

**ROLE OF MOBILE COMMUNICATION INFRASTRUCTURE ON
HORTICULTURAL DEVELOPMENT IN KENYA: A CASE OF NAKURU
COUNTY**

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DECLARATION

I declare that this dissertation is my original work and has not been previously published or submitted elsewhere for award of a degree. I also declare that this contains no material written or published by other people except where due reference is made and the author duly acknowledge.

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ABSTRACT

The study aimed at establishing the influence of mobile communication infrastructure on horticultural development in Kenya. The study was guided by three objectives namely: to establish the influence of mobile predictive analytics, development of M-applications and network connectivity on horticultural development in Nakuru County. This study was anchored on the Adaptive Saturation Theory; protection motivation theory; and the Information Infrastructure Design theory. The study adopted a descriptive research design. Additionally, the target population was the registered horticultural firms in Nakuru County where the top management staff were the respondents. Since the population is small at 155, the study adopted a census which was the most preferred method when the population was relatively small. Primary data was gathered through structured questionnaires which was self-administered. The data was collected using self-administered questionnaires to the management staff working with the registered horticultural firms in Nakuru County. Following data collection, quantitative data was coded and put into Statistical Packages for Social Scientists (SPSS Version 25), where they were analysed using descriptive and inferential statistics. Tables and figures were used to display quantitative data, while prose was used to explain it. The study recommended that the horticultural firms should install a storage database that records the prevailing climatic, inputs and revenues at different times which would be useful in the forecasting the future expectations. Further recommends that the firms in Nakuru county should develop a communication application focused on activities in the horticultural industry that allows for free flow of information from financiers thereby allowing for real time feedback from the firms. Also recommends that the firms should invest in the channel funds towards the installation of strong networks with strong connectivity and this would prevent any losses that would arise from any kind of network failure. Further, the study recommends that a study be conducted to determine the effects of petroleum extraction on the economic development in Kenya. In addition, the study recommends that a study to be done on the determinants of the involvement development financial institutions in the provision of electricity in manufacturing companies.

Key words: Horticultural development, mobile predictive analytics, M-application, network connectivity

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LIST OF ABBREVIATIONS AND ACRONYMS

AST	Adaptive Saturation Theory
GDP	Gross Domestic Product
GoK	Government of Kenya
HCDA	Horticultural Crops Development Authority
ICTs	Information Communication Technologies
IIDT	Information Infrastructure Design Theory
PMT	Protection Motivation Theory
SPSS	Statistical Packages for Social Scientists

OPERATIONAL DEFINITION OF TERMS

Horticultural Development: Refers to the growth in production and marketing of horticultural produce.

M-applications: M-apps refer to apps which are mobile based. It's a type of application software designed to run on a mobile device, such as a smartphone or tablet computer (Furuholt & Matotay, 2019).

Mobile predictive analytics: This is a phone based statistical methods realised from mining of data, models for predictions as well as leaning machines which basically analyse the present and past information in forecasting the occurrences that might take place in the near future (Baumüller, 2018).

Network Connectivity: Network connectivity describes the extensive process of connecting various parts of a network to one another, for example, through the use of routers, switches and gateways, and how that process works.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Information, communication and knowledge have always mattered in agriculture, with farmers continuously seeking information, communicating with each other and sharing knowledge on new agricultural technologies, markets, breeds, corporations, research etc. Lack of access to information and knowledge transfer can hamper agricultural production in rural farming communities in sub-Saharan Africa (SSA). Agricultural, market, and weather information is critical to agricultural productivity, especially for reducing uncertainty and risk associated with extreme weather events and disease (Baumüller, 2013). The dissemination of agro-meteorological information can improve livelihoods by reducing uncertainty and enable improved inputs and technology adoption. Access to information through mobile phones and mobile internet can also help agriculturalists manage risk and reduce vulnerabilities to a changing climate (Baumüller, 2013).

According to World Bank Group (2018), information communication technologies (ICTs) such as mobile phones are touted as digital platforms with transformative potential to reach many farmers at once across rural settings. Large-scale investment in ICT infrastructure has led to growth in telecommunications connectivity of unprecedented scale across Africa (World Bank Group, 2018). As the cost of mobile phones have fallen and connectivity has spread, phone ownership and internet access have become possible for populations in the continent's lowest-income areas (Wyche & Olson, 2018). With this uptake of mobile phones, users can subscribe to receive

mobile phone-enabled services or 'm-services' to access agro-meteorological (Baumüller, 2015) and market information (Wyche & Steinfield, 2016). Despite the fact that investments in infrastructure in several emerging economies remain low, among the most significant shifts over the last decade seems to be the expansion in mobile phone coverage and use. Nevertheless, due to the expensive cost of modern mobile equipment and insufficient infrastructure in developing nations' remote areas, the adoption of mobile technology remains limited.

The mobile communication infrastructure encompasses mobile predictive analytics, m-applications and the network connectivity. Mobile predictive analytics is a phone based statistical methods realised from mining of data, models for predictions as well as leaning machines which basically analyse the present and past information in forecasting the occurrences that might take place in the near future (Baumüller, 2018). Mobile predictive analytics as a whole may be made up of a variety of statistical abilities such as modelling, machine learning, and data mining.

Mobile predictive analytics, internet connection and mobile based applications systematically mine, compute and analyse data or statistics. Mobile predictive analytics involves measuring and analysing data generated by mobile platforms and properties, such as mobile sites and mobile applications. Modern agro-businesses are moving to precision farming to enhance productivity and efficiency (Aron, 2018). Data provided by in-field sensors help in predicting the number of resources needed to improve crop quality and yields. The agriculture industry endures the most of climate change. Baumüller (2018) precision farming using predictive analytics enables us to foresee the weather conditions for effective resource management and promotes sustainable

agriculture. In addition, Asenso-Okyere and Mekonnen (2017) held that Data-driven agriculture aids in continuous monitoring and enables efficient management of supply chains. Being able to predict the risks and alternatives ensures better and faster distribution of products.

1.1.1 Mobile Communication in Kenya

Mobile phones have certainly changed the way people communicate and is becoming a natural necessity for the people of Kenya. This can be seen from the number of mobile phone units sold in the past years. Most recently, the mobile phones in Kenya have grown whereby as of 30th September 2021, the number of mobile phone devices accessing mobile networks stood at 59.0 million, a penetration rate of almost 109%, out of which 33.0 million were feature phones and 26.0 million smartphones. Kenya has thus seen broad uptake of mobile technology, with higher phone penetration than the global average (67%) and near-universal use of mobile banking through M-PESA.

The mobile communication infrastructure includes; wireless infrastructure which include satellite receivers, construction of mobile phone towers, telecommunication masts, cellular network, mobile predictive analytics, M-applications and network and signal boosters etc. (Kiarie, 2020). The mobile communication infrastructure is key for horticultural development in Kenya and Nakuru County in specific. Because 70 percent of land within the county of Nakuru is productive in terms of agriculture, if measures such as mobile communication infrastructure are installed with the aim of encouraging the best practices in agriculture to be used which would transform the small-scale farmers into commercial farmers (Ogutu, et al., 2019). The horticulture business in Nakuru County, particularly the

floriculture sub-sector, has a lot of promise. For example, in 2020, the county produced more than Kshs 23 billion from the horticultural industry (Nakuru County, 2021).

Horticulture is the largest sub sector of agricultural produce in Nakuru County. The ideal tropical and temperate climatic condition in the county makes it favourable for production since it can support a wide range of horticultural products including cut flowers, vegetables, fruits, nuts, herbs and spices (Mwangi, et al., 2018). The local market for horticultural produce is mainly open hence the prices are controlled by demand and supply factors. Changes in demand at the markets are a problem especially because majority of the farmers marketing education is not well developed. Information, if used in the right way, is a powerful tool in addressing the County's agricultural needs and can definitely change the economy of the county positively, in terms of farmers making better decisions, increased production and higher income (Kiarie, 2020). Marketing of agricultural produce and products is critical to increasing agricultural productivity and commercialization of enterprises so that farming is perceived as a business. Lack of market information has been given as one of the major reasons for the low productivity and low income (Muyanga & Jayne, 2018). Mobile communication infrastructure can be applied in increasing the effectiveness of accessing information.

1.1.2 Horticultural Sector in Kenya

The horticultural industry produces the Kenya's approximately 25% of the Gross Domestic Product (GDP). It does, in fact, contribute for around 65% of Kenya's foreign exchange (Horticultural Crops Development Authority, 2020). High input costs, too many divisions of land into units that are not for economic purposes, low levels of using

technology in agricultural activities, farmers' institutions that are weak, restricted extension services, and insufficient finance facilities are all issues facing the agricultural industry. According to Mwangi, et al., (2018), the horticulture industry contributes to income creation, poverty reduction, and gender equity promotion, particularly in rural regions. Furthermore, the industry is regarded to be particularly important to the national economy because it has provided work to thousands of Kenyans. It has also made a major foreign exchange contributor. It is also suggested that the adoption of horticulture farming by conventional farmers for cash crop will increase revenue and financial stability.

The bulk of Kenyan farmers' primary occupation is cash crop farming, which includes horticulture farming (Mwangi, et al., 2018). Horticulture covers 20% while tea contributes 28% to the overall value of agricultural exports in Kenya (Made, et al., 2019). It should be mentioned that the country's horticulture sub-sector has recently seen phenomenal expansion driven by the exportation activities. Its importance is underscored by the idea that the sector directly uses approximately five million citizens in Kenya in producing, value adding and selling of the horticulture-related goods (HCDA, 2020).

Mwangi, et al., (2018) postulate that the horticulture industry contributes to income creation, poverty reduction, and gender equity promotion, particularly in rural regions. Furthermore, the industry is regarded to be particularly important to the national economy because it has provided work to thousands of Kenyans. It has also made a major foreign exchange contributor. It is also suggested that the adoption of

horticulture farming by conventional cash crop farmers would increase revenue and financial stability.

Nakuru County is county number 32 as established in the 2010 Constitution, and it is also one of the counties where horticulture cultivation is practiced. Flowers, French beans, and vegetables are among the horticultural products available. The majority of these products, especially French beans as well as the flowers, are shipped to markets within the continent of Europe, with Netherlands the most important importer (GoK, 2018). The majority of horticulture farming is done at Naivasha, which is home to the most prominent horticultural farms.

The majority of residents in Nakuru County dependent on agricultural activities as their primary source of income are locked in a cycle of drudgery that has left them impoverished year after year, harvest after harvest (Ogotu, et al., 2019). This is due to a variety of obstacles in the value chain that have hindered farmers' benefits in the past. A considerable percentage of farmers in the county own 0.77 hectares of land on average. 49 percent of the individuals are impoverished, while 36 percent of the residents are experiencing food insecurity (Muyanga& Jayne, 2018). Furthermore, the livelihoods of 60 percent of the county's residents are focused on agricultural industry, either directly or indirectly, are jeopardized.

1.1.3 Mobile Communications and Horticultural Development

M-services deliver electronic media content through mobile technologies and is an umbrella term that includes M-agro, m-commerce, m-banking or m-payments. M-services come in varied forms, including Short Message Service (SMS), Unstructured Supplementary Service Data (USSD), mobile applications (apps) and helplines. The

difference between SMS and USSD protocol is that SMS is a text messaging service, whereas USSD protocol are in the form of ‘Quick Codes’. Depending on the electronic media m-services contain, they can be accessed by phones with and without internet access. M-services can be used to connect buyers to sellers, disseminate general information about farming and livestock (such as market information on prices), and send alerts on pest and disease threats (Baumüller, 2018). Some m-services are free to use or may require a cost to use advanced features, while others are entirely proprietary. For example, Ujuzi Kilimo in Kenya offers actionable recommendations to farmers through subscription-based SMS and USSD services.

Qiang et al. (2012) showed that increased access to climate, crop disease, and market information via m-services improved farmers' production and profitability in Kenya. However, wealthier, educated, and typically urban populations have greater access and therefore benefit from m-services in comparison to rural, poorer populations, especially rural women (Wyche, Simiyu & Othieno, 2019). As a result of this limited access to information for some populations, scholars have questioned whether mobile-based market information can improve circulation of market prices and reduce information asymmetries between farmers and buyers. Srinivasan and Burrell (2013) and Wyche and Steinfield (2016) have detailed the underlying barriers to using mobile phones for accessing Market Information Systems (MIS). These barriers include, but are not limited to, cost of airtime, challenges with charging faulty and low-quality batteries, language, and literacy (Srinivasan & Burrell, 2013; Wyche & Steinfield, 2016).

Gruber and Koutroumpis (2017) revealed that mobile phone technology may offer farmers useful and very recent information on agriculture, which can help them increase their revenue. According to Gruber and Koutroumpis (2017), knowledge and information has always been a critical component in the evolution of every agricultural community, and it has impacted the way farmers think and act over time. This implies that the performance of every farming activity must be linked to the right use of agricultural information.

Conversely, as several studies have shown, the majority of farmers in poor countries, particularly in Africa, lack access to reliable and relevant agricultural information (Khodamoradi & Abedi, 2017). Efforts to increase agricultural development have been hampered as a result. Due to restricted access to contemporary agricultural technology, particularly ICTs, productivity is often poor, which has an impact on market participation (Barrett, 2018). Many farmers lack knowledge about market prices and demand, as well as links with potential purchasers (Jensen, 2017).

In essence, inadequate agricultural information has been one possible explanation for the stagnation of agricultural performance in developing nations, making farmers subject to a variety of dangers during growing, transportation, and sale of their commodities (Foster & Rosenzweig, 2018). Tanzanian farmers, like those in other Sub-Saharan African nations, have limited access to agricultural knowledge (Furuholt & Matotay, 2019). Goyal (2018) has also recognized certain important agricultural difficulties, one of which is a lack of access to marketing information in crop and animal sectors.

Low levels of knowledge of the market has been cited as one of the primary causes for Kenyan agriculture's low production and income (Asenso-Okyere & Mekonnen, 2017). Farmers may bargain and increase their profits by adjusting production plans and better allocating production elements, as well as using market information to make marketing decisions. Mobile communication infrastructure can be used to improve the efficiency of information access. Research has resulted in an invention that uses mobile phone connectivity to acquire information on a variety of requirements, including the availability, accessibility, and costs of various agricultural supplies, weather predictions, and market availability and prices of items in the market (Maritz, 2017).

1.2 Statement of the Problem

The Kenyan Economy majorly depends on Agriculture (Muyanga & Jayne, 2018). Horticulture is second most major part of the agricultural industry in Kenya, accounting for 20% of the sector's foreign revenues (Kiarie, 2020). Majority of the farmers choose to work as horticultural farmers compared to other kinds of agribusiness because of its anticipated to have higher and better returns. However, the horticultural industry is faced by significant hurdles. Farming operations are more expensive than other types of agriculture (Ogotu, Okello, & Otieno, 2019). Recognizing the importance of the horticulture industry, the government has consistently devoted significant resources to it. For example, in 2021/2022, the government set aside Ksh 1.5 billion to help flower and horticulture growers gain access to foreign markets (Thiga & Ndungu, 2021).

Regardless, the sector, like other agricultural sectors, has failed to accomplish its ambition.

For instance, only 4% of the fruits and vegetables produced is sold internationally while the rest is consumed within the Kenyan borders (Ogutu, Okello, & Otieno, 2019). Over 90% of the vegetables consumed locally is produced by the small farmers where majority of it is fed to the livestock which is considered as wasted. The massive local consumption has led to shortage in production resulting to minimax availability of exportable vegetables. An effective market information system, such as that offered by mobile communication infrastructure, is critical for the horticultural sector's performance and growth. This method allows for the open flow of information across the marketing chain (Baumüller, 2018). This can aid in increasing transparency, competition, and equitable benefit sharing among key actors in the horticulture marketing system. This is because farmers' ability to seek viable overseas markets for their goods is hampered by a lack of market knowledge. The ramifications of the preceding difficulty are far-reaching, as millions of Kenyans rely on the sub-sector for a living, both directly and indirectly (Mwangi, *et al.*, 2018). To address this, both the government and mobile service providers have made numerous initiatives to extend and upgrade mobile communications infrastructure in order to boost information access (Aron, 2018).

Several studies on the impact of technology on agriculture have been done. Okello (2017), for example, conducted a study on the role of ICT use on the productivity of agro-enterprises by smallholder pineapple producers in Kiambu County. The study focuses on ICT in general rather than the impact of mobile communication

infrastructure. Kiarie (2020) did research on the drivers of digital technology adoption among Kenyan small-scale farmers. This study concentrated on the factors that influence digital technology adoption rather than the causal link between digital technologies and agricultural progress. Clearly, research on the causal link between mobile phone infrastructure and horticulture growth are constrained. This study was purposed to focus mobile communication in Kenya on how mobile communication infrastructure has impacted horticulture growth in Kenya, with a particular focus on horticultural farms in Nakuru County, which is one of the horticultural producing counties.

1.3 Objectives of the Study

1.3.1 General Objective of the Study

The study aims at establishing the role of mobile communication infrastructure on horticultural development in Kenya specifically focusing on horticultural farms in Nakuru County.

1.3.2 Specific Objectives of the Study

- i. To establish the effect of the mobile predictive analytics on horticultural development in Nakuru County.
- ii. To evaluate the effect of the development of M-applications on horticultural development in Nakuru County.
- iii. To establish the effect of the network connectivity on horticultural development in Nakuru County.

1.4 Research Questions

- i. What is the role of mobile predictive analytics on horticultural development in Nakuru County?
- ii. What is the effect of the development of M-applications on horticultural development in Nakuru County?
- iii. What is the effect of the network connectivity on horticultural development in Nakuru County?

1.5 Significance of the Study

The study's findings will be useful to policymakers on the most policies that can be developed and executed to save the horticulture industry. The recommendations made will assist in developing realistic strategies to address the difficulties impacting the sub-sector.

It is unclear if investment in the country's mobile communications infrastructure would inevitably contribute to economic development. Establishing this link will aid in driving change in management policies regarding the incorporation of mobile communication infrastructure. The study will so aid farm managers by allowing them to better understand how they might improve the growth of their individual horticulture enterprises.

Future research in the horticulture and finance will find the study's conclusions useful as a reference. The study will be useful since it will become part of the existing literature.

1.6 Scope of the Study

The study was conducted on the connection that exist between the role of mobile communication infrastructure and horticultural development in Kenya. Specifically, the study focused on the mobile predictive analytics, M-applications and network connectivity and how they influence horticultural development. The study was carried out among the senior management staff of the horticultural firms in Nakuru County which defined the geographical scope of the study. The researcher made comparisons between theory as developed and discussed by various scholars and practice by way of conducting interviews, to arrive at reliable information appropriate for the study. The study took two months to collect relevant data from the field, prepare it for analysis and made the appropriate and incontestable conclusions as well as recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Literature focussed on the effect of mobile communication infrastructure on horticultural development has been reviewed. It covered the theoretical review and the empirical review which illustrates what other authors have found about mobile communication infrastructure. In addition, a conceptual framework was included showing the connection that exists between the study variables.

2.2 Theoretical Framework

The theoretical review helps in providing the foundation under which the study is developed. Adaptive Saturation Theory, protection motivation theory and the Information Infrastructure Design theory guided the study.

2.2.1 Adaptive Saturation Theory (AST)

The study was anchored on the Adaptive Saturation Theory as postulated Giddens (1979). Giddens (1979) described efficiency outcome as a driving factor that researchers want since they can expect dependable outcomes from their research. AST is commonly used by researchers while examining technological system improvements since they seek to detect conflicting findings in their studies by giving focus on specific factors that would help in explaining the differences (Niederman, et al., 2008). AST focuses on establishing organizational frameworks for technology industry research. Each group in the technology business is responsible for refining the existing technology and giving it to the stakeholders involved to learn, interact, as well as exchanging resources in terms of finances and ideas (Niederman & colleagues, 2008).

Adaptive Structuration Theory (AST) is one of the top three theories of group communication. AST is an approach for studying the role of advanced information technologies in organizational change. The theory seeks to understand the types of structures that are provided by advanced technologies and the structures that actually emerge in human action as people interact with these technologies. AST focuses on social structures, rules, and resources provided by technologies and institutions as the basis for human activity. The theory purports that structures in technology and structures in action are continually intertwined, continuously shaping each other. Social structures provided by advanced information technology have two parts. First, structural features are specific types of rules and resources, or capabilities, offered by the system. Second, spirit is the general intent with regard to values and goals underlying a given set of structural features. Spirit helps users understand and interpret the meaning of technology. Examples of dimensions that characterize the spirit of a social structure include: decision process, leadership, efficiency, conflict management, and atmosphere.

The theory stresses the convergence of two dynamics namely the growing phenomena of user-driven adaptation and the improved technological attentiveness (Schmitz et al., 2016). The employees without particular technical skills may be required to variate IT capacities for instance the portable devices for computing with the aim of attaining the aims using AST technique (Schmitz et al., 2016).The technology created through the guide of AST structure has given typical consumers the ability to utilize gadgets that were portable for instance the cell phones, laptops, radio calls, tablets that are editable, interactive, reprogrammable, adaptable, and transformable (Schmitz et al., 2016).

AST views organizations as systems of communication. When individuals desire to create a group, they begin by communicating. The individuals express their expectations for the group, and soon a set of rules, or structure, begins to emerge. The individuals establish the group by accepting the rules. As group members continue to communicate in the course of making decisions, weaknesses or limitations in the structure become apparent. Group members then modify the rules to better suit their needs. As members change, draw upon new resources to solve problems or experience shifts in environment, the group attempts to maintain stability by altering its structure. In this way, AST shows how communication allows groups to evolve while remaining stable. Indeed, without communication, organizations would cease to exist.

Technology actors largely depended on the AST in accomplishing the aims since focused on the various values, beliefs, views, attitudes, practices, habits, approaches for solving problems, and language that necessitate a high level of agreements while installing and adopting new innovative technologies (Barrett, 2018). Because researchers rely on one another for scientific developments, AST promotes unanimity to the technology industry (DeSanctis & Poole, 2014). Improvements to mobile technology infrastructure, such as mobile IoTs, in areas where most horticultural farmers dwell, likely to depend on the AST structures in the development of technological-based gadgets that can be employed by farmers in increasing the productivity. Technology must be applied in order to ensure expansion and success of farmers in the endeavours. The theory informed the study in that it laid foundation in informing the factors behind the adaptation of various mobile predictive analytics aimed at promoting the development of horticultural activities. The theory was

beneficial in informing the aspects accessing and adopting information aimed at improving the decision-making process and the outcomes of the decisions made.

2.2.2 Protection Motivation Theory

The research will also include Rogers' Protection Motivation Theory (PMT), which he created in 1975. PMT focuses on how people defend themselves when they are in the presence of a threat that is perceived by the application of the cognitive mediation process (Brooks & Bubela, 2020; Xing, et al., 2019). The theory is made up of aspects focused on the state of the emotions of a person and the way they influence the personal attitudes (Miraja, et al., 2019). In addition, this theory is composed of four vital items which are aimed at safeguarding an individual from damage. The four components are risk must be substantial; the person can never stand the danger; the response must be applicable in stopping the danger and that the individual involved must be in a capacity to handle the reaction (Miraja, et al., 2019). The PMT is focused on the responses rather than the ways to sustain technical advancement.

Protection motivation theory proposes that people protect themselves based on two factors: threat appraisal and coping appraisal. Threat appraisal assesses the severity of the situation and examines how serious the situation is, while coping appraisal is how one responds to the situation. Threat appraisal consists of the perceived severity of a threatening event and the perceived probability of the occurrence, or vulnerability. Coping appraisal consists of perceived response efficacy, or an individual's expectation that carrying out the recommended action will remove the threat, and perceived self-efficacy, or the belief in one's ability to execute the recommended courses of action successfully (Rogers, 1975).

The threat appraisal process consists of both the severity and vulnerability of the situation. It focuses on the source of the threat and factors that increase or decrease likelihood of maladaptive behaviours. Severity refers to the degree of harm from the unhealthy behaviour. Vulnerability is the probability that one will experience harm. Another aspect of the threat appraisal is rewards. Rewards refer to the positive aspects of starting or continuing the unhealthy behaviour. To calculate the amount of threat experienced take the combination of both the severity and vulnerability, and then subtract the rewards. Threat appraisal refers to children's evaluation of the degree to which an event has significant implications for their well-being. Theoretically, threat appraisal is related to Lazarus' and Folkman (1984) concept of primary appraisal, particularly to the way in which the event threatens the child's commitments, goals, or values. Threat appraisal is differentiated from the evaluation of stressfulness or impact of the event in that it assesses what is threatened, rather than simply the degree of stress or negativity of an event. Threat appraisal is also differentiated from negative cognitive styles, because it assesses children reported negative appraisals for specific events in their lives rather than their typical style of responding to stressful events. Theoretically, higher threat appraisals should lead to negative arousal and coping and to increased psychological symptomatology.

The coping appraisal consists of the response efficacy, self-efficacy, and the response costs. Response efficacy is the effectiveness of the recommended behaviour in removing or preventing possible harm. Self-efficacy is the belief that one can successfully enact the recommended behaviour. The response costs are the costs associated with the recommended behaviour. The amount of coping ability that one experiences is the combination of response efficacy and self-efficacy, minus the

response costs. The coping appraisal process focuses on the adaptive responses and one's ability to cope with and avert the threat. The coping appraisal is the sum of the appraisals of the response's efficacy and self-efficacy, minus any physical or psychological "costs" of adopting the recommended preventive response. Coping Appraisal involves the individual's assessment of the response efficacy of the recommended behaviour (i.e. perceived effectiveness of sunscreen in preventing premature aging) as well as one's perceived self-efficacy in carrying out the recommended actions. (i.e. confidence that one can use sunscreen consistently). The Threat and coping appraisal variables combine in a fairly straightforward way, although the relative emphasis may vary from topic to topic and with target population (Monat & Lazarus, 1991).

Response efficacy concerns beliefs that adopting a particular behavioural response will be effective in reducing the diseases' threat, and self-efficacy is the belief that one can successfully perform the coping response. In line with the traditional way of measuring the consequences of behaviour, response efficacy was operationalized by linking consequences to the recommended behaviour as well as to whether the subject regarded the consequences as likely outcomes of the recommended behaviour. Among the 6 factors (vulnerability, severity, rewards, response efficacy, self-efficacy, and response costs), self-efficacy is the most correlated with protection motivation, according to meta-analysis studies (Herath & Rao, 2009).

Government and business executives are required to make choices on mobile technology infrastructure enhancement without fear of personal ramifications (Westcott, *et al.*, 2017). Because of their PMT approach, these executives may fail to take necessary steps that may help enhance technology that is mobile based. PMT is

focused on assisting people in the development and reinforcement of the responses as well as efficiency that is personalized, as well as translating information into behaviors that are safe and efficient (Westcott, *et al.*, 2017). PMT is basically concerned with describing the cognitive mediation processes of behavioral adjustments in terms of an individual's danger and coping evaluation, as well as their ability to defend themselves.

This theory will be relevant in explicating the development of M-applications variable. As explained earlier, the theory focuses on how people defend themselves when they are in the presence of a threat that is perceived by the application of the cognitive mediation process. This theory was relevant to the goal of development of M-applications which is to alleviate threats by detecting trends in environmental changes, and enabling improved resource management to deal with it. The theory informed the study on the benefits that come along with the development of M-applications aimed at providing information targeting the countering the frictions in market outcomes by providing real time information on the existing markets as well as identifying and creating new ones.

2.2.3 Information Infrastructure Design Theory (IIDT)

IIDT is specialized on the telecommunication systems and databases administered and protected by a team made of diversified professionals (Knol & Yao-Hua, 2018). The presence of the team is to create a connection between the mobile technology and the humans (Knol & Yao-hua, 2018). According to Hanseth and Lyytinen (2016), technology studies have relied on IIDT to employ complicated IT systems as artifacts and mark them with general information infrastructure labels so that users may locate the application of mobile technologies. From a universalized technical view point, developing a whole information technology is entailed on the identification,

implementation, integration, regulation as well as the coordination of the increasingly varied IT competences (Hanseth & Lyytinen, 2016). The mixing of the different components allows farmers with the aim of enhancing the technological expertise.

Information infrastructure design theory is a theory for designing information infrastructures. As information infrastructure theory is a theory that aims to describe a class of politically and technically complex and often quality large information systems, such as the internet, mobile technologies, health information systems in developing countries, electronic patient journals, global management systems etc., one might expect the information infrastructure design theory giving prescriptive advice on how to assemble such systems. The notion of information infrastructures, introduced in the 1990s and refined during the following decade, has proven quite fruitful to the information systems (IS) field. It changed the perspective from organizations to networks and from systems to infrastructure, allowing for a global and emergent perspective on information systems. Information infrastructure is a technical structure of an organizational form, an analytical perspective or a semantic network (Ciborra, 2000).

Information infrastructure, as a theory, has been used to frame a number of extensive case studies and in particular to develop an alternative approach to IS design: "Infrastructures should rather be built by establishing working local solutions supporting local practices which subsequently are linked together rather than by defining universal standards and subsequently implementing them. It has later been developed into a full design theory, focusing on the growth of an installed base (Hanseth & Lyytinen, 2016).

Moreover, IIDT emphasizes on resource sharing across communities and individuals aimed at sharing resources as well as the provision of information services (Eikebrokk & Iden, 2017). The theory aims at promoting the responsiveness to any probable upgrading of the capacities of the stakeholders in the IT with the aim of collaborating at minimum theoretical performances that are aimed at informing the executive designing the information systems. The theory combines ideas for designing and implementing infrastructures for informational transactions (Knol & Yao-hua, 2018). Despite this theory creating a link between the communication systems and humans, IIDT was aimed at empowering leaders to explore ideas for installing successful mobile technology infrastructures for rural farmers. The theory was relevant in proving foundation on the benefits of network connectivity and platforms aimed at promoting information revolution thereby strengthening social capital that comes along the adoption of new paradigms.

2.3 Empirical Framework

2.3.1 Mobile communication and Horticultural Development in Kenya

Kenya has a long history of growing horticultural crops for both domestic and export markets. Over the years, the horticultural sub-sector has grown to emerge as the most important sub-sector in the Agricultural sector. Kenya's ideal tropical and temperate climatic condition makes it favourable for horticulture production and development. The climate is highly varied supporting the growth of a wide range of horticultural crops. Horticulture in Kenya is mainly rain fed though a number of farms, especially the ones growing horticultural crops for export, also use irrigation. The sub-sector is characterized by a tremendous diversity in terms of farm sizes, variety of produce, and

geographical area of production. Farm sizes range from large-scale estates with substantial investments in irrigation and high-level use of inputs, hired labour and skilled management to small-scale farms, usually under one acre.

The sub-sector generates over US\$300million in foreign exchange earnings. The total horticultural production is close to 3 million tonnes making Kenya one of the major producers and exporters of horticultural products in the world. Europe is the main market for Kenyan fresh horticultural produce with the main importing countries being United Kingdom, Germany, France, Switzerland, Belgium, Holland and Italy. Other importing countries include Saudi Arabia and South Africa. A well-developed and dynamic private sector has profitably marketed a wide range of horticultural products to diverse international markets. Government role in this sub-sector has been mainly facilitating the sectoral growth through infrastructure development, incentives and support services. Structural and macroeconomic reforms, plus the introduction of more liberal trading environment has also provided a major boost to the country's horticultural prospects.

Large-scale growers dominate commercial horticulture, while the majority of horticultural growers (about 80%) are small-scale farmers. However, virtually all rural households located in arable areas grow fruits and vegetables for home consumption and sale. A wide range of horticultural crops is grown which include bananas, mangoes, tomatoes, brinjals, French beans, summer flowers, apples, plums, peaches, carrots, kales, cabbages, snow peas, greenhouse flowers and local vegetables. These crops are grown under both rain-fed and irrigated conditions but production is inadequate due to seasonality and unreliability of rainfall. High potential agricultural land is heavily

populated, so plots farmed by households are mostly small which has led to settlement and farming activities in the ASALs. Irrigated horticulture for high value crops is considered a viable and very attractive option for the development of irrigation in the arid and semi-arid areas.

Kenyan horticulture is the third leading agricultural export, following tea and coffee. Exports of horticultural produce are estimated to account for about 3 to 5% of horticultural production. Fresh produce accounts for about 30% of horticultural exports, and include green beans, onions, cabbages, snow peas, avocados, mangoes and passion fruit. Flowers exported include roses, carnations, statice, alstroemeria, and lilies. Export statistics for fruit, vegetables and flowers, over the past five years, have shown significant increases in both quantities and total export values. In 2004, the horticultural export market, was reported to be worth 32.5 billion KES (US\$ 466 million), an increase of 13% compared with 2003. The main export destination for fresh horticultural produce is Europe, Middle East and other African countries. Fresh Produce Exporters Association of Kenya (FPEAK) and Kenyan horticultural exporters have been proactive in the development of the industry's codes of practices.

Although no financial values are available for domestic sales, it is currently estimated to account for sales of 95% - 97% of horticultural production by quantity. Fresh vegetables and fruits are significant components of the local diet, with estimations of annual per capita consumption of about 20 kgs in rural areas and 40 kgs in urban areas. About one third of all output is consumed by the household which produced it and the majority of production is traded within rural areas. In urban areas, fruits and vegetables account for around 25% of all expenditure on food. Most fruits and

vegetables are purchased from small-scale traders located in or around municipal markets or from retailers who sell from small shops, kiosks or roadside stalls. There is a small, growing amount of sales of higher-quality produce through supermarkets which is thought to account currently for about 5% of the total quantity of marketed production.

The main constraints facing the smallholder horticulture producer include high prices of farm inputs, poor distribution of farm inputs stockists, poor quality of seeds, and limited access to suitable credit facilities. Horticulture crops are often affected by high incidence of pests and diseases, and inadequate technical knowledge regarding pests and disease identification and control. Marketing is also a major problem for smallholder horticulture producers where middlemen frequently exploit farmers for both export-oriented crops and produce for local market. The problem is aggravated by lack of cold storage facilities, poor post-harvest handling techniques, and congested markets. Poor road infrastructure to horticulture production areas contributes to high post-harvest losses of horticultural produce and higher transportation costs. This also affects availability of farm inputs provided by buyers to their contracted farmers. Finally, smallholder commercial horticulture is constrained by inadequate technical information and skills with the extension staff and farmers who are not able to source information.

The shortage of water is also a major constraint to horticulture development in Kenya. Given that the most of Kenya's land area is ASAL, the country's heavy reliance on rain-fed agriculture slows the process of attaining food security and self-sufficiency. This is exacerbated by the fact that the pace of irrigation development in the country is

very slow, with only 19% of the total potential 65,800 ha having been developed to date. There are several factors constraining irrigation development in the country, chief among them being inadequate funding and the absence of a clear-cut government policy on irrigation development in the smallholder sector. To improve water services delivery, GOK has embarked on the water sector reforms. MoWNR initiated the process of developing a national water resource management strategy (NWRMS) in April 2003, which was revised in December 2004. The main role of the NWRMS is the operationalisation of the 2002 Water Act, which led to the establishment of the Water Resources Management Authority (WRMA) in November 2003 as the lead agency with respect to water resources planning, development and management in Kenya.

The flow of information on horticultural production and marketing to youth has been hampered by under-utilization of information and communication technologies (ICTs) (Njenga *et al.*, 2012). However, it is essential to digitize agricultural production and marketing information into web-based resources. This would enable wider outreach and use since the few available extension officers do not effectively reach the majority of the farmers at different locations.

Duncombe (2012) did a literature review of the potential and the limitations of mobile phones in the delivery of rural services for agricultural and rural development in developing countries. The results showed variation in levels of awareness and usage of services that could potentially be accessed via mobile phones. Most commonly, this was due to poor technological skills and experience and in many cases that the information provided lacked relevance to their needs. This was because traders preferred a system that allowed interaction with the broad range of participants in any given produce value chain including agents, brokers, assemblers, wholesalers and final

purchasers and voice best facilitates this. This review study differs with the current study in that data collected was secondary as compared to the current study which relied on primary data. However, there is similarity in that both looked in mobile phones usage in accessing agricultural information among farmers.

Nyaga (2012) did a study in Kiambu, Kenya on adoption of ICTs in enhancing marketing of agricultural produce. Random sampling was used for the study. Results showed that public extension services remain significant to small scale farmers but results point towards a need to strengthen this institution to provide up-to-date market information. The study showed that there is a need to use information and communication technology in identifying new markets and in dissemination of information to agricultural producers. The study is similar to the current study in that both are looking at importance of technology adoption in enhancing market information. However, the two differ in research methodology in that Nyaga (2012) used random sampling while the current study used purposive in selecting the study area and systematic sampling in selecting households. The current study also looked at specifically horticultural small holder farmers while that of Nyaga (2012) focused on all small holder farmers.

Mittal and Mehar (2012) carried out a study on how mobile phones contribute to growth of small holder farmers in India. The authors argue that rapid growth of mobile telephony and the introduction of mobile-enabled information services provide ways to improve information dissemination to the knowledge intensive agriculture sector and also help to overcome information asymmetry existing among the group of farmers. It also helps, at least partially, to bridge the gap between the availability and delivery of agricultural inputs and agriculture infrastructure. Data was collected from

focus group discussions. Results showed that mobile phone communication provided a better connectivity to markets and price realization and reduced transaction costs. The similarity with the current study is that both studies look at use of mobile phone communication in accessing agricultural information. However, Mittal and Mehar (2012) used only focus group discussions to collect data whereas the current study employed questionnaires and interviews in addition to focus group discussions

The formal Kenyan economy has been unable to create enough employment opportunities to absorb the constant supply of labour-seeking youth. Whatever the solution to this problem, a great deal of coordination and skilful thinking will be required to attract gadget-loving and efficiency-prone individuals into the agricultural sector. However, participation in the horticulture sector in many developing countries is low, largely because the sector is highly unattractive due to risks, costs, inefficiency and its labour-intensive nature. As such, motivating the youth to view agriculture as a career opportunity will require a multi-level intervention. Continuous initiatives to support youth in agricultural enterprises and widen the opportunities to showcase their successes in order to attract more people are paramount. One of these should be the incorporation of information and communication technologies (ICTs) such as the internet, mobile phones, computers and Global Positioning Systems (GPS) associated or not with traditional communication technologies such as radio, television, written press and video. It is against this background that the study aims at determining the role of mobile communication infrastructure on horticultural development in Kenya with a focus on Nakuru County.

2.3.2 Mobile Predictive Analytics and Horticultural Development

Mobile predictive analytics is a phone based statistical methods realised from mining of data, models for predictions as well as leaning machines which basically analyse the present and past information in forecasting the occurrences that might take place in the near future (Baumüller, 2018). Mobile predictive analytics as a whole may be made up of a variety of statistical abilities such as modelling, machine learning, and data mining. These approaches are used in agriculture to analyse what has happened in the past on the farm, as well as what is now occurring and what is likely to happen, in order to utilize the data to anticipate the future and make decisions that affect the bottom line and end usage of on-farm goods (Asenso-Okyere & Mekonnen, 2017).

Shan (2019) discovered a 30% increase in cereal grain yield with correct administration of nutrient infusion in soil and pesticides in his study in the United States, which was only achievable due to the adoption of mobile predictive analytics. In his research in China, Liu (2019) proposed that one of the most difficult difficulties for agriculture is coping with climate change and pollution of various types. He believed that mobile predictive analytics may enter this domain, detect trends in environmental changes, and enable improved resource management to deal with it. Using big data analytics, this type of precision farming can reduce crop health risks from pests, diseases, and environmental variables.

Baumüller (2018) proved that data-driven agricultural practices might help farmers to spend more in scientific breakthroughs while also reducing risks, protecting themselves from global adversities such as a pandemic. Farmers may use agricultural mobile predictive analytics to assess conditions of the weather, temperature changes,

consumption of water, as well as the conditions of the soil acquired from farms with the aim of making educated and informed business decisions such as deciding the most viable crop selections as well as the hybrid seeds waste reductions.

According to Liu (2019), the Chinese government have developed more-focused mobile based information gadgets aimed at monitoring and diagnosing farm conditions and it has facilitated the use of mobile predictive analytics in agricultural activities. At the moment, the equipment created and utilized mostly includes gadgets for agricultural information, environmental information monitoring as well as animals' activities monitoring (Shan, 2019).

According to Li et al. (2017), analysis of big data further determines maximized irrigation application, aids in the reduction of emission of greenhouse gases as well as pinpointing the specific requirements in terms of nutrients, light, soil and water for propagation. However, the ultimate goal of information processing is to gather and evaluate data (Baumüller, 2018). Mobile predictive analytics use AI technology to help with aim of detecting diseases, weeds, pests, insects as well as insufficient nutrients of the plants. The AI detectors helps in the identification and targeted unwanted plants in the process of determining the type and number of herbicides necessary to counter it (Aron, 2018).

According to Eikebrokk and Iden (2017), farmers are adopting mobile predictive analytics to increase agricultural precision by developing probabilistic season long models for forecasting the trends in agriculture. The models focus on several months ahead which helps in determining the most fit crops for a specific season, as well as appropriate planting timings and places. AI detectors allows the farm

managers to make informed decisions guided by the projected weather patterns for the future season. (2019, Shan).

In his study, Liu (2019) stated that climate and weather can be projected to a limited extent, there are additional factors that can be leveraged upon in farms. Harvesting data is used to feed prediction systems aimed at guiding decision-making processes on the harvest the coming year, for instance the population of the crops, strains of plants, types of irrigation, preparation of the soil as well as the management of pests' invasions (Gruber & Koutroumpis, 2017). Economic changes, commodity pricing, management of supply chain, whether farmers must take insurance from the government as well as the minimal production criteria are all determined using risk management products and algorithms (Foster & Rosenzweig, 2018).

According to Foster and Rosenzweig (2018), plant information monitoring is critical in agricultural output. It has the potential to greatly increase agricultural productivity and quality. Plant life information to be gathered consists mostly of observable data such as enlargement of fruits, pests and diseases, leaf area and internal data such as the content of chlorophyll, nitrogen of the crops and rate of photosynthesis.

2.3.3 M-applications and Horticultural Development

M-apps refer to apps which are mobile based, although there are versions for other devices such as computers. However, mobile phones offer several advantages, including cost, widespread ownership, voice conversations, and rapid and service delivery that is convenient as well as efficient (Furuholt & Matotay, 2019). For millions of people who have been barred from their usage, mobile applications for agricultural

development might provide the most cost-effective, practical, and accessible paths to information, market information, leadership, and funding (Wyche & Olson, 2018).

M-applications, according to Baumüller (2018) have diversified applications such as linking sellers and buyers, general information communication in regard to crops and animals such as pricing and delivering the disease/pests warnings. A number of mobile based services are free to use and other are have charges attached as they have advanced services. According to Wyche and Olson (2018), enhanced accessibility of market, disease, climate information by the use of mobile services which has promoted the production and profitability in Kenyan agricultural industry (Wyche, et al., 2019).

Furthermore, Gruber and Koutroumpis (2017) hypothesized that, despite technological improvement and greater use of mobile applications in other industries, the agriculture industry has witnessed significantly slower application utilization than other sectors. As a result of some populations' restricted information accessibility, experts have casted doubts on the quality of the market information from the mobile-based systems in determining the market price as it eliminates knowledge irregularities on the parts of the farmers and buyers of the farm outputs (Wyche & Olson, 2018).

In their analysis of climate change adaptation and mobile phone apps in the Caribbean and Latin America, Eakin et al. (2015) argue that M-applications help farmers adapt by strengthening social capital, improving access to essential information for decision-making, and coordinating players. Goyal (2018) argued in his study that the creation of mobile applications in the horticulture sector is generally done by private

developers, with initial financing primarily coming from development money via grants.

According to Furuholt and Matotay (2019), sector-specific apps have a restricted usage that includes only stakeholders in the stated sectors, hence would-be users who do not directly utilize the applications see no reason to download and install the applications. Furthermore, some sector-specific apps, such as crop information applications, may be used only at certain periods of the year (Xing, et al., 2019). In such cases, customers who do not utilize mobile applications as frequently as other programs may regard them as superfluous. Users of mobile phones may choose not to install programs on their phones and instead rely on other sources of information.

According to Yu and Madoff (2004) horticultural growers in Flanders make low use of connection to network. The Internet applications used most frequently are online banking, information on market prices and yields of outputs, and weather forecasts. However, a large variation of the Internet behaviour is observed among the growers. The influence of personal characteristics (biographical and social characteristics, communication behaviour) and business size is examined on the use of five groups of Internet applications: general applications, basic management information, specialised management information, information on output prices and yields, and e-commerce. Data were collected at 163 horticultural businesses with Internet use for business purposes. Categorical principal component analysis of the explaining variables resulted in five dimensions. "Openness and active search for information" shows a significantly positive influence for all examined Internet applications, except for e-commerce.

“Long-term perspectives of the business” is found to have a significantly positive influence on the use of general applications and e-commerce.

As per Qiang, Kuek, Dymond and Esselaar (2012) E-commerce is also significantly influenced by the connection to network, customised to marketing mobile applications and by “attitude towards risks and environmentally friendly production techniques” and “agricultural or horticultural education, supplemented by additional courses”. “Larger businesses with the search for specific advice” is a dimension with a significantly positive effect on the use of specialised management information and e-commerce. For many Internet applications the personal attitudes of the business manager seem to be important, suggesting that developing human capital is crucial to increase the speed and coverage of Internet adoption.

2.3.4 Network Connectivity and Horticultural Development

Internet access is needed for proper mobile functionality and data storage, whereas most monitoring systems provide an established method for communicating from the sensor to a home base (such as a computer in the office), there is no established method for communicating the monitoring report to the mobile device in the paddock (Foster & Rosenzweig, 2018). 3G and 4G mobile networks provide the most cost-effective and simple internet access via mobile devices such as smartphones and tablets Muyanga and Jayne (2018).

According to Clarke (2017), the effects of mobile communications consumption on development would be difficult to achieve without the increase of internet data and signal availability that enables mobile communications. According to Wyche and Olson (2018), mobile devices have radically revolutionized how digital technology is utilized

in agriculture by enabling location-based apps to be linked to real-time sensors and enabling the synchronization of multiple devices. However, Aron (2018) contends that connection is the most significant barrier to agricultural technology adoption.

Brooks and Bubela (2020) hypothesized in their study in the United States that despite 97 percent of Americans possess a mobile phone, cellular service is unequal across the country. Poor reception, sluggish downloading speeds, and missed SMS messages are typical in distant places and rural towns. Smaller, less-developed towns have yet to benefit from the most modern wireless technology (Eikebrokk & Iden, 2017). However, connection is equally as important in agriculture producing areas. Using a cell signal booster for farms is one technique for enhancing connectivity in non-urban locations.

Shan (2019) hypothesized in their study that in India, more than four farmers out of ten are reported to lack a decent network at their farms, preventing them from engaging in modern-day farming. As a result of the weak connectivity, important agricultural production increase is inhibited (Osadebamwen & Ele, 2019). Farmers are unable to adopt new technology that would assist the manufacturing of new goods due to a lack of adequate internet network. Aside from communication, it is extremely difficult for farmers and farm personnel to monitor their crops and other production data.

Dalberg, (2013) held that network connectivity removes the need for proximity to customers, allowing businesses to market their products outside of their local community and consequently have access to a broader pool of clients and consumers. Secondly, network connectivity lowers communication and transaction costs and it

improves the availability and the exchange of information, reducing information asymmetries and enabling sellers and buyers to access markets at a cheaper cost (Clarke & Wallsten, 2016). Further, Madon (2000) With the web, companies can establish increasing commercial connections with customers, business partners, suppliers and information resource providers.

Chukwu and Uzoma, (2014) held that network connectivity provides an improved and cheaper platform for marketing and advertising, the effectiveness of which has been recently boosted by the exponential increase in social networking, where customers can share their experience with other online users. There are almost 80 million active social network users in Africa today, corresponding to a social penetration⁹ of around 7% of the total population (We Are Social, 2014). According to a survey of more than 8,000 horticultural farmers in Ghana, Kenya, Tanzania and Zambia in 2009 and 2010 (Audience Scapes, 2010), 19.8% of the respondents who use the Internet visit a social networking website at least once a day, and an additional 15.2% at least once a week. Similarly, there are almost 10 million Facebook users in South Africa, where Facebook penetration is approximately 19%¹⁰. These individuals spend on average approximately three hours per day on social media channels (We Are Social, 2014). Internet users who also utilise social networks are more likely to be active online. For example, in South Africa, online social media users are more than twice as likely to go online daily (75%) than other Internet users (35%) (Balancing Act, 2014).

In addition, Chukwu & Uzoma, (2014) network connectivity for expanding e-commerce, in Nigeria, Cash on Delivery solutions, as seen for example with Jumia and Konga Nigeria Limited, two major online retailers, have been gradually substituted by

cashless policy campaigns. Cash payment systems, in fact, are expensive and less transparent than electronic payments. Also, if predominant, they result in great amounts of money outside of the formal economy, which limit the effectiveness of the monetary policy. Moreover, network connectivity presents an opportunity for direct online sales. E-commerce has been growing rapidly in SSA, but hindered by the lack of support services such as delivery systems and online payment platforms, which generate resistance to electronic payments. The McKinsey Global Institute (2013) estimated that, by 2025, e-commerce will account for 10% of total retail sales in Africa's main economies.

2.4 Conceptual Framework

A conceptual framework is a structural diagram that connects the study variables (Mugenda & Mugenda, 2009). The independent variables' changes are predicted to bring changes in the in the dependent study variable. The variables in this study and their relationships are shown in the figure 2.1 below;

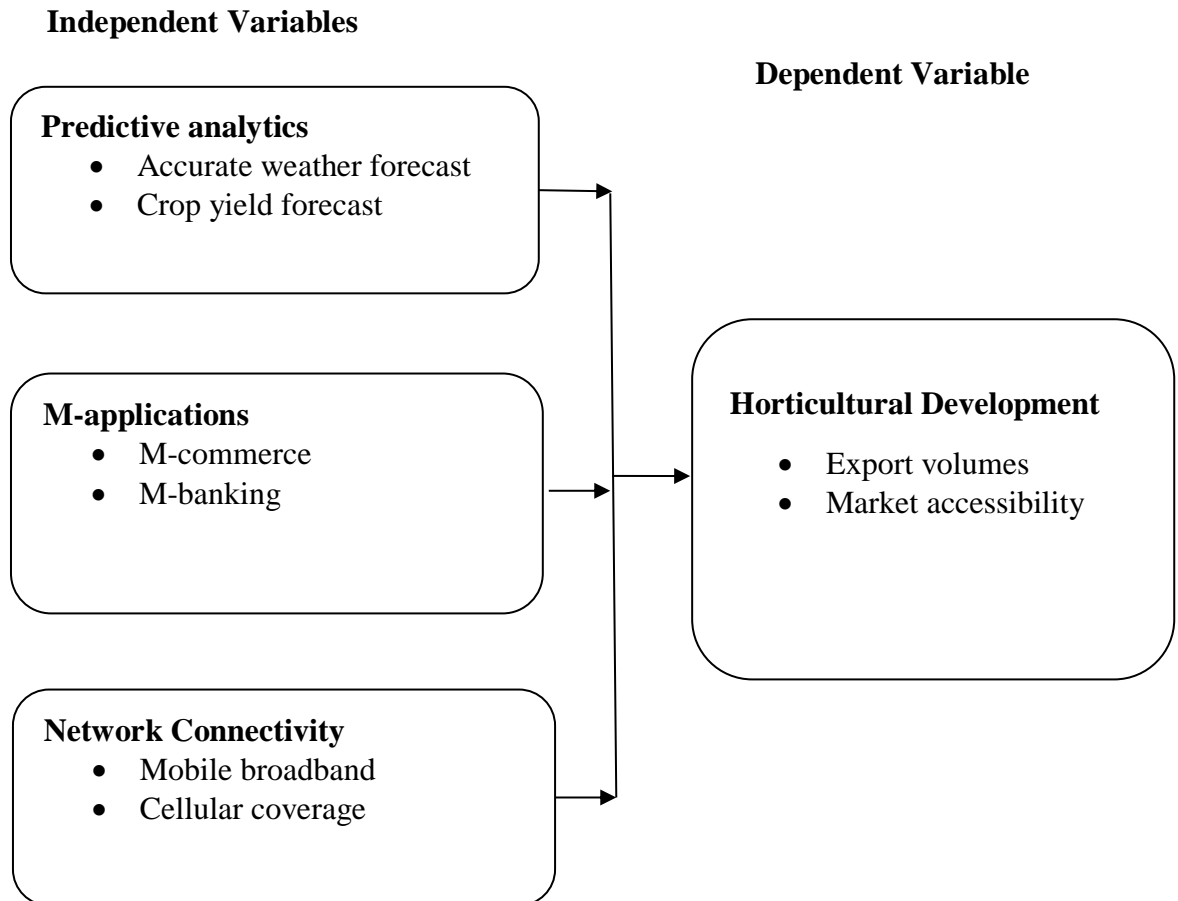


Figure 2.1: Conceptual Framework

2.5 Research Gap

The available literature on the influence of mobile communication infrastructure on horticultural development has been reviewed. However, as the literature that has been reviewed indicates, it is evident that there is scantiness of studies in the upcoming economies such as those in the sub-Saharan countries for instance Kenya. Majority of the studies have been carried out in countries that are developed and emergent economies. For instance, Liu (2019) who did his study in China, Eakin, et al., (2015) who carried out their study in the Caribbean and Latin America, Brooks and Bubela (2020) who did their study in the USA and Shan (2019) who conducted their study in India, among other studies. It is therefore easy to argue that most of these countries have contextual differences with Kenya. Therefore, the researcher sought to fill this void by conducting a study in Kenyan to have a local view on the issue. This study therefore sought to bridge this gap by investigating the influence of mobile communication infrastructure on horticultural development.

2.6 Summary of Literature Review

In this chapter, majority of the authors have expressed their views on influence of mobile communication infrastructure on horticultural development based on the literature review. Specifically, literature has been reviewed on the influence of development of mobile predictive analytics, M-applications and network and signal boosters and how they influence horticultural development. Three wider theories related to the study's independent variables were discussed in the theoretical reviews. As a result, the presented theories have been related to the research variables. Literature has also been researched within the conceptual framework domains in order to include

both predictive and predicted variables in this study. The chapter also discusses the research gap to illustrate the importance of doing this study.

2.7 Operationalization of the Variables

Table 2.1: Operationalization of the Variables

Variable	Variable Type	Operationalization of Variable	Variable Measurement	Type of analysis
Predictive analytics	Independent	Accurate weather for Crop yield forecast	Ordinal	Descriptive Inferential
M-applications	Independent	M-commerce M-banking	Ordinal	Descriptive Inferential
Network connectivity	Independent	Mobile broadband Cellular coverage	Ordinal	Descriptive Inferential
Horticultural Development	Dependent	Export volumes Market accessibility	Ordinal	Descriptive Inferential

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The section describes, discusses and justifies the approaches that were employed in fulfilling the purpose of this study. Specifically, the section covers the design that was employed; population targeted, study instruments methods for realizing data from the field, as well as the data analysis methods.

3.2 Research Design

A research design is a plan for carrying out a study. Descriptive research design was used for the investigation. The design is based on the notion that descriptive research strives to provide exact and valid representations of variables relevant to the research objectives (Creswell & Creswell, 2017). According to Creswell & Creswell (2017), this design is employed when a research tries to obtain information about a topic primarily via the posing of questions with the goal of analysing behaviour, values, attitude, and perceptions. As a result, descriptive design aided the study in efficiently and fully gathering information that allowed the study to determine the impact of mobile communication infrastructure on horticulture growth in Kenya.

3.3 Target Population

A population is the entire set of elements which are of interest to a researcher (Meyers, Gamst and Guarino, 2016). It constitutes all elements bearing observable characteristics that are of interest to a scholar. In this study, the target population was the horticultural farms that are registered under the county government of Nakuru and the top

management staff were selected as respondents to the study. Table 3.1 presents the target population.

Table 3.2: Target Population

Firm	Target population
Colour Crops Ltd	8
Datura E.A. Ltd	7
Gillan Nurseries	8
Hamer Kenya Ltd	13
Kandubu Blooms Ltd	10
Bahati Spring Farm	12
Kenya Highland Nurseries	9
Kijabe Limited	12
Keringet Flowers Ltd	9
Lake Flowers Ltd	12
Longnot Horticulture Ltd	7
Myaflower (K) Ltd	8
Majili Bud Ltd	9
Nakita Kinale Flowers	9
Sian Agriflora Ltd	16
Nini Flowers Ltd	6
Total	155

Source: Nakuru County Government, (2022)

3.4 Sample Size and Sampling Technique

According to Ngechu (2014), it is critical to pick a representative sample by creating a sampling frame. The sampling frame is a list of all the population units from which the sample is drawn (Creswell & Creswell, 2017). The study used census as the population was small, which is the recommended approach when the population is small. A census, according to Creswell & Creswell (2017) all elements in the population are included in the sample.

3.5 Research Tools

Structured questionnaires were self-administered by the researcher aimed at realizing raw data from the field. The popularity of questionnaires stems from their low cost and capacity to capture a large range of information in a short amount of time (Mugenda & Mugenda, 2009). The questionnaires were divided into sections, with each portion addressing a different aspect of the study's goals. Structured questions, according to Field (2015), are typically accompanied by a list of all possible responses. The items in the questionnaires were designed to target certain objectives and allow a range of solutions. A 5-point Likert scale of 1-5 was utilized, with 1-strongly disagree while 5-strongly agree. The questionnaires given to each respondent separately.

3.6 Pilot Test

According to Connelly (2008), a pilot research sample should be 1-10% of the sample size expected for the bigger parent study. As a result, a pilot research with a sample size of 10 respondents drawn from farms in the adjacent Nyandarua region as they were not part of the main study. Pilot study was done to determine the loopholes in the study tools and correct them with the aim of promoting the quality of the study tool.

According to Cooper and Schindler (2013), a pilot research is required to uncover design flaws and to offer proxy data for selecting a representative sample. According to Malhotra, Nunan, and Birks (2017), questionnaires are pre-tested in order to evaluate respondent reactions and rectify unclear items.

3.6.1 Reliability of research instruments

The Cronbach Alpha test was used in this study to assess the instrument's reliability. The consistency, stability, or dependability of the data is referred to as reliability (Cooper & Schindler, 2010). When a researcher measures a variable, he or she needs to know that the measurement yields reliable and consistent data (Cooper & Schindler, 2010). The degree of inaccuracy influences research reliability. Cronbach Alpha coefficients greater than 0.7 was used as the cut-off dependability in this investigation. The primary goal of the test re-test study was used to assess the suitability and simplicity of the questions on the objects that was developed, the value of the information, the language that was used, and the content of the validity of the objects based on the responses given.

3.6.2 Validity of research instruments

According to Vincent, Drawbridge, and Davis (2019), validity is the degree to which the output of data analysis represents the phenomena under research. The final copy of the study tool was given to 15 professionals comprising of the supervisors, colleagues and other researchers in the determination of the validity of the study instrument. The face and content validity were determined. The validity was determined on a scale of 1-5 where 5-Very good, 4-Good, 3-Fair, 2-poor and 1-Very poor. The responses given aided in determining the extent to which the instrument collected the desired

information. The comments from supervisors, colleagues, and other researchers and scholars were utilized to make required changes to the instrument, such as deleting unclear items, spelling issues, and other typographical errors.

3.7 Data Collection

The researcher personally administered the questionnaires. The researcher employed the 'drop and pick later' strategy to realize the intended information from the respondents. For purpose of giving the respondents ample time to read and fill the questionnaires to satisfaction, the researcher allowed the respondents to hold the questionnaires for a period of one week after which the researcher visited them at their places of work to collect the dully-filled questionnaires. The research was carried out over a two-month period. This was done to provide for adequate time for collecting data.

3.8 Methods of Data Analysis

Data analysis involves the sorting, arranging into specific categories that produce interpretable meanings (Kothari, 2011). Quantitative data was realised from the field where it was coded and entered into Statistical Packages for Social Scientists (SPSS Version 25), where it was analysed through the use of descriptive and inferential statistics. Descriptive statistics were used in the analysis of the data where the outcomes were presented in tables and figures and interpretations done in prose.

3.9 Diagnostic Test

The researcher conducted suitable diagnostic tests in order to determine the quality of the data realised from the field. Diagnostic tests for normality, homoscedasticity, heteroscedasticity and multicollinearity were performed.

3.9.1 Normality

The difference between projected and received response variables, which must be broadly distributed about the distributed dependent variable scores, is tested for normality (Cooper & Schindler, 2011). The study employed the One-Sample Kolmogorov-Smirnov and Shapiro-Wilk Tests to test the normality. The data was regarded regularly distributed if the significant value (p-value) was less than 0.05, and the null hypothesis was rejected, implying that the data was normally distributed.

3.9.2 Homoscedasticity and Heteroscedasticity

The assumption that the dependent variable has comparable amounts of variation across the range of values for an independent variable is known as homoscedasticity (Babbie, 2011). Homoscedasticity is a condition in which there is uniformity of the variance of error terms. The study applied the Levene's test of equality of error variances in testing the homoscedasticity. A homoscedasticity of 1.5 and below is considered satisfactory. On the other hand, heteroscedasticity refers to regression disturbances whose variances are not constant across observations (Greene, 2008). Heteroscedasticity arises in numerous applications, in both cross-section and time-series data thus causing the estimation results to be inefficient (Baltagi, 2005). The study used Breusch-Pagan Test in order to test for heteroscedasticity

3.9.3 Multicollinearity

To ascertain whether independent variables had resemblance with each other, Multicollinearity was carried out. If the independent variables were comparable in any manner, there was a very strong link (Kothari &Garg, 2014). According to Kumari (2008) the existence of a linear relationship among the independent variables is called multicollinearity. The usage of variation inflation factors was used to test for multicollinearity (VIF). A VIF number of 1-10 indicates the absence of Multicollinearity problem.

3.10 Ethical Considerations

According to Geffner, Shaw, and Crowell (2018), ethics entails the investigation and application of notions such as right and wrong, good and evil, transparency, accountability, and responsibility. They also indicate that ethical norms in research should be followed during study planning, data collecting, analysis, distribution, and use of results (Geffner, Shaw, and Crowell, 2018). This research complied to research standards. Before going to the field to gather data, the postgraduate coordinating office was consulted. An official letter describing the purpose of the research and the confidentiality of any information acquired was given to the respondents. Data was gathered and examined for discrepancies, and suitable coding and analytic methods was used in line with acknowledged research criteria, and the report adhered to academic study regulations.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents an analysis of the raw data obtained from the field. The results cover the general information of the respondents and analysis as per the three research objectives. After the fieldwork, data was sort, edited, coded, entered and analysed by the use of SPSS version 25. The study used descriptive statistics and regression were used to analyse the data. Data was analysed through use of measures of central tendency, (mean) and dispersion (standard deviation). Inferential statistics were used to show the collective effect of mobile predictive analytics, development of M-applications and connectivity on horticultural development in Nakuru County.

4.2 Pre-test results

4.2.1: Validity

The final copy of the study tool was given to 15 professionals comprising of the supervisors, colleagues and other researchers in the determination of the validity of the study instrument. The face and content validity were determined. The validity was determined on a scale of 1-5 where 5-Very good, 4-Good, 3-Fair, 2-poor and 1-Very poor. The results are presented in table 4.3 below;

Table 4.3: Validity

Response	Frequency (N)
Very good	4
Good	10
Fair	1
Poor	0
Very Poor	0
Total	15

From the results in table 4.3, the study instrument was adequate to realize sufficient information as 14 out of 15 respondents indicated it as good and very good. The results implied that the data realized from the field was sufficient in fulfilling the purpose of the study.

4.2.2: Reliability

The questionnaire was put to an internal consistency and overall reliability examination. Cronbach alpha, a coefficient of internal consistency, was used for the assessment. The pilot study was conducted on 10 respondents drawn from farms in the adjacent Nyandarua region. The following thumb guidelines as provided by Castillo (2009): >0.9 – Excellent, >0.8 – Good, >0.7 – Acceptable, >0.6 – Questionable, >0.5 – Poor, and 0.5 – Unacceptable. For the purposes of this study, a reliability cut-off of 0.7 was employed. Results are presented in table 4.4 below;

Table 4.4: Summarized Cronbach's Coefficients

	Cronbach's Alpha	N of Items	Conclusion
Mobile Predictive Analytics	0.736	7	scale reliable
Development of M-applications	0.713	5	scale reliable

Network Connectivity	0.749	5	scale reliable
Horticultural Development	0.711	5	scale reliable
Overall	0.727	22	Instrument reliable

The findings in table 4.4 above indicates that the alpha coefficient for the four items is 0.727, suggesting that the items had relatively high internal consistency implying as good since reliability coefficient of 0.70 or higher is considered good and acceptable for analysis and generalisation of study results.

4.3 Response Rate

The study targeted a sample of 155 respondents who were the top management staff. Out of 155 questionnaires issued out, 122 respondents completed the questionnaires contributing to 78.7% response rate. The rate was adequate for data analysis as Mugenda and Mugenda (2009) pointed that for the generalization, a response rate of 50% is adequate for analysis and reporting, 60% is good and a response rate of 70% and over is excellent as presented in table 4.5 below;

Table 4.5: Response Rate

Response	Frequency (N)	Percentage (%)
Completed questionnaires	122	78.7
Uncompleted questionnaires	33	21.3
Total	90	100

4.4 Demographic Information

The study sought to establish the background information of the respondents with the aim of establishing their suitability in providing information on the role of mobile communication infrastructure on horticultural development in Kenya. The background

information of interest was gender, age bracket, highest education level, the period of time they had been involved in working at the horticultural farms.

4.4.1 Respondents' Gender

The researcher requested the respondents to indicate their gender. The results were as presented in figure 4.2.



Figure 4.2: Respondents' Gender

According to the findings as presented in figure 4.1, majority 72(59%) of the respondents were male while 50(41%) were female. The results imply that recruitment of workforce involved in running and management the horticultural firms in Kenya was majorly interested in male faced workforce.

4.4.2 Age Bracket

The study used sought to establish the respondents' age bracket, the results are presented in table 4.6 below;

Table 4.6: Age Bracket

	Frequency (N)	Percent (%)
20 years and below	1	1
21-25 years	2	2
26-30 years	11	9
31-35 years	24	20
36-40 years	25	21
41-45 years	49	39
Above 45 years	10	8
Total	122	100

As illustrated in table 4.6, most 49(39%) of the of the respondents were 41-45 years; 25(21%) were 36-40 years; 24(20%) were 31-35 years; 11(9%) were 26-30 years; 10(8%) were aged above 45 years; while only 3(3%) of the respondents were aged 25 years and below. The outcomes show that the top management was composed of a majority aged above 30 years of age; representing a percentage (88%) of the population with optimum skills and motivation towards realization of personal and organisational goals.

4.4.3 Level of Education

The study sought to establish the level of education of the respondents. Figure 4.3 presents the findings on the level of education of the respondents as requirement to establish the academic eligibility to top management positions in the horticultural firms and qualification of the respondents to provide the information the study sought.

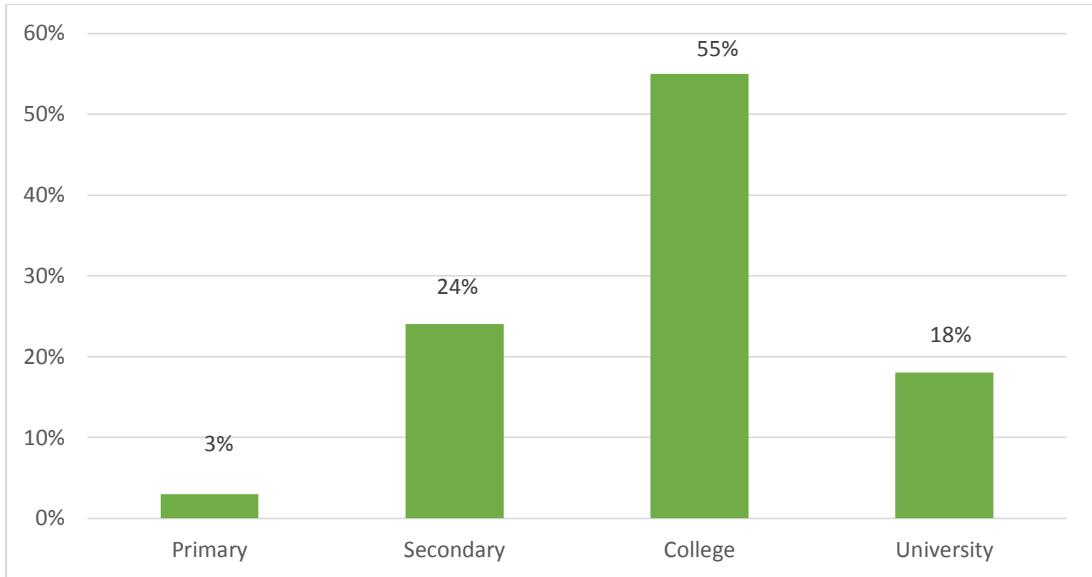


Figure 4.3: Level of Education

As depicted in the figure 4.3 above, majority 67(55%) of the respondents had a college level of education, 29(24%) were secondary school certificate holders; 22(18%) had a university level of academic qualification while 4(3%) of the respondents had primary level of education. The results shows that the respondents had achieved education and professional training, they were deemed competent in understanding the role of mobile communication infrastructure on horticultural development. In addition, the result implies that professionalism was a key factor during the recruitment of staff in the management of horticultural development in Kenya.

4.4.4 Duration of Service in the Horticultural Farms

The study required to determine the period of time the respondent had been working in the horticultural farms. Table 4.7 below presents the findings;

Table 4.7: Duration of Service in the Horticultural Farms

	Frequency (N)	Percent (%)
1- 5 years	25	21
6- 10 years	62	51
11- 15 years	23	19
Above 15 years	12	10
Total	122	100

Results in table 4.7 above shows that majority 62(51%) of the respondents had served in the horticultural farms for a period of 6-10 years and 25(21%) had worked in the horticultural farms for 1-5 years. Further, 23(19%) and 12(10%) of the respondents had worked in the horticultural farms for a period of 11- 15 years and over 15 years respectively. Over 70 percent of the respondents had worked in the horticultural farms for over 5 years. The results suggest that the respondents were had worked for a long period enough to understand the role of mobile communication infrastructure on horticultural development in Kenya.

4.5 Mobile Predictive analytics on Horticultural Development

The study aimed at establishing whether the firms had adopted mobile predictive analytics in its operations. The findings are presented in table 4.8 below;

Table 4.8: Adoption of Mobile Predictive Analytics

Response	Frequency (N)	Percent (%)
Yes	112	92
No	10	8
Total	122	100

The findings in table 4.8 above shows that majority 112(92%) of the respondents indicated that their firms had adopted adoption of mobile predictive analytics while 10(8%) indicated otherwise. The results imply that horticultural firms in Nakuru county

had realised the importance of mobile predictive analytics in the growth and development of the horticultural industry.

In addition, the study sought to establish the extent to which the mobile predictive analytics been important for the growth of horticultural firms. The findings are tabulated in table 4.9 below;

Table 4.9: Mobile Predictive analytics on Horticultural Development

	Frequency (N)	Percent (%)
Moderate extent	37	30
Great extent	73	60
Very great extent	12	10
Total	122	100

The findings in table 4.9 shows that majority 73(60%) of the respondents indicated that mobile predictive analytics influenced horticultural development to a great extent and 37(30%) indicated that mobile predictive analytics influenced horticultural development to a moderate extent. In addition, 12(10%) indicated that the mobile predictive analytics influenced horticultural development to a very great extent. The respondents were aware of what it entails the role of mobile predictive analytics influenced horticultural development.

4.5.1 Mobile Predictive Analytics

Using a scale of 1-5 where 1=strong disagreement and 5 = strong agreement. The respondents were asked to indicate their level of agreement with statements relating to mobile predictive analytics. The results are presented in table 4.10 below;

Table 4.10: Mobile Predictive analytics

	Mean	Std. Deviation
AI sensors detects and target weeds while deciding which herbicides to apply	3.6885	.84386
The mobile predictive analytics provides us with predictions for the most suitable crop varieties for the season and ideal planting times	3.6393	.57590
Mobile predictive analytics aids in detecting diseases in plants, pests and poor plant nutrition on farms	3.6311	.63247
Utilization of big data analytics minimizes risks to crop health from pests, diseases, and environmental factors	3.5574	.57567
We are able to analyse water usage and soil conditions collected from the farm to make informed decisions	3.5246	.77367
Mobile predictive analytics helps determine optimized irrigation and reduce greenhouse gas emissions	3.5164	.64582
Mobile predictive analytics helps us predict patterns in environmental changes	3.5082	.51820

As per the results in table 4.10 above shows that the respondents agreed that AI sensors detected and targeted weeds while deciding which herbicides that could be applied (Mean=3.6885) and that the mobile predictive analytics provided the managers with predictions for the most suitable crop varieties for the season and ideal planting times (Mean=3.6393). Moreover, the respondents agreed that mobile predictive analytics aided in detecting diseases in plants, pests and poor plant nutrition on farms (Mean=3.6311). Also, the respondents agreed that utilization of big data analytics minimized risks to crop health from pests, diseases, and environmental factors (Mean=3.5574). In addition, the respondents agreed that horticultural firms were able

to analyse water usage and soil conditions collected from the farm with the aim of making informed decisions (Mean=3.5246). Further the respondents agreed that mobile predictive analytics helped in determining optimized irrigation and reduced greenhouse gas emissions (Mean=3.5164). In addition, the respondents agreed that mobile predictive analytics helped horticultural firms in predicting patterns in environmental changes (Mean=3.5082). The findings imply that the respondents were well informed on the role of mobile predictive analytics horticultural firms in the horticultural development.

4.6 M-applications on Horticultural Development

The study employed a 2-point scale in determining whether the horticultural firms had adopted M-applications in their operations. The results are presented in figure 4.4 below;

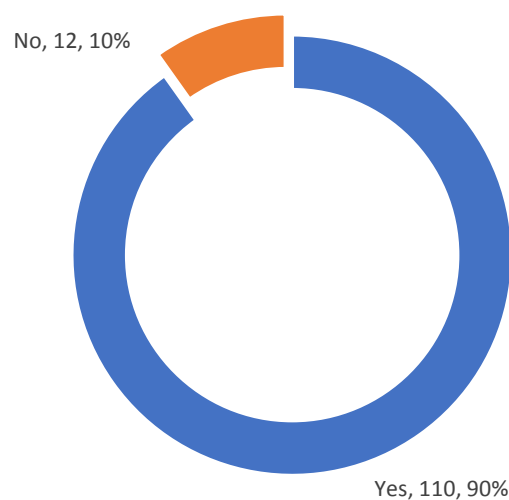


Figure 4.4: Adoption of M-applications

The findings presented in figure 4.4 above, majority 110(90%) of the respondents indicated that the horticultural firms had adopted M-applications in their operations while 12(10%) indicated that they had not adopted M-applications in their operations. The outcomes show that the horticultural firms had recognised the position of M-applications on horticultural development.

Moreover, the study sought to establish the extent to which the M-applications had been important for the growth of the horticultural firms. The results are presented in table 4.11 below;

Table 4.11: M-applications on Horticultural Development

	Frequency (N)	Percent (%)
Moderate extent	27	22
Great extent	82	67
Very great extent	13	11
Total	122	100

The findings in table 4.11 show that majority 82(67%) of the respondents indicated that M-applications influenced horticultural development to a great extent and 27(22%) indicated that M-applications influenced horticultural development to a moderate extent. Additionally, 13(11%) indicated that the M-applications influenced horticultural development to a very great extent. The respondents were aware of the extent M-applications influenced horticultural development.

4.6.1 M-applications

The study used a five-point scale where 1=strongly disagree and 5 = strongly agree. The respondents are requested to indicate the agreement level to the statements relating to M-applications. The results are presented in table 4.12 below;

Table 4.12: M-applications

	Mean	Std. Deviation
M-applications reduces information asymmetries between farmers and buyers	3.7295	.58968
M-applications supports farmers' adaptation through increasing social capital	3.7295	.72769
We use mobile money services when giving advances to employees thus saving time	3.7213	.78480
M-applications helps us to connect to sellers as well as get market information on prices	3.5820	.60083
Mobile applications helps in expanding timely access to rural extension and advisory services	3.5738	.80204

The findings in table 4.12 above shows that the respondents agreed that M-applications reduced information asymmetries between farmers and buyers (Mean=3.7295) and that M-applications supported farmers' adaptation through increasing social capital (Mean=3.7295). In addition, the respondents agreed that the horticultural firms used mobile money services while giving advances to employees thus saving time (Mean=3.7213) and M-applications helped horticultural firms in connecting to sellers as well as receiving market information on prices (Mean=3.5820). Moreover, the respondents agreed that mobile applications helped in expanding timely access to rural extension and advisory services (Mean=3.5738). The findings imply that the respondents were aware of the role played by M-applications in the development of horticultural industry in Kenya.

4.7 Network Connectivity on Horticultural Development

The study asked the respondents to indicate whether there was network connectivity in their horticultural firms. The findings are presented in table 4.13 below;

Table 4.13: Presence of Network Connectivity

	Frequency (N)	Percent (%)
Yes	115	94
No	7	6
Total	122	100

The results presented in table 4.13 above shows that majority 115(94%) the respondents indicated that there was network connectivity in their horticultural firms and 7(6%) indicated otherwise. The results imply that the respondents were aware of the presence network in the horticultural firms they managed.

Additionally, the study aimed at determining the extent to which the network connectivity installation had been important for the growth of horticultural firms. The results are presented in table 4.14 below;

Table 4.14: Network Connectivity on Horticultural Development

	Frequency (N)	Percent (%)
Low extent	2	2
Moderate extent	26	21
Great extent	84	69
Very great extent	10	8
Total	122	100

The study findings in table 4.14 above, majority 84(69%) of the respondents indicated that the network connectivity installation had been important for the growth of horticultural firms to great extent; 26(21%) indicated to a moderate extent; 10(8%) to very great extent while 2(2%) of the respondents indicated that to a low extent the

network connectivity installation had been important for the growth of horticultural firms. The findings imply that the respondents were cognizant of the role played the network connectivity horticultural growth.

4.7.1 Network Connectivity

Using a scale of 1-5 with 1 denoting strongly disagree and 5 denoting strongly agree.

The respondents were requested to indicate their agreement level to the statements that relate to network connectivity. The findings are tabulated in table 4.15 below;

Table 4.15: Network Connectivity

	Mean	Std. Deviation
The cell network connection in our farm has helped in improving connectivity	3.7705	.68979
Lack of good internet and dropping signals prohibit the farmers from adopting new technologies	3.6885	.80373
Network connectivity enables our mobile applications to be location-based and linked to real-time sensors	3.5738	.75971
Network boosters has helped solve poor reception problems and slow downloading speeds	3.5656	.79240
Installation of network boosters enables synchronisation of many devices	3.5328	.78398

The study findings in table 4.15 above; shows that the respondents agreed that the cell network connection in the farms had helped in improving connectivity (Mean=3.7705) and that lack of good internet and dropping connectivity prohibited the farmers from adopting new technologies (Mean=3.6885). Moreover, the respondents agreed that network connectivity enabled mobile applications to be location-based and linked to real-time sensors (Mean=3.5738). In addition, the respondents agreed that

network boosters had helped in solving poor reception problems and slow downloading speeds (Mean=3.5656). Also, the respondents agreed that installation of network boosters enabled synchronisation of many devices (Mean=3.5328). The findings imply that the respondents were aware of the aspects of network connectivity in the development of horticultural industry.

4.8 Horticultural Development

The respondents were asked to indicate the extent to which the horticultural farming was improved. The results are presented in table 4.16 below;

Table 4.16: Horticultural Farming Improvement

	Frequency (N)	Percent (%)
Low extent	4	3
Moderate extent	24	20
Great extent	86	70
Very great extent	8	7
Total	122	100

The outcomes in table 4.16 show majority 86(70%) of the respondents that the horticultural farming was improved to a great extent. Further, 24(20%) indicated to a moderate extent horticultural farming was improved; 8(7%) indicated to a very great extent while 4(3%) of the respondents indicated that horticultural farming was improved to low extent. The results imply that the respondent had realised notable improvement in the horticultural farming.

In addition, the study employed a scale of 1-5 where 1=strongly disagree while 5 = strongly agree. The study respondents were asked to indicate their level of agreement to the statements relating to horticultural development. The outcomes are presented in table 4.17 below;

Table 4.17: Horticultural Development

	Mean	Std. Deviation
Local consumption of the horticultural products has increased	3.9016	.94833
Market demand for our products has increased due to timely delivery	3.8361	.52002
We have increased the acreage of horticultural products to cater for the rising demand	3.7787	.55316
Diversification of agriculture towards horticultural products has increased	3.6475	.85205
Exports of fruits and vegetables have greatly increased	3.5902	.95133

The results in table 4.17 above show that the respondents agreed that local consumption of the horticultural products had increased (Mean=3.9016) and that market demand for horticultural products had increased due to timely delivery (Mean=3.8361). The respondents agreed that the firms had increased the acreage of horticultural framing to cater for the rising demand (Mean=3.7787) and that diversification of agriculture towards horticultural products had increased (Mean=3.6475). Finally, the respondents agreed that exports of fruits and vegetables had greatly increased (Mean=3.5902). The results imply that the respondents were aware of the different aspects that indicated the horticultural development over time.

4.9 Diagnostic Test

4.9.1 Normality

The study employed the One-Sample Kolmogorov-Smirnov and Shapiro-Wilk Tests to test the normality. The following null and alternative hypotheses were used:

H0: The data is not normally distributed

H1: The data is normally distributed

The results are presented in table 4.18 below;

Table 4.18: Normality Test

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Horticultural Development	.132	122	.000	.964	122	.002
Mobile Predictive Analytics	.155	122	.000	.950	122	.000
Development of M-applications	.150	122	.000	.943	122	.000
Network Connectivity	.138	122	.000	.970	122	.009

a. Lilliefors Significance Correction

The results in table 4.18 indicated that Kolmogorov-Smirnov test and Shapiro-Wilk Test to provide evidence of a collected data being normally distributed. The null hypothesis of the test was that the data was not normally distributed. The Kolmogorov-Smirnov^a shows that the p-value for four variables was less than 0.05, indicating significance and thus null hypothesis was rejected and the alternative hypothesis approved, showing the data is normally distributed.

4.9.2 Homoscedasticity

The assumption that the dependent variable has comparable amounts of variation across the range of values for an independent variable is known as homoscedasticity (Babbie, 2011). Homoscedasticity is a condition in which there is uniformity of the variance of error terms. The study applied the Levene's test of equality of error variances in testing the homoscedasticity. A homoscedasticity of 1.5 and below is considered. In table 4.19 the homoscedasticity test produced a p-value is .000 which shows the error variance of

the dependent variable is equal across groups and therefore the condition was satisfied.

The error term (ϵ) constant variance and identically distributed.

Table 4.19: Levene's Test of Equality of Error Variances^a

		Levene			
		Statistic	df1	df2	Sig.
Horticultural Development	Based on Mean	5.423	21	28	.000
	Based on Median	1.207	21	28	.316
	Based on Median and with adjusted df	1.207	21	4.949	.457
	Based on trimmed mean	4.934	21	28	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Horticultural Development

b. Design: Intercept + MPA + DoMA + DoNC + MPA * DoMA * DoNC

4.9.3: Heteroscedasticity

Heteroscedasticity refers to regression disturbances whose variances are not constant across observations (Greene, 2008). Heteroscedasticity arises in numerous applications, in both cross-section and time-series data thus causing the estimation results to be inefficient (Baltagi, 2005). The study used Breusch-Pagan Test to test for heteroscedasticity. Based on the result obtained the sig. value of .217 suggesting that there was no Heteroskedasticity problem as the significance value was above 0.05.

Results are presented in table 4.20 below;

Table 4.20: Breusch-Pagan Test for Heteroskedasticity

Chi-Square	Df	Sig.
1.525	1	.217

a. Dependent variable: Horticultural Development

b. Tests the null hypothesis that the variance of the errors does not depend on the values of the independent variables.

c. Predicted values from design: Intercept + MPA * DoMA * DoNC

4.9.4 Multicollinearity Tests

Multicollinearity was used to determine whether independent variables were similar to one another. According to Kumari (2008) the existence of a linear relationship among the independent variables is called multicollinearity. Multicollinearity can cause large forecasting error and make it difficult to assess the relative importance of individual variables in the model. This study opted for both the Variance Inflation Factor (VIF) and Tolerance to test for multicollinearity. The results are presented in table 4.21 below;

Table 4.21: Multicollinearity Tests

Model		Collinearity Statistics	
		Tolerance	VIF
1	Mobile Predictive Analytics	.998	1.002
	Development of M-applications	.990	1.010
	Network Connectivity	.992	1.008

a. Dependent Variable: Horticultural Development

As per the results in table 4.21, VIF of all values for the variables were less than 5 which shows that the variables were not Multi-collineated. The VIF were mobile predictive analytics (1.002), development of m-applications (1.010), and network connectivity (1.008). The outcome agrees with Lai and Kwok (2015) who states that

the rule of the thumb indicates that a VIF of 1 indicates presence of no collinearity and 5 indicates that the variable with high collinearity.

4.10 Inferential Statistics

The researcher conducted inferential statistics to establish role of mobile communication infrastructure on horticultural development in Kenya. The study employed ordered logit model.

Table 4.22: Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	462.991			
Final	459.916	3.075	3	.380

Link function: Logit.

In table 4.22 above the model fitting information contains -2 likelihood for an intercept only or null hypothesis and the full model containing the full set of predictors. Also, the model fitting contains a likelihood ratio chi-square test to test whether there is a significant in fit of the final model relative to ten intercepts only model. The higher the chi square score, the more likely it is to be significant. In this case there is an insignificant improvement in fit of the final model over the null model $\{x^2(3) = 3.075, p > .380\}$

Table 4.23: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	801.390	834	.786
Deviance	426.514	834	1.000

Link function: Logit.

The goodness of fit table above contains the deviance and Pearson chi-square tests as they are useful in determining whether the model exhibits good fit to the data. The insignificant test outcomes indicate that the model fits the data well (Field, 2018). In this study the both the Pearson chi-square test $\{x^2(834) = 801.390, p=.786\}$ and the deviance test $\{x^2(834) = 426.514, p=1.000\}$ were both non-significant. These results suggest good model fit.

Table 4.24: Parameter Estimates

Parameter	B	95% Wald Confidence Interval		Standard Error	Wald Chi-Square	df	Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B)	
		Lower	Upper						Lower	Upper
Threshold [Horticultural Development=2.60]	-4.641	-11.776	-2.494	1.621	1.2	.02	.010	7.684	12.105	E-6
[Horticultural Development=3.00]	-2.372	-9.269	-4.526	.454	1.5	.00	.093	9.430	92.376	E-5
[Horticultural Development=3.20]	-1.732	-8.619	-5.155	.243	1.6	.022	.177	.000	173.260	

[Horticultural Development= 3.40]	- .705	:	-	6.15	.041	1	.8	.494	.001	468.936
		:	7.56	0			40			
		:	0							
		:								
		:								
[Horticultural Development= 3.60]	- .129	:	-	6.71	.001	1	.9	.879	.001	826.023
		:	6.97	7			71			
		:	4							
		:								
		:								
[Horticultural Development= 3.80]	.573	:	-	7.42	.027	1	.8	1.774	.002	1672.92
		:	6.27	2			70			1
		:	5							
		:								
		:								
[Horticultural Development= 4.00]	1.668	:	-	8.52	.227	1	.6	5.303	.006	5045.82
		:	5.19	6			34			9
		:	0							
		:								
		:								
[Horticultural Development= 4.20]	2.439	:	-	9.32	.483	1	.4	11.46	.012	11162.2
		:	4.44	0			87	7		72
		:	1							
		:								
		:								
[Horticultural Development= 4.40]	5.021	:	-	12.1	1.89	1	.1	151.5	.119	192874.
		:	2.12	70	5		69	41		461
		:	8							
		:								
		:								
Mobile Predictive Analytics	.740	:	-	2.25	.924	1	.3	2.096	.463	9.484
		:	.769	0			36			
		:								
		:								

Development of M-applications	-0.143	1.149	0.863	0.077	1.781	0.781	0.867	0.317	2.371
Network Connectivity	-0.536	1.281	0.210	1.984	1.159	0.159	0.585	0.278	1.233
(Scale)		1 ^a							

Dependent Variable: Horticultural Development

Model: (Threshold), Mobile Predictive Analytics, Development of M-applications, Network Connectivity

a. Fixed at the displayed value.

Table 4.24 presents the coefficient and significance tests for each of the independent variables in the model. The regression coefficients are interpreted as the predicted change in log odds of being in a higher group of the dependent variable per unit increase on the independent variable. In general, a score increases in the independent, there would be an increased probability of falling at a higher level on the dependent variable. Also, score increase in the independent, there would be a decreased probability of falling at a higher level on the dependent variable.

In this study, the mobile predictive analytics was an insignificant positive predictor of horticultural development. For every one unit increase in mobile predictive analytics there was a predicted increase of .740 in the log odds of horticulture being in category of development. This implies that a farm scoring higher on mobile predictive analytics were more likely to indicate greater development in horticulture.

The development of M-applications as well was not a significant predictor in the model. From the outcomes for every one-unit increase in development of M-

applications there would be a predicted decrease of -.143 in the log odds of being in the higher category of the horticultural development in Kenya.

The network connectivity was not significant determinant of horticultural development. From the results for every unit score increase in network connectivity there would be a predicted decrease of -.536 in the log odds of being in the higher category of the horticultural development in Kenya

Table 4.25: Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	459.916			
General	420.982 ^b	38.935 ^c	24	.028

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

In the test of parallel lines when the outcomes indicate non-significance, then it interpreted as the assumption satisfied. Statistical significance is taken as an indicator that the assumption is not satisfied. In this study the parallel the assumption was not satisfied as the p-value was $p=.028$ which was below .05.

4.11 Factor Analysis

Table 4.26: Correlation Matrix

		Mobile Predictive Analytics	Development of M- applications	Development of Network Connectivity	Horticultural Development
Correlation	Mobile Predictive Analytics	1.000	.041	-.014	.087
	Development of M- applications	.041	1.000	.088	-.024
	Development of Network Connectivity	-.014	.088	1.000	-.131
	Horticultural Development	.087	-.024	-.131	1.000
Sig. (1- tailed)	Mobile Predictive Analytics		.325	.440	.170
	Development of M- applications	.325		.167	.397
	Development of Network Connectivity	.440	.167		.075
	Horticultural Development	.170	.397	.075	

a. Determinant = .966

As per the findings in table 4.26 above, weak positive relationships between the mobile predictive analytics and development of m-applications; mobile predictive analytics and horticultural development with correlation values of .041 and .087 respectively. Further the bivariate analysis results indicated that weak positive relationships between development of m-applications and network connectivity with correlation coefficient of .088. The study factors with positive correlations are closely

related and moving in the same direction. The determinant value has to be greater than .00001 and therefore all the studied factors were related.

Table 4.27: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.510
Bartlett's Test of Sphericity	Approx. Chi-Square	4.133
	Df	6
	Sig.	.659

For the KMO any value above .5 is fine and in this study, it was .510 although Bartlett's test of Sphericity shows statistical insignificance with a p-value of .659.

Table 4.28: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.182	29.547	29.547	1.182	29.547	29.547
2	1.065	26.634	56.181	1.065	26.634	56.181
3	.908	22.696	78.877			
4	.845	21.123	100.000			

Extraction Method: Principal Component Analysis.

The total variance explanation, component 1 and 2 failed to meet the Initial Eigenvalues of 1 and they collectively explain 56.181% of the variance.

Table 4.29: Component Matrix

	Component	
	1	2
Mobile Predictive Analytics	-.302	.714
Development of M-applications	.359	.662
Development of Network Connectivity	.695	.225
Horticultural Development	-.692	.258

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

The Mobile Predictive Analytics and Development of M-applications values load together fairly tightly both for component 1 and 2 of the variables and they seem to represent one construct. Similarly, development of network connectivity and horticultural development are same construct as they load together fairly tightly for component 1 and 2 of the variables.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The section presents the findings summary and derived conclusions on the influence of mobile communication infrastructure on horticultural development in Kenya. It also contains recommendations and areas for further studies.

5.2 Summary of Findings

The study's main objective was to determine the influence of mobile communication infrastructure on horticultural development in Kenya. The study specific objectives were to establish the effect of network connectivity, mobile predictive analytics, development of M-applications on horticultural development in Kenya. The study collected, analysed presented data in chapter four guided by the study variable and specific objectives.

5.2.1 Mobile Predictive Analytics

The study found that AI sensors detected and targeted weeds while deciding which herbicides that could be applied and that the mobile predictive analytics provided the managers with predictions for the most suitable crop varieties for the season and ideal planting times. Moreover, the study found that mobile predictive analytics aided in detecting diseases in plants, pests and poor plant nutrition on farms. Also, the study found that utilization of big data analytics minimized risks to crop health from pests, diseases, and environmental factors. In addition, the study found that horticultural firms were able to analyse water usage and soil conditions collected from the farm with the aim of making informed decisions. Further, the study found that mobile predictive

analytics helped in determining optimized irrigation and reduced greenhouse gas emissions. In addition, the study found that mobile predictive analytics helped horticultural firms in predicting patterns in environmental changes. The findings imply that the respondents were well informed on the role of mobile predictive analytics horticultural firms in the horticultural development.

5.2.2 Development of M-applications

The study found that M-applications reduced information asymmetries between farmers and buyers and that M-applications supported farmers' adaptation through increasing social capital. In addition, the study found that the horticultural firms used mobile money services while giving advances to employees thus saving time and M-applications helped horticultural firms in connecting to sellers as well as receiving market information on prices. Moreover, the study found that mobile applications helped in expanding timely access to rural extension and advisory services. The findings imply that the respondents were aware of the role played by M-applications in the development of horticultural industry in Kenya.

5.2.3 Network Connectivity

The study found that the cell network connection in the farms had helped in improving connectivity and that lack of good internet and dropping connectivity prohibited the farmers from adopting new technologies. Moreover, the study found that network connectivity enabled mobile applications to be location-based and linked to real-time sensors. In addition, the study found that network boosters had helped in solving poor reception problems and slow downloading speeds. Also, the study found that installation of network boosters enabled synchronisation of many devices. The findings

imply that the respondents were aware of the aspects of network connectivity in the development of horticultural industry.

5.2.4 Horticultural Development

The study found that local consumption of the horticultural products had increased and that market demand for horticultural products had increased due to timely delivery. The study further found that the firms had increased the acreage of horticultural farming to cater for the rising demand and that diversification of agriculture towards horticultural products had increased. In addition, the study found that exports of fruits and vegetables had greatly increased. The results imply that the respondents were aware of the different aspects that indicated the horticultural development over time.

5.3 Conclusions

The study concludes that AI sensors detected and targeted weeds while deciding which herbicides that could be applied and that the mobile predictive analytics provided the managers with predictions for the most suitable crop varieties for the season and ideal planting times. Moreover, the study concludes that mobile predictive analytics aided in detecting diseases in plants, pests and poor plant nutrition on farms. Also, the study concludes that utilization of big data analytics minimized risks to crop health from pests, diseases, and environmental factors. In addition, the study concludes that horticultural firms were able to analyse water usage and soil conditions collected from the farm with the aim of making informed decisions. Further, the study concludes that mobile predictive analytics helped in determining optimized irrigation and reduced greenhouse gas emissions. In addition, the study concludes that mobile predictive analytics helped horticultural firms in predicting patterns in environmental changes.

The study concludes that M-applications reduced information asymmetries between farmers and buyers and that M-applications supported farmers' adaptation through increasing social capital. In addition, the study concludes that the horticultural firms used mobile money services while giving advances to employees thus saving time and M-applications helped horticultural firms in connecting to sellers as well as receiving market information on prices. Moreover, the study concludes that mobile applications helped in expanding timely access to rural extension and advisory services.

The study concludes that the cell network connection in the farms had helped in improving connectivity and that lack of good internet and dropping connectivity prohibited the farmers from adopting new technologies. Moreover, the study concludes that network connectivity enabled mobile applications to be location-based and linked to real-time sensors. In addition, the study concludes that network boosters had helped in solving poor reception problems and slow downloading speeds. Also, the study concludes that installation of network boosters enabled synchronisation of many devices.

The study concludes that local consumption of the horticultural products had increased and that market demand for horticultural products had increased due to timely delivery. The study further concludes that the firms had increased the acreage of horticultural farming to cater for the rising demand and that diversification of agriculture towards horticultural products had increased. In addition, the study concludes that exports of fruits and vegetables had greatly increased.

5.4 Recommendation

The study recommends that in order to promote mobile predictive analytics the horticultural firms should install a storage database that records the prevailing climatic, inputs and revenues at different times which would be useful in the forecasting the future expectations.

Further the study recommends that in order to promote the development of m-applications, the firms in Nakuru county should develop a communication application focused on activities in the horticultural industry that allows for free flow of information from financiers thereby allowing for real time feedback from the firms.

Finally, the study recommends that in order to promote the network connectivity the firms should invest and channel funds towards the installation of strong networks with strong connectivity and this would prevent any losses that would arise from any kind of network failure.

5.5 Area for Further Study

The study established that the three independent variables studied insignificant predictors of horticultural development in Kenya. Therefore, further research should be conducted to determine the significant predictors of the horticultural development in Kenya. Further, the study recommends that a study be conducted to determine the effects of petroleum extraction on the economic development in Kenya. In addition, the study recommends that a study to be done on the determinants of the involvement development financial institutions in the provision of electricity in manufacturing companies.

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APPENDICES

Appendix II: Questionnaire

Kindly fill in the questions in the spaces provided to the best of your ability. Be assured that the information you provide here will only be used for the academic purposes only.

Part A: Background of the Study

5 Gender

Female [] Male []

6 Age Bracket

20 years and below [] 21-25 years []

26-30 years [] 31-35 years []

36-40 years [] 41-45 years []

Above 45 years []

7 Highest Education Level

Primary [] Secondary []

College [] University []

Post graduate []

8 Period in the organization

1- 5 years []

6- 10years []

11- 15 years []

Above 15 years []

Part B: Mobile Predictive analytics and Horticultural Development

9 Has your firm adopted mobile predictive analytics in its operations?

Yes [] No []

10 To what extent have the mobile predictive analytics been important for the growth of your firm?

Very low extent [] Low extent []
Moderate extent [] Great extent []
Very great extent []

11 Using a scale of 1-5 where 1=strong disagreement, 2 = disagreement, 3 = moderate agreement, 4 = agreement and 5 = strong agreement, kindly indicate your agreement level to the statements below that relate to mobile predictive analytics.

Statements	1	2	3	4	5
Mobile predictive analytics helps us predict patterns in environmental changes					
Utilization of big data analytics minimizes risks to crop health from pests, diseases, and environmental factors					
We are able to analyze water usage and soil conditions collected from the farm to make informed decisions					
Mobile predictive analytics helps determine optimized irrigation and reduce greenhouse gas emissions					
Mobile predictive analytics aids in detecting diseases in plants, pests and poor plant nutrition on farms					

AI sensors detects and target weeds while deciding which herbicides to apply					
The mobile predictive analytics provides us with predictions for the most suitable crop varieties for the season and ideal planting times					

12 In what other ways does mobile predictive analytics influence horticultural development?

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.....

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.....

Part C: M-applications and Horticultural Development

13 Has your firm adopted M-applications in its operations?

Yes [] No []

14 To what extent have the M-applications been important for the growth of your firm?

Very low extent [] Low extent []

Moderate extent [] Great extent []

Very great extent []

15 Using a scale of 1-5 where 1=strong disagreement, 2 = disagreement, 3 = moderate agreement, 4 = agreement and 5 = strong agreement, kindly indicate your agreement level to the statements below that relate to M-applications.

Statements	1	2	3	4	5
M-applications helps us to connect to sellers as well as get market information on prices					
M-applications reduces information asymmetries between farmers and buyers					
M-applications supports farmers' adaptation through increasing social capital					
We use mobile money services when giving advances to employees thus saving time					
Mobile applications help in expanding timely access to rural extension and advisory services					

16 In what other ways do M-applications influence horticultural development?

.....

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.....

Part D: Network Connectivity and Horticultural Development

17 Is there network connectivity in your farms?

Yes [] No []

18 To what extent has the network connectivity installation been important for the growth of your firm?

Very low extent [] Low extent []

Moderate extent [] Great extent []

Very great extent []

19 Using a scale of 1-5 where 1=strong disagreement, 2 = disagreement, 3 = moderate agreement, 4 = agreement and 5 = strong agreement, kindly indicate your agreement level to the statements below that relate to network connectivity.

Statements	1	2	3	4	5
Network connectivity enables our mobile applications to be location-based and linked to real-time sensors					
Installation of network boosters enables synchronization of many devices					
Network boosters has helped solve poor reception problems and slow downloading speeds					
The cell network connection in our farm has helped in improving connectivity					
Lack of good internet and dropping connectivity prohibit the farmers from adopting new technologies					

20 How else do network connectivity influence horticultural development?

.....

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.....

.....

Part E: Horticultural Development

21 To what extent has horticultural farming improved in your farm?

Very low extent [] Low extent []

Moderate extent [] Great extent []

Very great extent []

22 Using a scale of 1-5 where 1=strong disagreement, 2 = disagreement, 3 = moderate agreement, 4 = agreement and 5 = strong agreement, kindly indicate your agreement level to the statements below that relate to horticultural development.

Statements	1	2	3	4	5
Exports of fruits and vegetables have greatly increased					
Local consumption of the horticultural products has increased					
Market demand for our products has increased due to timely delivery					
Diversification of agriculture towards horticultural products has increased					
We have increased the acreage of horticultural products to cater for the rising demand					

23 How else has horticultural farming developed?

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.....

.....