only 11% not responding to the study questionnaire distributed.

### 4.3.2 Period in the company

Respondents were requested to indicate the period in which the firms have been in operation. The findings are illustrated in Table 4.2.

**Table 4. 2: Years of Experience at the company**

| Years of Experience | Frequency | Percentage |
|---|---|---|
| 4.1-8.0 years | 33 | 18.5 |
| 8.1-12.0 years | 70 | 39.3 |
| Above 12 years | 75 | 42.1 |
| **Total** | **178** | **100.0** |

Findings in Table 4.2 indicate that more managers (42.1%) have operated has stayed in firms for more than 12 years followed by those who had worked in their respective pharmaceutical firms between 8 years to 12 years were 39.3 percent and 4 to 8 years were 18.5 percent. The findings indicate that before a person promoted to management position years of experience and stability of having worked in the same firm was found to be a significant determinant.

### 4.3.3 Major Functions of the Firms

Respondents were requested to indicate the major functions of the firms. The findings indicated that all firms (100%) engaged in manufacturing, distribution, customer care, marketing, quality control and advocacy. The firms manufactured and distributed human and livestock drugs. The distribution was supported by robust marketing strategies. In addition, the firms invested and complied with standards that ensured quality in the operations. Also, the firms engaged in forms of advocacy including promotion of safe usage of drugs and favourable legislation on pharmaceutical legal frameworks. The findings imply that pharmaceutical firms in Kenya engage in multiple activities that utilise technology in one form or another.

## 4.4 Operational Performance

This section presents findings on operation performance of pharmaceutical firms. There were five items used for testing operational performance variable on a five Likert scale. The scale

ranged from strongly agree (5), Agree (4), undecided (3), disagree (2) and strongly disagree (1). The findings are illustrated in Table 4.3

**Table 4. 3: Operational Performance**

| Statement | 1 (%) | 2 (%) | 3 (%) | 4 (%) | 5 (%) | Mean N=178 | Standard deviation |
|---|---|---|---|---|---|---|---|
| There is increased timely delivery of products to customers. | 0 | 21.9 | 16.9 | 23.0 | 40.2 | 3.29 | 1.189 |
| There is increased level of obtaining customer compliments and complaints. | 0 | 22.5 | 21.3 | 16.9 | 39.3 | 3.25 | 1.216 |
| There is reduced costs of supply chain operations. | 0 | 21.3 | 21.3 | 16.9 | 40.4 | 3.25 | 1.157 |
| There is improved product awareness for customers in the market | 0 | 23.6 | 17.4 | 18.5 | 40.4 | 3.22 | 1.191 |
| There is reduced costs of marketing activities. | 0 | 17.4 | 24.2 | 16.9 | 41.6 | 3.20 | 1.156 |
| There is improved time of serving customers | 0 | 21.9 | 20.8 | 14.0 | 43.3 | 3.19 | 1.183 |
| There is increased the firm's ability to respond to customer/ market demands | 0 | 19.7 | 21.9 | 19.7 | 38.8 | 3.17 | 1.186 |
| There is improved satisfaction level of customers. | 0 | 20.8 | 23.0 | 19.7 | 36.5 | 3.16 | 1.109 |
| Any other (improved research) | 0 | 19.1 | 14.6 | 22.3 | 43.8 | 3.16 | 1.104 |
| There is increase in revenues resulting from marketing activities | 0 | 16.3 | 24.2 | 21.3 | 38.2 | 3.15 | 1.198 |
| There is increased level of responding to customer compliments and complaints. | 0 | 15.7 | 21.9 | 18.0 | 44.4 | 3.10 | 1.130 |
| The firm has ability to meet regulatory demands | 0 | 13.5 | 20.2 | 19.1 | 47.2 | 3.05 | 1.121 |
| There is improved overall product and service quality offering by introducing global standards. | 0 | 15.2 | 21.9 | 24.2 | 38.8 | 2.99 | 1.100 |
| **Overall Mean** | | | | | | **3.17** | **1.157** |

Findings in Table 4.3 indicate that high operational performance of the pharmaceutical firms is observed in timely delivery of products to customers (mean of 3.29). Least performance is observed in introduction of global standards (mean of 2.99). The findings imply that with an overall mean of 3.17, pharmaceutical firms have high performance resulting from supply chain, marketing and quality control activities. Overall mean of 3.17 also implies that the pharmaceutical firms have technologies that help in undertaking supply chain, marketing and quality control operations.

### 4.5 Levels of Technology Used

This section presents findings of the first objective of the study. The section presents findings on level of technology used by pharmaceutical firms in Kenya. There were five items used for testing Levels of Technology variable on a five Likert scale. The scale ranged from strongly agree (5), Agree (4), undecided (3), disagree (2) and strongly disagree (1). The findings are illustrated in Table 4.4

**Table 4. 4: Levels of Technology Used**

| **Statement** | **1 (%)** | **2 (%)** | **3 (%)** | **4 (%)** | **5 (%)** | **Mean N=178** | **Standard deviation** |
|---|---|---|---|---|---|---|---|
| Firms use technology in making orders. | 0 | 0 | 0 | 52.2 | 47.8 | **4.48** | **.501** |
| Firms use technology in marketing | 0 | 35.4 | 13.5 | 21.9 | 29.2 | **3.49** | **.970** |
| Firms use technology in making sales (taking customer requests, payment and dispensing drugs). | 0 | 18.0 | 30.9 | 34.8 | 16.3 | **3.45** | **1.244** |
| Firms use technology in managing inventories. | 0 | 38.2 | 21.3 | 20.8 | 19.7 | **3.41** | **1.152** |
| Firms use technology in advising members of the public and customers on drugs and usage. | 0 | 29.8 | 23.6 | 22.5 | 24.2 | **3.22** | **1.156** |
| Others (planning, analysis and reporting) | 0 | 43.8 | 16.3 | 19.7 | 20.0 | **3.16** | **1.194** |

| | | |
|---|---|---|
| **Overall mean** | **3.54** | **1.036** |

Findings in Table 4.4 indicate that pharmaceutical firms in Kenya use technology for various activities. Technology is most used in making orders (mean of 4.48) followed by marketing (mean of 3.49) and making sales (mean of 3.45). The least use of technology is in general planning, analysis and reporting (mean of 3.16). From the overall mean of 3.33, the level of technology was considered high. The values on the Likert scale above 2.5 represented high level of technology while mean values of below 2.5 represented low use of technology. The findings indicate that pharmaceutical firms in Kenya use technology highly in their operations mainly supply chain, marketing and quality control.

### 4.6 Supply Chain Technology and Operational Performance

This section presents findings on supply chain technology that supported the second objective on the influence of supply chain technology on the operational performance of pharmaceutical firms in Kenya. The findings are illustrated as follows:

#### 4.6.1 Supply Chain Technology

There were five items used for testing Levels of Technology variable on a five Likert scale. The scale ranged from strongly agree (5), Agree (4), undecided (3), disagree (2) and strongly disagree (1). The findings are illustrated in Table 4.5

**Table 4. 5: Supply Chain Technology**

| Statement | 1 (%) | 2 (%) | 3 (%) | 4 (%) | 5 (%) | Mean N=178 | Standard deviation |
|---|---|---|---|---|---|---|---|
| Firms share information with suppliers through the electronic network | 0 | 24.2 | 18.0 | 16.3 | 41.6 | **3.46** | **1.189** |
| Firms use an MRP system (to harmonize forecasting, procurement, production and sales) | 0 | 25.8 | 15.7 | 26.4 | 32.0 | **3.25** | **1.162** |
| Firms use technology to ensure product availability JIT | 0 | 20.8 | 20.8 | 19.7 | 38.8 | **3.24** | **1.160** |
| Firms use technology in planning and developing supply chain needs | 0 | 21.3 | 23.6 | 18.5 | 36.5 | **3.23** | **1.225** |
| Firms and suppliers relate to an electronic system to control inventory | 0 | 17.4 | 15.2 | 19.7 | 47.8 | **3.22** | **1.172** |
| Others (supply chain reporting) | 0 | 18.5 | 23.6 | 14.1 | 38.8 | **3.22** | **1.156** |
| Distributors profiles are used in their relationship management | 0 | 21.3 | 24.7 | 17.4 | 36.5 | **3.17** | **1.139** |
| Firms employ technology to collect customer feedback to improve its supply chain. | 0 | 20.2 | 20.8 | 18.0 | 41.0 | **3.17** | **1.173** |
| Firms' internal departments are electronically interconnected | 0 | 16.3 | 18.5 | 18.0 | 47.2 | **3.07** | **1.172** |
| Firms employ technology to collect customer feedback to improve products. | 0 | 19.1 | 19.7 | 22.5 | 38.8 | **3.03** | **1.144** |
| **Overall mean** | | | | | | **3.206** | **1.169** |

Findings in Table 4.5 indicate that pharmaceutical firms are using technology to perform supply chain activities. With mean of 3.46, the firms share information regarding supplies on electronic network that include emails. Also, with mean of 3.25, the firms use MRP systems to harmonise forecasting, procurement, production and sales. With an overall mean of 3.21, the findings imply

that technology was intensively used in all stages of supply chain mainly planning, implementation and reporting.

### 4.7 Marketing Technology and Operation Performance

This section presents findings of objective 3 on influence of marketing technology on the operational performance of pharmaceutical firms in Kenya as follows:

#### 4.7.1 Marketing Technology

There were five items used for testing Levels of Technology variable on a five Likert scale. The scale ranged from strongly agree (5), Agree (4), undecided (3), disagree (2) and strongly disagree (1). The findings are illustrated in Table 4.6. Findings on marketing technology are as follows:

**Table 4. 6: Marketing Technology**

| Statement | 1 (%) | 2 (%) | 3 (%) | 4 (%) | 5 (%) | Mean N=178 | Standard deviation |
|---|---|---|---|---|---|---|---|
| Firms use social media (Facebook, Twitter and You Tube) to actively market its products | 0 | 34.3 | 19.1 | 24.7 | 21.9 | **3.34** | **1.165** |
| Others (research) | 0 | 33.7 | 24.7 | 23.0 | 18.5 | **3.33** | **1.172** |
| Social media is used to create market awareness about new products. | 0 | 40.4 | 19.1 | 18.0 | 22.5 | **3.30** | **1.167** |
| Firms use technology to articulate its unique selling perspective (USP) | 0 | 37.6 | 14.6 | 28.1 | 19.7 | **3.29** | **1.189** |
| Technology has reduced the firm's marketing budget | 0 | 43.8 | 20.8 | 16.9 | 18.5 | **3.26** | **1.116** |
| Firms use social media to receive customer feedback about a product. | 0 | 39.9 | 21.3 | 15.2 | 23.6 | **3.22** | **1.200** |
| Firms use webinars and e-conferencing to capacitate physicians | 0 | 46.1 | 17.4 | 15.2 | 21.3 | **3.22** | **1.205** |
| Firm use technology to segment the consumer markets | 0 | 43.3 | 18.0 | 13.5 | 25.3 | **3.21** | **1.243** |
| Firms monitor the market using technology | 0 | 38.8 | 24.7 | 15.2 | 21.3 | **3.19** | **1.168** |
| Firms anchor on technology to support its exposes | 0 | 36.0 | 23.6 | 16.3 | 24.2 | **3.12** | **1.209** |
| Firms have data base of relevant physicians for its product portfolio | 0 | 36.0 | 16.9 | 25.8 | 21.3 | **3.10** | **1.160** |
| **Overall mean** | | | | | | **3.23** | **1.181** |

The findings in Table 4.10 indicate that marketing technology is used to increase brand image on social media platforms (mean 3.34), research (mean of 3.33) and market awareness (mean of 3.30). Other uses of technology in marketing include monitoring and reporting. With an overall mean of 3.23, the findings imply that technology is highly utilised in marketing operations. The operations are both internal (planning and control) and external (interactions with consumers).

### 4.8 Quality Control Technology and Operational Performance

In this section, findings on quality control technology and its influence on operation performance were presented with regard to objective 4.

#### 4.8.1 Quality Control Technology

The findings on quality control technology are presented in Table 4.15 as follows:

There were five items used for testing Levels of Technology variable on a five Likert scale. The scale ranged from strongly agree (5), Agree (4), undecided (3), disagree (2) and strongly disagree (1). The findings are illustrated in Table 4.4

**Table 4. 7:Quality Control Technology**

| Statement | 1 (%) | 2 (%) | 3 (%) | 4 (%) | 5 (%) | Mean N=178 | Standard deviation |
|---|---|---|---|---|---|---|---|
| Firms have automated its drug registry | 0 | 38.8 | 18.0 | 21.3 | 21.9 | 3.26 | 1.190 |
| Firms train staff and agents on latest industry innovations and trends | 0 | 39.9 | 19.1 | 21.9 | 19.1 | 3.21 | 1.182 |
| Firms have control tracking system to keep the inventory valid | 0 | 41.0 | 17.4 | 21.3 | 20.2 | 3.20 | 1.161 |
| Firms use technology to maintain just in time responses from end users | 0 | 43.3 | 20.8 | 16.3 | 19.7 | 3.17 | 1.154 |
| Firms rely on technology for testing of new molecules | 0 | 41.0 | 20.2 | 26.8 | 18.0 | 3.16 | 1.149 |
| Firms anchor on technology to meet its regulatory mandate | 0 | 41.6 | 16.9 | 24.2 | 17.4 | 3.12 | 1.172 |
| Any other (reporting) | 0 | 41.6 | 24.6 | 14.6 | 19.1 | 3.11 | 1.149 |
| **Overall mean** | | | | | | **3.18** | **1.165** |

Findings in Table 4.15 indicate that pharmaceutical firms are utilising quality control technology for various activities. The most utilised activities are automation of drug registry (mean of 3.26), followed by training (mean of 3.21), tracking of inventories (mean of 3.20), testing (mean of 3.16). Other quality control activities in which technology is used include fulfilment of

regulatory technology (mean of 3.12) and reporting (mean of 3.11). With an overall mean of 3.18, the findings imply that technology supports quality control activities. The findings also indicate that the pharmaceutical firms derive benefits from using technology in quality control operations.

### 4.9 Tests for Model Assumptions

Use of inferential parametric tests statistics procedures requires that the assumptions of such test's normality, homoscedastity test, multicollinearity tests done

#### 4.9.1 Linearity Test

Linearity test was done to determine whether relationship between independent variables (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance) are linear or not. The findings are illustrated in Table 4.21.

**Table 4. 8:Linearity Test**

| Linearity Test | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| Operation performance * Supply technology | Between Groups | (Combined) | 1.587 | 17 | .093 | 1.101 | .357 |
| | | Linearity | .000 | 1 | .000 | .002 | .966 |
| | | Deviation from Linearity | 1.587 | 16 | .099 | 1.169 | .298 |
| | Within Groups | | 13.570 | 160 | .085 | | |
| | Total | | 15.157 | 177 | | | |
| Operation performance * Marketing technology | Between Groups | (Combined) | 1.621 | 19 | .085 | .996 | .469 |
| | | Linearity | .003 | 1 | .003 | .039 | .844 |
| | | Deviation from Linearity | 1.617 | 18 | .090 | 1.049 | .409 |
| | Within Groups | | 13.536 | 158 | .086 | | |
| | Total | | 15.157 | 177 | | | |
| Operation performance * Quality control technology | Between Groups | (Combined) | 1.173 | 12 | .098 | 1.153 | .321 |
| | | Linearity | .205 | 1 | .205 | 2.422 | .122 |
| | | Deviation from Linearity | .968 | 11 | .088 | 1.038 | .415 |
| | Within Groups | | 13.984 | 165 | .085 | | |
| | Total | | 15.157 | 177 | | | |

In linearity test, if values sig. Deviation from Linearity>0.05, the relationship between the independent and dependent variables are linearly dependent. The findings in Table 4.21 indicate that the Deviation from Linearity value of 0.298 for the relationship between supply chain technology and operation performance is >0.05. Also, the findings indicate that the Deviation from Linearity value of 0.409 for the relationship between marketing technology and operation

performance is >0.05. In addition, the findings indicate that the Deviation from Linearity value of 0.415 for the relationship between quality control technology and operation performance is >0.05. As the all the Deviation from Linearity values are >0.05, the findings imply that there is linear relationship between independent variables (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance). In this regard, any significant change in supply chain technology, marketing technology and quality control technology results into proportionate change in operation performance.

### 4.9.2 Tests of Normality

Normality tests according to Wheeler (2001) is useful since it helps to confirm whether the data follows a normal distribution. In cases where normality is violated, the results may fail to reflect a true picture of the relationship among the variables in the study. In this study normality was tested using Shapiro – Waik tests which is considered most appropriate for small samples < 500 samples. In using this tests procedure, when significance value is less than 0.05 then the data significantly deviates from normality and therefore appropriate procedure to perform data transformation so as to observe normality must follow before running parametric tests statistics. The findings are illustrated in

**Table 4. 9:Normality tests**

| **Variables** | **Shapiro – Wilk** | | |
|---|---|---|---|
| | **Statistics** | **df** | **Sig.** |
| Supply technology | 0.872 | 178 | .267 |
| Marketing technology | 0.711 | 178 | .478 |
| Quality control technology | 0.625 | 178 | 0.350 |
| a. Dependent Variable: Operation performance | | | |

A Lililiefors Significance Correction

The table shows that significance value for Shapiro- Wilk tests were 0.267 for supply technology, marketing technology 0.478 and 0.350 for quality control technology. Since p-values for Shapiro walk tests for all the variables were greater than 0.05 then we can accept null hypothesis that the data came from normally distributed population and therefore parametric tests statistics were considered ideal and therefore inferential statistics of persons correlations and multiple linear regression was considered permissible.

### 4.9.3 Multicollinearity Test

Multicollinearity is a test that evaluates whether the independent variables are highly correlated. The primary concern is that as the degree of multicollinearity increases, the general regression model estimates of the model becomes unstable and the standard errors for the coefficients can get wildly inflated. Multicollinearity in this study was tested using Variance Inflation Factor (VIF). For the purpose of this study VIF less than 3 (VIF<3) means that no multicolliearity exists between the variables and (VIF> 3) means that there is multicollinearity which calls for correction before proceeding with testing for inferential tests statistics (Maddala & Lahiri, 1992). In the multicollinearity table, is shows that there was no multicollinearity among the independent variables since the VIF was less than the threshold of value 3.

**Table 4. 10: Multicollinearity Test**

| **Model 1** | **Collinearity Statistics[a]** | |
|---|---|---|
| | **Tolerance** | **VIF** |
| Supply technology | .742 | 1.500 |
| Marketing technology | .721 | 2.494 |
| Quality control technology | .799 | 1.301 |

a. Dependent Variable: Operation performance

The results showed that VIF for supply technology 1.5, marketing technology 2.494 and Quality control technology 1.301. There were no similarity between the independent variables with operational performance which would interfere with interpreting the model equation.

### 4.9.4 Homoscedasticity Test

Homoscedasticity is an assumption which is tested to confirm that variability of the variable is unequal across the range of values of a second variable which predicts it (Vinod, 2008). In this study homoscedasticity was tested using Breuch- Pagan/ Cook Weisberg test. For this test the null hypothesis is that the error variances are all equal while the alternative hypothesis is that the error variances are multiplicative function of one or more variables. In making decision whether a given population demonstrate homoscedasticity, p – values should be equal to or same as 0.05 (Bera & Jarque, 2012). The results show that the constant variance ($Chi^2 = 12.12$) is insignificant (p= 0.153). Thus, we fail to reject null hypothesis and conclude that the error variance is equal thus homescedasticity is evidence in the study data. In such a case, we therefore accept the null

hypothesis that there is no difference in residual variance of independent to dependent variables tested in the dataset.

**Table 4. 11:**Test for Homoscedasticity

| HO | Variables | $Chi^2$ | Pro. > $Chi^2$ |
|---|---|---|---|
| Constant variance | $X_1$ $X_2$ $X_3$ | 12.12 | 0.153 |

### 4.10 Inferential Statistics

#### 4.10.1 Correlation Results

The results of the Pearson's correlation coefficient indicate that there is significant positive correlation between supply chain technology, marketing technology, and quality control with operation performance. Correlation analysis was done to determine the strength of relationship between supply chain technology and operation performance, marketing technology and operation performance and quality control technology and operation performance.

**Table 4. 12: Correlation Analysis**

| | Supply Chain Technology | Marketing Technology | Quality control Technology | Operation Performance |
|---|---|---|---|---|
| Supply Chain Tech<br>Sig. | 1 | - | - | 0.61*<br><br>0.00 |
| Marketing Tech<br>Sig | - | 1 | - | 0.58*<br>0.012 |
| Quality control tech<br>sig | - | - | 1 | 0.66*<br>0.000 |
| Operation Performance | 0.61* | 0.58* | 0.66* | 1 |

The results of Pearson's correlation coefficient indicates that there is a significant positive correlation between supply chain technology, marketing technology and quality control technology and operation performance whereas (r = 0.61, p value < 0.05; a significant positive correlation between marketing technology with operation performance (r = $0.58^{*}$ , p value is less than 0.05; and positive significant correlation between quality control technology and operation performance (r = $0.66^{*}$ , p = 0.00). Overall, the study indicates that independent variable (supply chain technology, marketing technology and quality control technology) had positively moderately stronger association with dependent variables. This simply implies that any positive changes in supply chain technology, marketing technology and quality control technology would enhance operation performance of pharmaceutical industries.

### 4.11 Simple Regression Results

A simple regression analysis was performance in order to analyse the relationship between the three independent variables and the dependent variables. This was done by regressing the independent variables (supply chain technology, marketing technology and quality control technology) and operational performance. The regression results were organised on the basis of research question (hypothesis) of the study.

#### 4.11.1 To what extent has supply chain technology influenced operational performance of pharmaceutical firms in Kenya?

Model Summary of Supply chain technology and operation performance

**Table 4. 13:Model Summary for Supply chain Technology**

| Parameters | Coefficients |
|---|---|
| Model | 1 |
| R | . 784[a] |
| R Square | .665 |
| Adjusted R Square | 0.616 |
| Std. Error of the Estimate | . 714 |
| a. Predictors: (Constant), Supply Chain technology | |

The above R Square is 0.665 which means that 66.5 % variation in operation performance in pharmaceutical industries is caused by supply chain technology by 33.5% variability being caused by other factors which are not attributed to supply chain technology.

**Table 4. 14:**ANOVA (Analysis of Variance) for Supply Chain Technology

**Analysis of Variance**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 265.53 | 1 | 265.53 | 441.35 | .0.001[b] |
| Residual | 125.88 | 174 | .585 | | |
| Total | 391.41 | 177 | | | |

a. Predictors (constant), supply chain technology, dependent variable; operation performance

Analysis of Variance (ANOVA) consists of calculations that provide information about the level of variability within the regression model and forms the basis for tests significance. The F column provides the basis for testing the hypothesis between the alternative and null hypothesis. From the table, the significance value is less than 0.05 thus indicating that the model is statistically significant in predicting how supply chain technology influence operation performance of pharmaceutical industries in Kenya.

**Table 4. 15:**Coefficient Results for Supply Chain Technology

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.313 | 0.518 | | 9.03 | .000 |
| Supply technology | 0.65. | 0.188 | .502 | 3.925 | .0025 |

a. Dependent Variable: Operation performance

Based on the regression results, holding Supply chain Technology constant at zero, operation performance of pharmaceutical firms would be 4.313. A unit increase in supply chain technology would lead to a 0.65 increase in operation performance of pharmaceutical firms in Kenya. At 5% significance level, supply chain technology had 0.0025 which is less than $p< 0.05$ and therefore it can be concluded that supply chain technology positively and significantly influences operation performance of pharmaceutical firms to a large extent.

### 4.11.2 To what extent does marketing technology influence the operational performance of pharmaceutical firms in Kenya?

**Table 4. 16:Model Summary**

**Model Summary for Marketing Technology**

| Parameters | Coefficients |
|---|---|
| Model | 1 |
| R | 0.58[a] |
| R Square | 0.336 |
| Adjusted R Square | 0.378 |
| Std. Error of the Estimate | 0.386 |

a. Predictors: (Constant), marketing technology

The value of R-Square is 0.336 which means that 33.6% variation in operation performance of pharmaceutical firms is due to the use of marketing technology with 66.4% being cause by other factors which is outside this model which is not marketing technology.

**Table 4. 17:ANOVA (Analysis of Variance) for Marketing Technology**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 365.90 | 1 | 365.9 | 481.35 | .0.000[a] |
| Residual | 122.88 | 194 | .585 | | |
| Total | 488.78 | 195 | | | |

a. Predictors (constant), marketing technology, dependent variable; operation performance

ANOVA comprise of calculations that provide information about the level of variability within a regression model and usually forms the basis for conducting tests of significance. The F column normally provides the basis for testing both null and alternative hypothesis of the variable. For instance, in the table the significance value is 0.000 which is less than 0.05 thus the model is statistically significant in predicting how marketing technology influences operation performance of pharmaceutical firms in Kenya.

**Table 4. 18:Coefficient Results for Marketing Technology**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.709 | 0.814 | | 5.03 | .000 |
| Marketing technology ( $X_2$) | 0.719 | 0.411 | .642 | 4.925 | .000 |

a. Dependent Variable: Operation performance

Based on the regression results, holding marketing technology constant at Zero, operation performance of pharmaceutical firms would be 4.709. A positive unit change in marketing technology would lead to a 0.719 increase in operation performance of pharmaceutical firms in Kenya. At 5% confidence level, marketing technology had p= 0.000 which is less than 0.05 and hence the study can conclude that marketing technology positively and significantly affecting operation performance of pharmaceutical firms in Kenya to a great extent.

### 4.11.2 To what extent has quality control technology influence the operational performance of pharmaceutical firms in Kenya?

**Table 4. 19:Model Summary for Quality Control Technology**

| Parameters | Coefficients |
|---|---|
| Model | 1 |
| R | 0.66.[a] |
| R Square | 0.4356 |
| Adjusted R Square | 0.4451 |
| Std. Error of the Estimate | 0.5251 |

According to the table, the value for R-Square is 0.4356 which simply means that 43.56% of the variation in operation performance is due to variation in operation performance meaning that 56.44% of the variation in operation performance of pharmaceutical firms is due to other factors other than quality control technology.

**Table 4. 20:ANOVA (Analysis of Variance) for Quality Control technology**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 339.90 | 1 | 339.408 | 512.35 | .0.000[a] |
| Residual | 180.88 | 274 | .6625 | | |
| Total | 520.78 | 275 | | | |

a. Predictors (constant), Quality Control technology, dependent variable; operation performance

Analysis of Variance (ANOVA) consists of calculations that provide information about the levels of variability within the regression model and form a basis for tests of significance. The F column provides a statistic for testing hypothesis. From the findings, the significance value is 0.000 which is less than 0.05 thus it can be deduced that the model is statistically significant in predicting how quality control technology influences operation performance of pharmaceutical firms in Kenya.

**Table 4. 21:Coefficient Results for Quality Control Technology**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.231 | 0.711 | | 6.03 | .000 |
| Quality Control Technology ( $X_3$) | 0.635 | 0.221 | .647 | 2.925 | .0025 |

a. Dependent Variable: Operation performance

Based on the regression results shown, holding quality control technology constant zero, operation performance of pharmaceutical firms in Kenya would be 4.231. A positive unit change in quality control technology would lead to 0.635 increase in operation performance. At 5% significance level, quality control technology had p= 0.0025 which is less than 0.05 and hence the study can deduce that quality control technology significantly and positively affects the operation performance of pharmaceutical firms in Kenya.

### 4.12 Overall Model

A regression analysis of the overall model was performance. The results for the overall summary was presented. The study findings indicated that supply chain technology, marketing technology and quality control technology are positively associated with operation performance of pharmaceutical firms in Kenya as indicated by Person correlation R value of 0.909. Consequently, the proportion of the variance explained by R- Square which is 0.825. This simply means that 82.5% of operation performance is explained by combined effects of supply chain technology, marketing technology and quality control technology. From the ANOVA results the study confirmed the model fitness by comparing the F critical values where F value of 126.014 which is significant at 0.000 which is less than 0.05. This shows that the model was significantly fit for the study.

**Table 4. 22:Overall Model Summary**

| Parameters | Coefficients |
|---|---|
| Model | 1 |
| R | . 909[a] |
| R Square | .827 |
| Adjusted R Square | 0.821 |
| Std. Error of the Estimate | . 036 |

a. Predictors: (Constant), Quality control technology, Marketing technology, Supply technology

**Table 4. 23:Analysis of Variance**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 78.12 | 3 | 19.52 | 128.12 | .0.00[b] |
| Residual | 16.12 | 174 | .085 | | |
| Total | 94 .24 | 177 | | | |

a. Dependent Variable: Operation performance

b. Predictors: (Constant), Quality control technology, Marketing technology, Supply technology

The regression coefficient, the results indicate that the relationship between supply chain technology, marketing technology, and quality control technology was significant. This

relationship means that increase in any of the factors will result to significant increase in operation performance

### 4.12.1Distribution of Coefficients in Joint Influence

Regression was done to determine the distribution of coefficients with regard to influence of independent (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance). The influence is represented by Beta coefficients/weights which show the relative importance of independent variable in both standardized and unstandardized terms as follows:

**Table 4. 24:Distribution of Coefficients in Joint Influence**

| **Model 2** | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| (Constant) | 3.313 | .297 | | 1.425 | .002 |
| Supply technology | .316 | .342 | .402 | 8.521 | .000 |
| Marketing technology | .355 | .377 | .409 | 6.082 | .000 |
| Quality control technology | .382 | .056 | 0.573 | 6.26 | .001 |

a. Dependent Variable: Operation performance

Findings in Table 4.25 indicate that there is a positive influence of supply technology on operation performance (β =.316). There is also positive influence of marketing technology on operation performance (β =.355). Quality control performance (β = .382). Furthermore, the significance levels were analysed and as shown in the table, all the variables were significant. This simply means that 31.6% of operation performance could be explained by a unit change in supply technology at p= 0.000, on marketing technology the model established that 35.5% operation performance could be influenced by a unit change in marketing technology and finally, 38.2% of quality control technology would influence operation performance at P= 0.00./Overall, the consistency of regression coefficients on the predictors in the model suggest that these variables are important factors influencing operation performance. From the regression model the following regression equation is derived:

$$\mathbf{Y = 3.313+.316X_1+.355X_2+ .382X_3}$$

Where: Y = Operation performance

$X_1$= Supply chain technology

$X_2$= Marketing technology

$X_3$= Quality control technology

# CHAPTER FIVE
# DISCUSSION, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents the findings presented in chapter four of the study in line with literature review. The main aim of this study was to analyse the influence technology on operational performance of pharmaceutical firms in Kenya. This chapter therefore presents summarized findings and linkages on empirical studies. The chapter also presents conclusion and recommendations.

## 5.2 Discussions

### 5.2.1Level of technology used by pharmaceutical firms in Kenya

Findings on level of technology used by pharmaceutical firms in Kenya indicated that with an overall mean of 3.33, pharmaceutical firms in Kenya use technology highly for various activities. Technology is most used in making orders (mean of 4.48) followed by marketing (mean of 3.49) and making sales (mean of 3.45). The least use of technology is in general planning, analysis and reporting (mean of 3.16). From the overall mean of 3.33, the level of technology was considered high.

The findings on level of technology as established in the study agree with a study by Boldeanu and Pugna (2012) that firms are utilising technology-based intelligence framework to improve integration of business intelligence initiatives. According to Boldeanu and Pugna (2012) pharmaceutical firms use technology highly in research, interaction with Healthcare providers and patients to even healthcare systems in different markets. Also, the findings of this study are in agreement with Abdolvand, Albadvi and Ferdowsi (2012) that pharmaceutical companies are highly leveraging technology to go further and faster in monitoring patient safety. Placed in the context of adoption of technology, this study supports the Technology Acceptance Model (TAM) that organisations adopt technologies easily with intention of applying in several activities. This justifies the high utilisation of the technologies by the pharmaceutical firms.

### 5.2.2 Supply chain technology on the operational performance of pharmaceutical firms in Kenya

Findings on influence of supply chain technology on operational performance indicated that firms use technology to perform supply chain activities. The activities include sharing information regarding supplies on electronic network that include emails. Also, the firms use MRP systems to harmonise forecasting, procurement, production and sales. The least use of technology regarding supply chain is the interconnection between departments. With an overall mean of 3.21, the findings imply that technology was intensively used in all stages of supply chain mainly planning, implementation and reporting.

The R-Square 0.665 which means that 66.5% variation in operation performance in pharmaceutical firms is caused by supply chain technology whereas 33.5% variability is caused by other factors. Analysis of Variance (ANOVA) consists of calculations that provide information about the level of variability within the regression model and forms the basis for tests significance. The F column provides the basis for testing the hypothesis between the alternative and null hypothesis. From the table, the significance value is less than 0.05 thus indicating that the model is statistically significant in predicting how supply chain technology influence operation performance of pharmaceutical industries in Kenya. Regression results, holding Supply chain Technology constant at zero, operation performance of pharmaceutical firms would be 4.313. A unit increase in supply chain technology would lead to a 0.65 increase in operation performance of pharmaceutical firms in Kenya. At 5% significance level, supply chain technology had 0.0025 which is less than $p< 0.05$ and therefore it can be concluded that supply chain technology positively and significantly influences operation performance of pharmaceutical firms to a large extent.

In general, supply chain technology has no significant influence on operational performance among pharmaceutical firms in Kenya. The findings of the study are therefore not in agreement with Vivarelli (2015) who established that technological innovations deployed in the pharmaceutical industry in Europe had led to may be direct labor saving through increased efficiency and productivity with the most notable changes noted in the supply chain of drugs and other pharmaceutical products.

The findings of this study also differ with findings by Munyasi (2015) who established that pharmaceutical companies that embraced new technologies had a competitive edge in sourcing and distribution of drugs due to the reduction in the costs associated with transportation, coordination and storage of products. The findings of this study do not support other empirical studies indicate that diffusion of technology has enabled pharmaceutical firms to solve challenges in the supply chain. This study therefore differs with the Diffusion of innovation (DOI) theory that the technologies adopted are compatible to business processes hence significant influence on operation performance.

### 5.2.3 Marketing technology on the operational performance of pharmaceutical firms in Kenya

Findings on influence of marketing technology on operation performance indicate that marketing technology is used to increase brand image on social media platforms (mean 3.34), research (mean of 3.33) and market awareness (mean of 3.30). Other uses of technology in marketing include monitoring and reporting. With an overall mean of 3.23, the findings imply that technology is highly utilised in marketing operations. The operations are both internal (planning and control) and external (interactions with consumers).

While establishing the relationship between marketing technologies R-Square 0.336 which means that 33.6% variation in operation performance of pharmaceutical firms is due to the use of marketing technology with 66.4% being cause by other factors which is outside this model which is not marketing technology. ANOVA comprise of calculations that provide information about the level of variability within a regression model and usually forms the basis for conducting tests of significance. The F column normally provides the basis for testing both null and alternative hypothesis of the variable. For instance, in the table the significance value is 0.000 which is less than 0.05 thus the model is statistically significant in predicting how marketing technology influences operation performance of pharmaceutical firms in Kenya. Based on the regression results, holding marketing technology constant at Zero, operation performance of pharmaceutical firms would be 4.709. A positive unit change in marketing technology would lead to a 0.719 increase in operation performance of pharmaceutical firms in Kenya. At 5% confidence level, marketing technology had p= 0.000 which is less than 0.05 and hence the study can conclude that

marketing technology positively and significantly affecting operation performance of pharmaceutical firms in Kenya to a great extent

The findings are therefore largely disagreeing with Kor and Mahoney (2005) and Khedkar (2015) who established that marketing technology helps pharmaceutical firms to build interactions with customers and other stakeholders. The significant benefit of marketing technology therefore does not necessarily support the Technology Acceptance Model (TAM) that organizations which perceive technologies will improve overall performance end up adopting the technology. It is not therefore guaranteed that organizations that perceive that any technology if applied will reduce costs and deployment of more resources eventually adopt such technology. Thus, acceptance of marketing technology by pharmaceutical firms in Kenya does not necessarily increase performance where costs are reduced.

### 5.2.4 Quality control technology on the operational performance of pharmaceuticals firms in Kenya

Findings on influence of quality control technology on operation performance indicated that with an overall mean of 2.97, the findings technology supports quality control activities. The most utilised activities are automation of drug registry (mean of 3.26), followed by training (mean of 3.21), tracking of inventories (mean of 3.20), testing (mean of 3.16). Other quality control activities in which technology is used include fulfilment of regulatory technology (mean of 3.12) and reporting (mean of 3.11). With an overall mean of 3.18, the findings imply that technology supports quality control activities. The findings also indicate that the pharmaceutical firms derive benefits from using technology in quality control operations.

In testing the relationship between quality control technology and operation performance the value for R-Square is 0.4356 which simply means that 43.56% of the variation in operation performance is due to variation in quality control technology meaning that 56.44% of the variation in operation performance of pharmaceutical firms is due to other factors other than quality control technology.

Analysis of Variance (ANOVA) consists of calculations that provide information about the levels of variability within the regression model and form a basis for tests of significance. The F column provides a statistic for testing hypothesis. From the findings, the significance value is 0.000 which is less than 0.05 thus it can be deduced that the model is statistically significant in

predicting how quality control technology influences operation performance of pharmaceutical firms in Kenya.

Based on the regression results shown, holding quality control technology constant zero, operation performance of pharmaceutical firms in Kenya would be 4.231. A positive unit change in quality control technology would lead to 0.635 increase in operation performance. At 5% significance level, quality control technology had p= 0.0025 which is less than 0.05 and hence the study can deduce that quality control technology significantly and positively affects the operation performance of pharmaceutical firms in Kenya.

These findings are therefore not in agreement with Guzman (2010) that pharmaceutical companies are under significant pressure to both innovate and successfully manage increasingly complex operations, more stringent regulatory requirements and frequent consolidations. According to Guzman (2010), there is high chance of restricted regulations inhibiting performance. WHO (2016) also agrees that while the benefits are clear, a misalignment between the QMS and a company's operational requirements can have downsides and impact on costs.

The negative influence of the quality control measures on operation performance reveal that diffusion of technology can therefore be slow due to uncertainties and perceptions of the organisations towards some effects of the technology on overall performance. The findings therefore agree with the Diffusion Theory that if pharmaceuticals are at persuasive level, there is likelihood of slow adoption. In addition, the findings of this study are in concurrence with Technology Acceptance model that organisations which perceive that technology will have negative influence on overall performance, are likely not to adopt the technology.

Linearity test was done to determine whether relationship between independent variables (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance) were linearly related. The results showed that the Deviation from Linearity value of 0.298 for the relationship between supply chain technology and operation performance is >0.05. Also, the findings indicate that the Deviation from Linearity value of 0.409 for the relationship between marketing technology and operation performance is >0.05. In addition, the findings indicate that the Deviation from Linearity value of 0.415 for the relationship between quality control technology and operation performance is >0.05. As the all the Deviation from Linearity values are >0.05, the findings imply that there is linear relationship

between independent variables (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance). In this regard, any significant change in supply chain technology, marketing technology and quality control technology results into proportionate change in operation performance.

Normality tests according to Wheeler (2001) is useful since it helps to confirm whether the data follows a normal distribution. In cases where normality is violated, the results may fail to reflect a true picture of the relationship among the variables in the study. In this study normality was tested using Shapiro –Wilk tests which is considered most appropriate for small samples < 500 samples. In using this tests procedure, when significance value is less than 0.05 then the data significantly deviates from normality and therefore appropriate procedure to perform data transformation to observe normality must follow before running parametric tests statistics.
The findings are illustrated in

The table shows that significance value for Shapiro- Wilk tests were 0.267 for supply technology, marketing technology 0.478 and 0.350 for quality control technology. Since p-values for Shapiro walk tests for all the variables were greater than 0.05 then we can accept null hypothesis that the data came from normally distributed population and therefore parametric tests statistics were considered ideal and therefore inferential statistics of persons correlations and multiple linear regression was considered permissible

Multicollinearity is a test that evaluates whether the independent variables are highly correlated. The primary concern is that as the degree of multicollinearity increases, the general regression model estimates of the model becomes unstable and the standard errors for the coefficients can get wildly inflated. Multicollinearity in this study was tested using Variance Inflation Factor (VIF). For the purpose of this study VIF less than 3 (VIF<3) means that no multicolliearity exists between the variables and (VIF> 3) means that there are multicollinearity which calls for correction before proceeding with testing for inferential tests statistics (Maddala & Lahiri, 1992). In the multicollinearity table, is shows that there was no multicollinearity among the independent variables since the VIF was less than the threshold of value 3. The results showed that VIF for supply technology 1.5, marketing technology 2.494 and Quality control technology 1.301. There

was no similarity between the independent variables with operational performance which would interfere with interpreting the model equation. In this study homoscedasticity was tested using Breuch- Pagan/ Cook Weisberg test. For this test the null hypothesis is that the error variances are all equal while the alternative hypothesis is that the error variances are multiplicative function of one or more variables. In making decision whether a given population demonstrate homoscedasticity, p – values should be equal to or same as 0.05 (Bera & Jarque, 2012). The results show that the constant variance ($Chi^2 = 12.12$) is insignificant ($p= 0.153$). Thus, we fail to reject null hypothesis and conclude that the error variance is equal thus homoscedasticity is evidence in the study data. In such a case, we therefore accept the null hypothesis that there is no difference in residual variance of independent to dependent variables tested in the dataset.

The results of the Persons correlation indicate that there is significant positive correlation between supply chain technology, marketing technology, and quality control with operation performance. Correlation analysis was done to determine the strength of relationship between supply chain technology and operation performance, marketing technology and operation performance and quality control technology and operation performance. The results of persons correlation coefficient indicates that there is a significant positive correlation between supply chain technology, marketing technology and quality control technology and operation performance whereas ( $r = 0.61$, p value $< 0.05$; a significant positive correlation between marketing technology with operation performance ( $r = 0.58^*$ , p value is less than 0.05; and positive significant correlation between quality control technology and operation performance ( $r = 0.66^*$ , $p = 0.00$). Overall, the study indicates that independent variable (supply chain technology, marketing technology and quality control technology) had positively moderately stronger association with dependent variables. This simply implies that any positive changes in supply chain technology, marketing technology and quality control technology would enhance operation performance of pharmaceutical industries. The above R Square is 0.665 which means that 66.5 % variation in operation performance in pharmaceutical industries is caused by supply chain technology by 33.5% variability being caused by other factors which are not attributed to supply chain technology.

Analysis of Variance (ANOVA) consists of calculations that provide information about the level of variability within the regression model and forms the basis for tests significance. The F

column provides the basis for testing the hypothesis between the alternative and null hypothesis. From the table, the significance value is less than 0.05 thus indicating that the model is statistically significant in predicting how supply chain technology influence operation performance of pharmaceutical industries in Kenya.

Based on the regression results, holding Supply chain Technology constant at zero, operation performance of pharmaceutical firms would be 4.313. A unit increase in supply chain technology would lead to a 0.65 increase in operation performance of pharmaceutical firms in Kenya. At 5% significance level, supply chain technology had 0.0025 which is less than $p< 0.05$ and therefore it can be concluded that supply chain technology positively significantly influences operation performance of pharmaceutical firms.

The value of R-Square is 0.336 which means that 33.6% variation in operation performance of pharmaceutical firms is due to the use of marketing technology with 66.4% being cause by other factors which is outside this model which is not marketing technology. ANOVA comprise of calculations that provide information about the level of variability within a regression model and usually forms the basis for conducting tests of significance. The F column normally provides the basis for testing both null and alternative hypothesis of the variable. For instance, in the table the significance value is 0.000 which is less than 0.05 thus the model is statistically significant in predicting how marketing technology influences operation performance of pharmaceutical firms in Kenya.

Based on the regression results, holding marketing technology constant at Zero, operation performance of pharmaceutical firms would be 4.709. A positive unit change in marketing technology would lead to a 0.719 increase in operation performance of pharmaceutical firms in Kenya. At 5% confidence level, marketing technology had $p= 0.000$ which is less than 0.05 and hence the study can conclude that marketing technology positively and significantly affecting operation performance of pharmaceutical firms in Kenya to a great extent.

According to the table, the value for R-Square is 0.4356 which simply means that 43.56% of the variation in operation performance is due to variation in operation performance meaning that 56.44% of the variation in operation performance of pharmaceutical firms is due to other factors other than quality control technology. Analysis of Variance (ANOVA) consists of calculations

that provide information about the levels of variability within the regression model and form a basis for tests of significance. The F column provides a statistic for testing hypothesis. From the findings, the significance value is 0.000 which is less than 0.05 thus it can be deduced that the model is statistically significant in predicting how quality control technology influences operation performance of pharmaceutical firms in Kenya.

Based on the regression results shown, holding quality control technology constant zero, operation performance of pharmaceutical firms in Kenya would be 4.231. A positive unit change in quality control technology would lead to 0.635 increase in operation performance. At 5% significance level, quality control technology had p= 0.0025 which is less than 0.05 and hence the study can deduce that quality control technology significantly and positively affects the operation performance of pharmaceutical firms in Kenya.

A regression analysis of the overall model was performance. The results for the overall summary was presented. The study findings indicated that supply chain technology, marketing technology and quality control technology are positively associated with operation performance of pharmaceutical firms in Kenya as indicated by Person correlation R value of 0.909. Consequently, the proportion of the variance explained by R- Square which is 0.825. This simply means that 82.5% of operation performance is explained by combined effects of supply chain technology, marketing technology and quality control technology. From the ANOVA results the study confirmed the model fitness by comparing the F critical values where F value of 126.014 which is significant at 0.000 which is less than 0.05. This shows that the model was significantly fit for the study.

b. Predictors: (Constant), Quality control technology, Marketing technology, Supply technology

The regression coefficient, the results indicate that the relationship between supply chain technology, marketing technology, and quality control technology was significant. This relationship means that increase in any of the factors will result to significant increase in operation performance. Regression was done to determine the distribution of coefficients with regard to influence of independent (supply chain technology, marketing technology and quality control technology) and dependent variable (operation performance). The influence is represented by Beta coefficients/weights which show the relative importance of independent variable in both standardized and unstandardized terms as follows:

Findings indicate that there is a positive influence of supply technology on operation performance (β =.316). There is also positive influence of marketing technology on operation performance (β =.355). Quality control performance (β = .382). Furthermore, the significance levels were analysed and as shown in the table, all the variables were significant. This simply means that 31.6% of operation performance could be explained by a unit change in supply technology at p= 0.000, on marketing technology the model established that 35.5% operation performance could be influenced by a unit change in marketing technology and finally, 38.2% of quality control technology would influence operation performance at P= 0.00. Overall, the consistency of regression coefficients on the predictors in the model suggest that these variables are important factors influencing operation performance. From the regression model the following regression equation is derived:

### 5.3 Conclusion

The study concluded that pharmaceuticals in Kenya have indeed employed technologies. The expectation of the pharmaceuticals in Kenya is for the technologies to improve operation performance either individually or joint. The findings of this study have indicated that individual influence of supply chain technology, marketing technology and quality control technology is positive and significant. The high performance of operation in pharmaceuticals in Kenya is realised when there is joint influence of supply chain technology, marketing technology and quality control technology. The joint influence is significant and strong as opposed to individual parameters.

### 5.4 Recommendations

The following are recommendations of the study:

#### 5.4.1 Supply chain technology

The researcher recommends to pharmaceutical firms operating in Nairobi to enhance the use of supply chain technology since it has positive and significant influence on operation performance of pharmaceutical companies. Supply chain department is very essential and therefore looking for ways of automating the processes and giving customers excellent experience in delivery because of technology is the supply chain should be a top priority in every firm interested to scale up the bottom line.

### 5.4.2 Marketing Technology

The researcher recommends pharmaceutical firms to use more often technology in their pursuit to enhance operational performance since marketing is critical to the success of the firm. By adopting online platform and embracing technology in marketing, the results of inferential statistics proved significant positive relationship.

### 5.4.3 Quality Control Technology

Pharmaceutical firms should maintain quality control technologies. The quality control technologies ensure compliance and improvement in customer needs. However, the negative influence should be compensated by improving uptake of other technologies.

## 5.5 Suggestions for Further Studies

This study looked at influence of technology on operational performance of pharmaceutical firms in Kenya, other studies could look at other aspects of performance such as employee performance, and performance of macro environmental factors on pharmaceutical firms in Kenya.

The operationalization of technology was based on three aspects: supply chain, marketing and quality control. Further studies could be done that look at other dimensions of technology e.g. human resources, finance etc.

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## APPENDICES

### Appendix 1: Letter of Introduction

APPENDIX II-QUESTIONNAIRE

**INFLUENCE OF TECHNOLOGY ON THE OPERATIONAL PERFORMANCE OF PHARMACEUTICAL FIRMS IN KENYA.**

The purpose of this survey is to seek your opinions on the various technologies deployed by pharmaceutical firms in Kenya. It purely for the purpose of academic work that is assessing how these technologies influence operational performance of pharmaceutical firms. Feel free to respond as you wish since there is no right or wrong answers. Please fill out the questionnaire in the spaces below. Kindly tick **[√]** only one response in the spaces provided.

**SECTION A: BACKGROUND INFORMATION**

1. Name of your firm (Optional) _____
2. What is your department

   Supply chain [ ] Marketing [ ] Quality control [ ] Operation [ ]
3. Duration in Employment

   1 -4 years [ ] 4-8 years [ ]

   8-12 years [ ] 12 years and above [ ]
4. Firm's major functions (multiple response)?

   Manufacturing [ ] Distribution [ ] Customer care [ ]

   Marketing [ ] Quality control [ ] Advocacy [ ]

   Others [ ] (please explain) _____

**SECTION B: LEVELS OF TECHNOLOGIES USED**

Below are several statements on levels of technologies of pharmaceutical firms. Please indicate the extent to which they apply to your organization on a Likert Scale of 1 to 5 where 1=Strongly Disagree=1, 2=Disagree, 3=Neutral, 4=Agree and 5=Strongly Agree

| **STATEMENT** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| The firm uses technology in receiving or making orders. | | | | | |
| The firm uses technology in making sales (taking customer requests, payment and dispensing drugs). | | | | | |
| The firm uses technology in marketing | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| The firm uses technology in advising members of the public and customers on drugs and usage. | | | | | |
| The firm uses technology in managing inventories. | | | | | |
| Any other (specify) | | | | | |

**SECTION C: SUPPLY CHAIN TECHNOLOGY**

Below are several statements on supply chain technology of pharmaceutical firms in Kenya. Please indicate the extent to which they apply to your organization on a Likert Scale of 1 to 5 where 1=Strongly Disagree=1, 2=Disagree, 3=Neutral, 4=Agree and 5=Strongly Agree

| **Indicator** | **STATEMENT** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| Distributor RM tools | The firm uses technology in planning and developing supply chain needs. | | | | | |
| | The firm shares information with suppliers through the electronic network | | | | | |
| | The firm and its suppliers relate to an electronic system to control inventory | | | | | |
| | The firm uses an MRP system (to harmonize forecasting, procurement, production and sales) | | | | | |
| | The firm's internal departments are electronically interconnected | | | | | |
| | | | | | | |
| | The firm uses technology to ensure product availability JIT | | | | | |
| | The firm employs technology to collect customer feedback to improve its supply chain. | | | | | |
| | The firm employs technology to collect customer feedback to improve products. | | | | | |
| Any other (specify) | | | | | | |

**SECTION D: MARKETING TECHNOLOGY**

5. Below are several statements on marketing technology and how it influences the operational performance of pharmaceutical firms in Kenya. Please indicate the extent to which they apply to your organization on a Likert Scale of 1 to 5 where 1= No extent, 2= little extent, 3=moderate extent, 4=great extent and 5=very great extent.

| Indicator | STATEMENT | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Social media | The firm uses social media (Facebook, Twitter and You Tube) to actively market its products | | | | | |
| | Technology has reduced the firm's marketing budget | | | | | |
| | The firm uses social media to receive customer feedback about a product. | | | | | |
| | Social media is used to create market awareness about new products. | | | | | |
| Webinars | Company has a data base of relevant physicians for its product portfolio | | | | | |
| | The company uses webinars and e-conferencing to capacitate physicians | | | | | |
| | The company anchors on technology to support its exposes | | | | | |
| Market segmentation tools | The company uses technology to segment the consumer markets | | | | | |
| | The company monitors the market using technology | | | | | |
| | The company uses Technology to articulate its unique selling perspective (USP) | | | | | |
| Any other (specify) | | | | | | |

**SECTION E: QUALITY CONTROL TECHNOLOGY**

6. Below are several statements on quality control technology and how it influences the operational performance of pharmaceutical firms in Kenya. Please indicate the extent to which they apply to your organization on a Likert Scale of 1 to 5 where 1= No extent, 2= little extent, 3=moderate extent, 4=great extent and 5=very great extent.

| STATEMENT | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| The firm has automated its drug registry | | | | | |
| The firm has a control tracking system to keep the inventory valid | | | | | |
| The firm trains staff and agents on latest industry innovations and trends | | | | | |
| The firm anchors on technology to meet its regulatory mandate | | | | | |
| The firm relies on technology for testing of new molecules | | | | | |
| The firm uses technology to maintain just in time responses from end users | | | | | |
| Any other (specify) | | | | | |

**SECTION F: OPERATIONAL PERFORMANCE**

7. Operational performance refers to the level of effectiveness and efficiency of a firm in operations such as marketing, distribution and quality control. To what extent do you agree with the following statements? Please indicate the extent to which they apply to your organization on a Likert Scale of 1 to 5 where 1=Strongly Disagree=1, 2=Disagree, 3=Neutral, 4=Agree and 5=Strongly Agree

| **Indicator** | **Operational Performance** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| Service to customers | Supply chain technology has increased timely delivery of products to customers. | | | | | |
| | Marketing technology has enabled us to improve product awareness for customers in the market | | | | | |
| | Supply chain technology has improved time of serving customers | | | | | |
| | Supply chain technology has increased level of obtaining customer compliments and complaints. | | | | | |
| | Supply chain technology has increased level of responding to customer compliments and complaints. | | | | | |
| Cost controls | Marketing technology has supported increase in revenues. | | | | | |
| | Marketing technology has reduced costs of marketing activities. | | | | | |
| | Supply chain technology has reduced costs of supply chain operations. | | | | | |
| | | | | | | |
| Flexibility of operations | Quality control technology has increased the firm's ability to respond to customer/ market demands | | | | | |
| | Quality control technology has improved satisfaction levels of customers. | | | | | |
| | Quality control technology has aided the firm's ability to meet regulatory demands | | | | | |
| | Quality control technology has improved the overall product and service quality offering by introducing global standards. | | | | | |
| Any other (specify) | | | | | | |

8. Any other comment----------
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**APPENDIX III-LIST OF PHARMACEUTICAL MANUFACTURING COMPANIES IN KENYA**

1. Apple Pharmaceuticals Ltd
2. Benmed
3. Biodeal laboratories
4. Elys Chemicals
5. Beta Healthcare
6. Astra Zeneca
7. Pfizer Laboratories
8. Johnson & Johnson
9. Servier
10. Kam Industries
11. Novartis Pharmaceuticals
12. Sanofi
13. Merck Consumer Health & Life Science
14. Lords Healthcare
15. Indoco Remedies
16. Cipla Medpro
17. Cadilla Healthcare
18. C.Mehta & Company
19. Phillips Pharmaceuticals
20. Ely Lilly
21. Merck Schering Plough
22. Novelty Manufacturing
23. Simba Pharmaceuticals
24. Biopharm
25. Bayer East Africa
26. Glaxo Smithkline
27. Concepts (Africa) Ltd
28. Cosmos Ltd Cosmos Limited
29. Lab & Allied

30. Gesto Pharmaceuticals
31. Pharmaceutical Manufacturing Ltd – PMC
32. Universal Corporation Ltd
33. Dawa Company
34. Sphinx Pharmaceuticals Ltd
35. Square Pharmaceuticals
36. Statim
37. MACs Pharmaceuticals
38. Medina Chemicals
39. Nairobi Enterprises
40. Laborex Kenya Ltd
41. Diddy Pharmaceuticals
42. Dafra
43. Unisel
44. Medisel
45. Armicon
46. SynerMed Pharmaceuticals
47. Norbrook Kenya Limited
48. Surgilinks Pharmaceuticals
49. Comet Healthcare
50. Regal Pharmaceuticals

Source: Pharmacy & Poisons Board – Manufacturer registration renewal list 2019