FACTORS INFLUENCING MOBILE TELECOMMUNICATION INFRASTRUCTURE SHARING IN KENYA

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Factors influencing mobile telecommunication infrastructure sharing in Kenya

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

Signature……Date.....

Jessy Maruti Kiveu

This thesis has been presented for examination with our approval as the university supervisors.

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JKUAT, Kenya

DEDICATION

This work is dedicated to Almighty God for giving me the opportunity to further my studies. To my wife Esther and daughters Mitchell, Edna and Bethany for making the sacrifice of time and resources to allow me to complete my studies.

ACKNOWLEDGMENT

This work would not have been completed without the gracious support from my supervisors. I also acknowledge the moral support received from my family and friends

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LIST OF ACRONYMS/ ABBREVIATIONS

ARPU	Average revenue per user
BEREC	Body of European Regulators for Electronic Communications
CA	Communications Authority of Kenya
CAK	Competition Authority of Kenya
CAPEX	Capital Expenditure
CBK	Central Bank of Kenya
CCK	Communication Commission of Kenya ((predecessor of the CA)
EU	European Commission
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile Switching Center
GPRS	General Packet Radio Service
HLR	Home Location Register
ICT	Information and Communications Technology
IT	Information Technology
ITU	International Telecommunication Union
LOI	Ladder of investment Theory
LTE	Long-Term Evolution
MENA	Middle East and North Africa
MNO	Mobile Network Operator
MSC	Mobile Switching Center

NFP	Network facilities provider
NRA	National Regulatory Authority
OECD	Organization for Economic Co-operation and Development
OPEX	Operational Expenditure
RNC	Radio Network Controller
SGSN	Servicing GPRS Support Node
TOE	Technology, Organization and Environment
TRA	Telecommunication Regulatory Authority
WSIS	World Summit on the Information Society

DEFINITION OF TERMS

Active Infrastructure Sharing	The concept of sharing electronic infrastructure encompasses various components such as antennas, backbone transmission networks, base transceiver stations (BTS), base station controllers (BSC), bit streams, databases, radio access networks (RAN), radio network controllers (RNC), feeder cables, microwave radio equipment, mobile switching centers (MSC), registers, spectrum, optical fiber as well as wired access (CA, 2016).
Frequency resource	Volume of radio- Communication spectrum available for use (CCK, 2008)
Infrastructure	Consist of tangible and intangible facilities, which enable provision of ICT services (CA, 2016)
Infrastructure Sharing	Allowing other licensees of access to network elements used in connection with a public ICT network or intangible network elements facilitating the utilization of a public ICT network; and for the avoidance of doubt (CA, 2016)
Infrastructure Provider	A provider that owns or manages ICT Infrastructure (CA, 2016)
Service Providers	Any provider who provides ICT services to its subscribers or other licensees. (CA, 2016)
Local Loop	According to Newton (2003), the technology used for wireless, optical fibre, and other applicable methods is

utilized to establish the connection from the customer's premises to the carrier's point of presence, commonly known as the "last mile."

Numbering Resource

The International Telecommunication Union (2021) defines a resource that comprises letters, numbers, or a combination of both, which service providers assign to customers and equipment. This resource serves the purpose of identifying, charging, and routing traffic.

ABSTRACT

The Government of Kenya recognizes Information and Communication Technology (ICT) as a strategic enabler to achieve its aspirations of transforming Kenya into a digital-driven economy by providing universal access to quality, affordable, and reliable ICT services. Digital connectivity has the potential to support development through digital transformation, but universal access to the internet is crucial to realize its full benefits. In many developing countries, unaffordable broadband internet access is a major obstacle to digital inclusion, leaving large populations offline. Infrastructure is lacking, especially in sub-Saharan Africa, hindering sustainable development. To address this, mobile phone service providers must invest in infrastructure development to meet the increasing demand for ICT services. However, rapid technological evolution, regulatory requirements, and heavy capital investment require new strategies. Furthermore, connectivity costs in Kenya remain high, with the bottom 40% spending an average of 45% of their gross income on fixed broadband. Infrastructure sharing among mobile operators could accelerate digital connectivity at a lower cost, especially in underdeveloped markets where returns on investment are limited, leading to improved sustainability. Despite its potential benefits, infrastructure sharing among mobile operators in Kenya is low, and the policy framework for shared infrastructure has not been fully utilized. This study investigates the factors that influence infrastructure sharing among mobile operators in Kenya, revealing that competition, technology, and regulation influence network infrastructure sharing, leading to a significant reduction in the cost of network infrastructure roll-out and capacity expansion. This improvement in infrastructure usage efficiency enables telecom operators to have a competitive advantage through new product development and innovations. The study recommends the adoption of initiatives to promote infrastructure sharing as a pathway towards growing the digital economy, which is crucial for economic development, social well-being, and job creation. The study found that the factors studied influenced infrastructure sharing among mobile operators where competition, technology, and regulation were significant factors. Implying that promoting infrastructure sharing initiatives could lead to improvements in usage efficiency, increased innovation, and economic growth.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Infrastructure sharing solutions that facilitate access to broadband Internet have proven to be a critical lever contributing to the growth of the telecommunication sector and promoting digital transformation (Meddour, Rasheed & Gourhant ,2011). This can only be attained by having infrastructure in place according to the International Telecommunication Union [ITU], (2021). The value of broadband internet has kept increasing even in the face of increased subscriptions for both the mobile and fixed broadband across the globe. In the era of technological evolution and as people shift to smartphone usage, there is need for upgrading and modernizing them mobile networks. The masses and corporations all demand for superfast fiber access network and also broadband networks, this is to increase their performance rate as well as keep up with development at the global scene. The telecommunication companies are therefore forced to improve on the quality of the networks they provide, and to be able to meet the needs of the customers, these companies need a lot of financial investment in the sector. In Africa, ICT infrastructure is viewed as one of the aspects that will lead to the growth and development of the sector (Africa Development Bank [ADB], 2016).

In the broadband market, the demand and transformation has led the main service providers to heavily invest in the sector so as to upgrade their network provision. And as most of the broadband customers stick to mobile networks, they are often migrated from 3G which was the dominant one to 4G and recently to LTE –Long Term Evolution and now 5G. These upgrades and shift upwards by the providers and operators is to meet the demand of the emerging market needs in terms of bandwidth. Many of these customers' demand for highspeed network connectivity so as to enable them be able to stream

videos, music and movies, do e-learning, conduct e-commerce and get services from e-government portals.

These demands and evolution can only be achieved using improved infrastructure.

For the service providers of mobile phones companies, as the demand keeps increasing, these companies are forced to invest in the infrastructure so as to meet the growing demand and uptake of mobile services (Northstream, 2009). And as such, the traditional model of single ownership has been deemed outdated as the mobile network operators shift to be able to satisfy the customers in an efficient way by using shared network layers. In any case, sharing of network is cost-effective (Booz, 2009).

The trend of sharing network is majorly due to migration to fast-moving and advancement in technology that demand thorough and increased regulatory requirements, high capital expenses even in the face of limited organizational resources, both physical and human resources (Hussein, 2010). With these facts coming to light, where there is a rapid increase in commoditization of equipment in the telecommunication sector, network separation and heightened competition in the sector; the telecommunication operators and service providers have come up with many strategies to overcome these challenges and network infrastructure sharing and radio access networks is at its core as one of key mechanism to lower costs of network and increase sustainability of the network (Hultell, Johansson & Markendahl, 2009).

One of the arguments that has emerged is infrastructure sharing in the developing countries and the emerging economies for affordable and reliable access to mobile phone services and broadband services. Infrastructure sharing can lead to growth and development of the technologies, markets and regulatory frameworks(European Regulatory Group, 2009) In addition, the network providers and the operators can consolidate their efforts and enter these emerging markets as one, which will save on capital expenses as well as the operating expenses through mobile infrastructure sharing (Northstream, 2009).

Mobile phones played a key role in connecting the masses to different networks, and also through cellular service provision which has helped many people in rural areas in the developing countries. But at the same time, a lot more needs to be done to increase the penetration into the rural areas of access to mobile services that are affordable and also for reliable information and communication technology (ICT) services (Ericsson, 2010). The telecommunications industry is facing rapid technology migration and network rollout, which require heavy investment and adherence to strict regulatory requirements for coverage and quality of service, while also operating in a saturated and competitive market (Frisanco, 2010; Frisanco & Krehle, 2003; Frisanco & Kiritkumar, 2003). To keep costs low, compete for economies of scale, and remain relevant, infrastructure sharing has become a popular business process among telecommunication companies (Saphyere, 2010).

Infrastructure sharing, as defined by Saphyere (2010), involves multiple operators using the same infrastructure on agreed terms. According to Lefevre (2008), the concept of sharing in the context of mobile networks can be broadly classified into two types: passive sharing, which involves the sharing of non-electronic infrastructure such as building premises, sites, and masts; and active sharing, which entails the sharing of electronic components of a mobile network including antennas, radio nodes, node controllers, backhaul, backbone transmission, and features of the main network. Passive sharing does not require coordination between operators, while active sharing is more complex and requires more coordination. Infrastructure sharing can take several forms, including mast or tower sharing, site sharing, radio access network (RAN) sharing, core network sharing, and network roaming (Forge et al., 2008). The concept of roaming-based sharing refers to the practice of one mobile network operator using another operator's coverage within a specific geographic area on a continual basis.

In 2011, Meddour and colleagues developed a framework that identified four dimensions of network sharing: the business model, which involves the contractual

relationship between parties; the geographic prototype, which takes into account the physical coverage of each operator; the technology prototype, which pertains to the technical methodology used for sharing; and the process prototype, which determines the shared services. They highlighted the interdependence between the choice of technological approach and the business, geographic, and process prototypes, and how this decision can impede the level of flexibility.

Research has demonstrated that infrastructure sharing is a crucial factor in promoting the expansion of the telecommunications industry. According to Lehman's (2001) findings, site sharing can result in cost reductions of 5-15% for 3G network deployment. Similarly, Ericsson (2001) suggests that more comprehensive sharing models, such as RAN sharing, can generate savings of approximately 40-50% of RAN expenses during the initial stage of network construction and 10% of RAN costs as the network reaches maturity.

In addition to cost savings, network sharing can create an extra revenue stream for network operators and enable them to meet their regulatory commitments. It can also be an effective option for upgrading mobile services to broadband wireless access technologies, launching more value-added services, reducing delays and hurdles for site acquisition, and spreading the risk of investment among different providers. By reducing costs, improving balance sheets, and fostering greater competition, the use of shared infrastructure has the potential to improve service affordability. Reduced capital costs for connection service providers as a consequence of eliminating infrastructure redundancy may eventually translate into cheaper connectivity service costs. This may encourage more accessible prices and better online connectivity. An accessible and open shared infrastructure can make it easier for mobile network operators (MNOs) and internet service providers (ISPs) to expand into low-income areas, increasing connection availability and bridging the digital divide, according to a 2017 World Bank research.

1.1.1 Global Perspective

Globally infrastructure sharing elements has been in commercial operation by mobile providers with tower sharing being dominant in America and Europe. Mobile operators in many European countries are encouraged to share their passive infrastructure, as demonstrated by Orange and Vodafone's partnership to share infrastructure in the UK and Spain while retaining their individual traffic management and remaining competitors in both wholesale and retail operations (ITU, 2017). The UK sharing agreement reportedly decreased both capital and operating expenses by up to 30 percent, while in Spain, it reduced the number of sites by approximately 40 percent and expanded service coverage to small towns with less than 25,000 residents. The partnership also enabled the provision of 3G wireless services to 19 rural provinces in Spain.

Jordan has made it mandatory for all mobile telecommunications license holders to provide infrastructure sharing and collocation services to other licensees, subject to the availability of resources, according to the ITU's most recent report from 2022. If the firms concerned are unable to come to an agreement on infrastructure sharing and national roaming, the Jordanian Telecommunications Regulatory Commission (TRC) retains the authority to step in. The TRC establishes the criteria of the sharing agreement if it determines that sharing infrastructure is possible. Operators must also provide one another with national roaming agreements, which must be filed with the TRC. According to the most recent ITU report (2022), the Malaysian Communications and Multimedia Commission (MCMC) has also mandated infrastructure sharing as a necessary condition for issuing licenses for 3G mobile spectrum in Malaysia. In order to maximize the use of already-existing network resources, such as capacity, base stations, and backbone facilities, applicants must demonstrate their ability and desire to share infrastructure, such as physical facilities and network capacity.

The Telecom Regulatory Authority of India (2008) states that tower sharing has become a profitable business in India worth billions of dollars. The concept of tower sharing has

become a crucial aspect of the telecommunication industry in emerging markets. For instance, in India, the Telecom Regulatory Authority of India (2008) estimated that by 2007, 135,000 towers were required to meet the industry's target, and by 2010, the number had increased to 330,000 towers. To set up these towers, an investment of US$10 billion was required by 2007, and by 2010, the amount increased to US$25 billion. Initially, the service providers were reluctant to share towers with their competitors as they believed it would result in losing their market share. Some service providers even thought that by denying tower sharing, they would have an advantage over their competitors by delaying their service rollout in the area. To encourage tower sharing among operators, the Indian government initiated the "Mobile Operator Shared Tower (MOST)" project.

The need for the government initiative arose due to rising competition and investments in constantly evolving technology, which have compelled telecom operators to seek new means of maintaining their profit margins. Building and operating infrastructure is a substantial expense for these operators, and therefore represents a viable avenue for generating swift gains. Bhardwaj (2013) asserts that the rapid growth and development of mobile devices and telecommunication resulted into expansion of Indian telecommunication sector. The sector attempted to maintain the quality of the services provided by developing the necessary infrastructure. According to Narayan (2013), in Bangkok, passive sharing resulted in cost savings ranging from 15-30% and even up to 60% annually, depending on the geographical extent of the sharing and the portion of OPEX and coverage improvement. Furthermore, tower sharing in the Middle East and Africa region resulted in estimated capex savings of USD 8 billion.

According to ITU (2017), the telecommunication companies in Africa can achieve significant cost savings of up to 30% and decrease capital expenditure by 60% by sharing resources and reducing individual infrastructure needs. This approach would result in faster deployment of new technologies, which would provide greater services

and improve the lives of people beyond just connectivity. ITU highlights that collaborating on network infrastructure and services has been a successful model globally. Thus, incumbent companies in Africa can generate new revenue by opening up their networks.

1.1.2 Kenyan Perspective.

The Kenyan telecommunications market faces intense competition and demand for international connectivity and stronger bandwidth has seen the growth and development of the mobile market due to these changes. A report by the Communications Authority of

Kenya (CA, 2021) shows that the Kenyan's mobile market has approximately 64 million subscribers by early 2021 with 46% broadband penetration, and the report further shows that the trend keeps growing as more people join different telecommunication companies and networks. This demand has made network operators invest in the infrastructure upgrades and technologies for mobiles. But due to competition, uneven growth and challenges in profits, the government has come in with the open-access approach to advance LTE services development. The search for competitive advantage has pushed mobile operators to think of new models of business operations and infrastructure sharing is one of them. Many operators are shifting from owning and deploying network infrastructure to sharing it with other players. The 2013 Kenya Information and Communications Act (KICA) promotes sharing and ensures that operators interconnect in order to offer critical services such as cross network calls, short messages and emergency services. Regulations mandate that operators in this sector must procure network facility provider licenses in order to participate in infrastructure deployment either in active or passive capacity but it must be within the framework. The power of regulation lies with the Communication Authority of Kenya.

According to Frankline (2016) ICT Ministry in Kenya had developed a draft regulation for the deployment of communications infrastructure pending gazettement after various

discussions with key plays in the telecommunication and Information technology industry. The law requires that Telecommunication service providers share up to 30% of new ICT infrastructure. With this new requirement, the telecommunication sector becomes lucrative which will attract many investors and increase competition as per the May, 2016 report from the Communications Authority of Kenya which is the regulator. The regulation is on the Kenya Information and Communication on infrastructure sharing of 2016, which seeks to abolish instances of duplication, restriction of passive infrastructure deployment and also covers aspects of licenses, franchises, partnerships right of way and other intangible interests of sector members.

1.2 Statement of the Problem

ICT has been identified by the e-Government of Kenya as a critical pillar for the attainment of Vision 2030 and its aspirations aimed at transforming Kenya into a digital economy (ICTA, 2014, Oğuz, & Benli, 2015). ICT is a key pillar for growth of the economy since production process, distribution networks and consumption is heavily dependent on broadband networks and it is a useful enabler of development (KNBS & CA, 2016). In line with this, World Bank (2013) argues that inadequate infrastructure especially in sub-Sahara Africa is one of the key barriers to sustainable growth and development.

According to Ponelis and Holmer (2014), increased access to affordable ICTs is the greatest benefit for development. They further argue that having a common network infrastructure can lead to inclusion of entire societies in a socially and economically aspect. And again, the developing countries and emerging economies can have advantages of sharing infrastructure and gain technological, regulatory and market development aspects through cheaper, affordable mobile broadband services. For the operators, they gain in terms of savings, capital employed and operating expenses through network sharing both in an active or passive way (Northstream, 2009).

Telecommunication market through infrastructure sharing can create a health business environment for competition amongst the players and since there is no duplication, then the players who collaborate gain in terms of economies of scale and infrastructure sharing also creates an enabling environment for innovation and creativity and expansion of activities. Some of the newer innovative products include the next generation networks which also decreases assets of telecom, while tower sharing leads to expertise sharing and reduction of CapEx and OpEx shared the among operators (ITU,2013; Milam, 2012).)

For instance, the latest mobile technology being rolled out is 4G Long Term Evolution (LTE), which provides for the high- speed communication of data across networks. However, building LTE networks requires huge investment; hence investing in shared infrastructure may often be the only option that mobile operators can afford to offer LTE to their customers' base. Also, in rural areas where site CapEx and OpEx is high and/or where return on investment can be scarce, sharing may be necessary in order for telecommunications businesses to be sound (Jones, Simmons, Packham, Beynon-Davies & Pickernell, 2014). According to Oxford Business Group (2016), if there are no requirements for mobile infrastructure sharing, new players will have to match the existing licensees' infrastructure capabilities to be able to compete, creating a barrier to market entry.

In the past two decades, affordable internet access has been a significant driver of development in emerging markets. Expanding markets, improving business and government efficiency, and fostering innovation in conventional sectors, all have the potential to boost economic output, generate employment opportunities, and alleviate poverty (Milam, 2012). However, universal internet access is essential for the full realization of the benefits of digital connectivity. Affordability remains one of the most significant challenges in emerging markets, with a large population remaining offline due to the lack of affordable broadband internet access. In emerging economies huge

population remain offline, partly due to a lack of affordable broadband Internet access. (GSMA,2019). According to International telecommunication Union [ITU] (2021) global report, cost of connectivity in Kenya remains out of reach for millions. The report further states that fixed connectivity in Kenya remains expensive for the button population who spends an average of 45 percent of their gross income on fixed broadband.

Infrastructure sharing can be a viable solution to promote faster and cheaper digital connectivity, particularly in underdeveloped markets where investment returns are limited. This approach has the potential to decrease the costs of investment and operations for both investors and operators, enhancing their financial sustainability. Moreover, by minimizing duplication, infrastructure sharing allows for multiple market players to share the cost of network expansion and generate substantial savings in capital expenditure. In addition to these advantages, sharing models can also benefit end-users by increasing competition, lowering prices, and improving service quality, as highlighted (Strusani & Houngbonon , 2019: Milliams, 2011).

Moturi and Malungu (2015) highlighted that network infrastructure sharing has great developmental benefits. It is further argued that as telecommunication demand is beyond the infrastructural development due to rapid technological evolution, sharing network infrastructure and services is possible enabler to bridge the digital divide. Kenyan mobile companies tend to prioritize investing in their own infrastructure, even though there are underutilized ICT resources offered by other companies and entities. From the above discussions, there is limited study that has assessed factors influencing mobile infrastructure sharing in Kenya. This study aimed to fill the research gap by investigating the factors that influenced mobile infrastructure sharing among mobile operators in Kenya telecommunication industry.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of the study was to examine the factors influencing telecommunication infrastructure sharing among mobile network operators in Kenya.

1.3.2 Specific Objectives

The study was based on the following three specific objectives:

i. To assess how the regulatory framework, influence the sharing of telecommunication infrastructure in Kenya.

ii. . To determine the impact of competition quality on the sharing of telecommunication infrastructure in Kenya.

iii. . To investigate the role of technology development in influencing the sharing of telecommunication infrastructure in Kenya.

1.4 Research Hypotheses

H_1: Regulatory framework has a significant influence on telecommunication infrastructure sharing in Kenya.

H_2: Competition quality has a significant influence on telecommunication infrastructure sharing in Kenya.

H_3: Technology development has a significant influence on telecommunication infrastructure sharing in Kenya.

1.5 Justification of the study

This study is necessitated by the need to share ICT infrastructure by mobile operators as a driver for sustained telecommunication growth in Kenya. Sharing mobile networks is significant as it can have a substantial impact on enhancing availability of cost-effective ICTs, producing economic development, enhancing living standards, and supporting

both developing and developed nations in fulfilling the goals set by the World Summit on the Information Society (WSIS) and the Millennium Development Goals established by the UN. Shared infrastructure by telecommunication market is essential for cost reduction, encourage shift to new technologies and mobile broadband deployment which leads to accessibility of broadband services. This is also key pillar in realization of Kenya Vison 2030 goals and aspirations as all the three pillars of sustainable development namely, economic, social inclusivity and environment protection as envisaged in Vision 2030 need ICTs as an enabler towards achieving the Sustainable Development Goals (SDGs) and targets (Tjoa, & Tjoa, 2016).

Access to affordable to ICT positively impacts growth and development of the economy and income earnings in the first-world counties. Use of ICT can also increase supply chain performance and according to Lio and Liu (2006) this is because, ICT increases income channels from the common and traditional ones. ICT also plays a key role in reducing income inequalities and improves the quality of life since infrastructure sharing causes innovation and expansion of activities (Lee, et al., (2018). They further state that allowing telecommunication infrastructure sharing is likely to push down operational costs in promote healthier competitive environment in the highly competitive telecoms market where firms seek to outperform the other with reduced margins

This study was carried out to provide insights into infrastructure sharing feasibility by telecommunication operators as a cost-effective way of enhancing the provision of their services to a wider section of Kenyans. Moreover, infrastructure sharing can minimize unnecessary service disruptions in a rapidly growing telecommunications environment like Kenya's. Research to identify factors influencing infrastructure sharing will be key in informing policy makers on appropriate policies to facilitate easier and comprehensive mechanisms to encourage telecommunications infrastructure sharing in Kenya in realization of affordable access to ICT.

1.6 Significance of the study

This study was aimed at assessing the factors which influence infrastructure sharing by telecommunication operators in Kenya. The study provided useful information through the findings and recommendation that the researcher recommended to policy makers and telecommunications operators to promote enabling environment for shared be infrastructure that is key for sustainable development.

Findings from this study may guide mobile phone service providers as they formulate strategies that promote network infrastructure sharing. Such strategies will lead to a reduction in capital expenditure and hence offer new technologies for better experience by customers with variety of choices at better margins. Cost reductions will also enable providers to provide mobile broadband access to a larger segment of the population. This way, Kenya will gradually transform into a digital driven economy as ICT services become more accessible and reliable.

1.7 Scope of the Study

The study covered the influencing factors for infrastructure sharing to facilitate broadband access that is key for digital transformation. The study considered competition, technology and, the regulatory environment as the main elements. Questionnaires were used in collecting raw data from Safaricom, Airtel and Telkom as the mobile providers operating in Kenya and their employees who have deep knowledge in telecommunication market, regulatory environment, strategy and acquisition among the three mobile service providers under jurisdiction of this study.

1.8 Limitations

Major limitations for the researcher encountered in the field were: slow pace of the operators to share information since infrastructure sharing is a relatively new concept or business arrangement in the Kenyan telecoms market with increased level of competition environment where one of the service providers is viewed as dominant. Secondly the study was based on expert judgement by some respondents. Thirdly the

secondary information especially from some websites may not be conclusive due to rapid evolution of technology and inadequate research information in the space of telecommunication infrastructure sharing. However, strategies were incorporated to minimize their impact on the outcome of the research by sample size and structured questionnaire

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Mugenda and Mugenda (2019) provide a definition of literature review as the methodical process of identifying, finding, and evaluating relevant documents that contain information pertinent to the research problem being studied. This chapter reviews empirical study done by researchers in the domain of telecommunication infrastructure sharing. It also highlights research gaps of the study. The chapter examined the factors influencing mobile operators ' sharing of telecommunications infrastructure in Kenyan industry. The main factors discussed were; regulatory environment, competition quality and technological evolution of ICT resources.

2.2 Theoretical Framework

In the past, the regulatory framework underwent changes while various pushing and pulling forces impacted access to ICTs were explained in this study using the cooperative game and the ladder of investment theories.

2.2.1 Game theory

To predict the results of strategy games in which players, such as businesses competing in a market, have incomplete information about each other's intentions, game theory is primarily concerned. Thomson (2007) proposes a game-theoretical strategy that links a cooperative game to the problem and solves it by determining an allocation that reflects the strengths and opportunities of each player suitably.

It is the study of strategic decision making applicable in science and economics as well as logic leveraging on mathematical objects that are well clearly defined. A game is made up of a set of players, a set of choices (or strategies) available to players, and a payoff specification for each strategy that are combined together. Usually the normal (or strategic) game is depicted by a matrix showing players, strategies, and pay-offs. More

usually, any feature associating a payoff for each player with every possible mixture of actions can represent it.

A Nash Equilibrium is a term in game theory that describes a situation where all players in a game are playing their best possible strategies based on the choices made by all other players. When a game reaches Nash Equilibrium, it means that both Player A and Player B have made the best choices considering the other player's actions. According to Young (1985), this concept can encourage mutual agreement among parties with different interests, especially in competitive scenarios that involve a decision matrix, as demonstrated above. Each firm has the option to accept the common interest to cooperate with the competitors without change of the initial agreed strategies.

Game theory analysis is applicable to this study where, telecommunication firms are compelled, by emerging business factors like need to share infrastructure, to cooperate and influence their business environment for sustainability. Mobile companies use cooperative game theory to determine their approach to sharing network infrastructure as a strategic move to promote the adoption of new technologies and the implementation of mobile broadband. This is becoming a popular solution for providing broadband services to a wider global population.

2.2.2 Ladder of Investment Theory

The Ladder of Investment Theory was proposed by Cave (2006) as a regulatory strategy commonly adopted by European national regulatory authorities in the field of telecommunications. The approach is aimed at promoting inter-platform competition by firms through phase of access-phased competition. He further argued that the theory is fundamental in influencing the dynamic of competition in broadband market by successively offering entrants with distinct levels of access–the investment ladder's "rungs," while at the same time causing them to climb the ladder by setting an access fee that rises over time or by removing the access to commitments after a certain predetermined date.

Hunt et al. (2016) explain that the Ladder of Investment theory involves a stage of competition based on services in which new players depend on regulated access to the existing network. This approach allows new entrants to establish their brand, build a customer base, and acquire knowledge and experience while avoiding some of the entry barriers that could discourage investment in infrastructure. Over time, new entrants are encouraged to progress up the ladder towards sustainable competition between platforms, as shown in Figure 2.1 below;

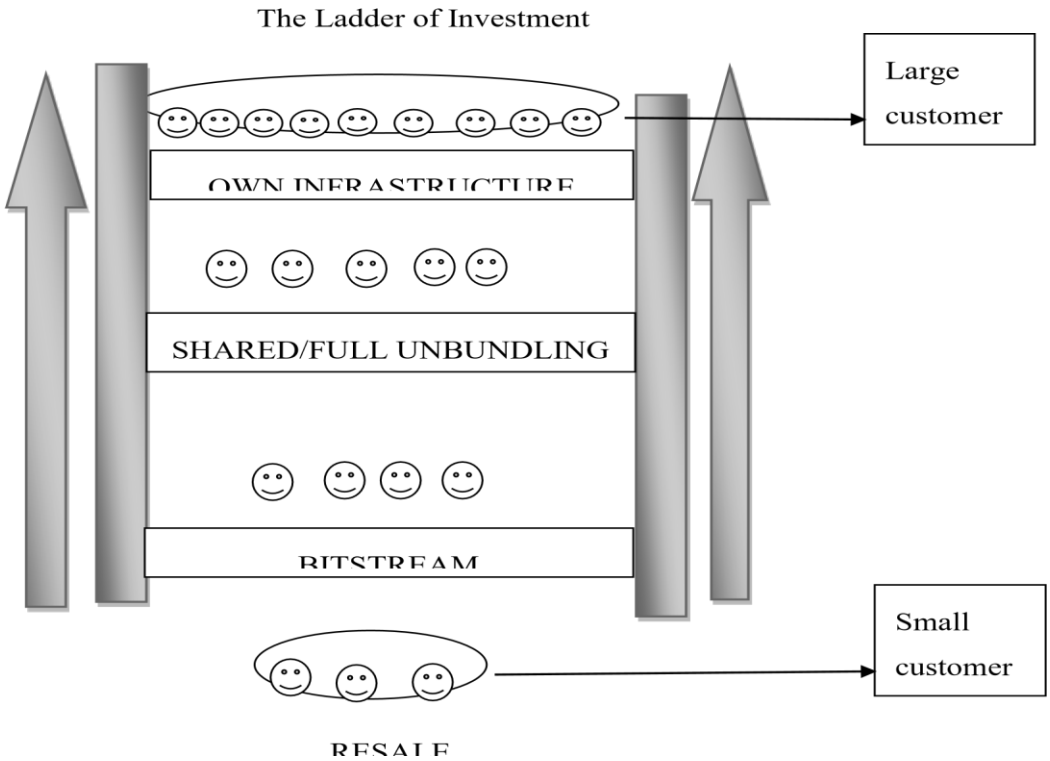

Figure 2.1 Ladder of investment theory

Source: European Regulators Group (2011)

Bourreau, Dogn and Manant, (2010) recognizes the replacement impact and the "stepping stone impact" as the two opposing variables in encouraging investment in infrastructurebased entry. They consider replacement impact as how a fresh entrant's incentives to invest in infrastructure-based entry can be reduced by access regulation.

According to Crandall, Ingraham, and Singer (2004), if wholesale access products are priced in favor of new entrants, it creates opportunity costs for incumbent operators who are considering investing in infrastructure, which can lead to infrastructure-based entry being delayed. This is because the higher the profits that can be obtained through access-based competition, the greater the incentive for new entrants to delay investment in infrastructure. The concept of the stepping stone effect pertains to a time frame wherein the existing entity permits the fresh participant to acquire knowledge, skills, and progressively establish their brand and followers, facilitating the swift adoption of infrastructure-based entry.

Globally, competition authorities have implemented the Ladder of investment model with the main aim of describing the entry model and the extension seen in broadband markets. According to Hunt et al (2016), the Ladder of Investment suggests a potential solution for regulators who aim to promote competition without hindering the incentives for new entrants to invest in their own infrastructure. Instead of considering access-based entry and infrastructure-based entry as alternative forms of competition, they should be considered as complementary and sequential steps. It is clearly highlighted that from the above discussion, the Ladder of investment theory is a key instrument used by regulators in shaping policies used in fostering development of broadband markets hence its viability in this study.

2.3 Conceptual Framework

In the conceptual frame work shown in figure 2.2, it is assumed that telecommunication infrastructure sharing models among mobile operators is influenced by regulatory framework, competition quality and technology development. The indicators of regulatory framework are: policy structure, tariff regulation and market structures. For competition quality are: competition policy, service competition and infrastructure competition while for Technology development are sharing models, innovation evolution and spectrum management. The indicators that measured infrastructure sharing are process and geographical.

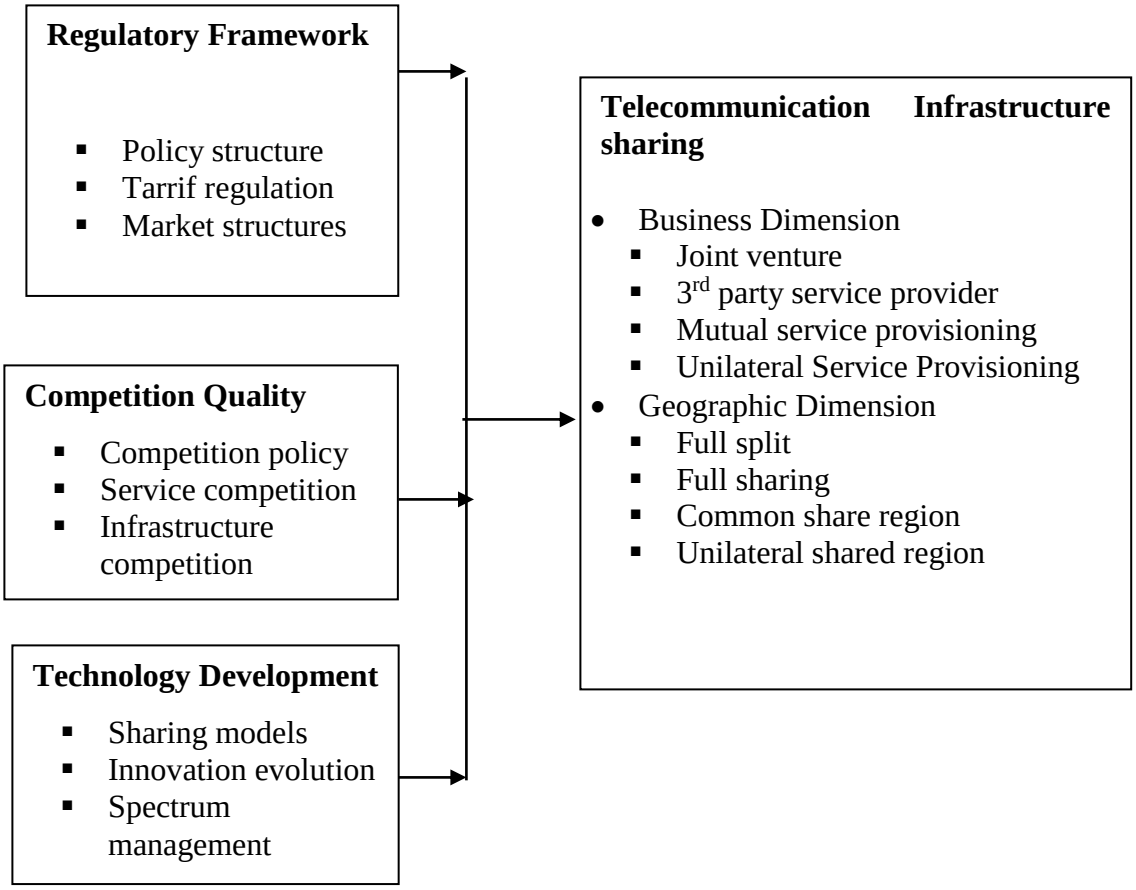

Figure 2.2: Conceptual Framework

2.4 Review of Variables

2.4.1 Regulatory Framework

Carlo and Yanjan (2009) defined regulation as the government's control over business activities in order to ensure a minimum tariff and maximum service standards. They explained that regulatory systems include institutions, laws, and processes that facilitate formal government control over operating and investment activities that provide infrastructure services. Sabat (2010) noted that countries regulate network sharing to protect their social, economic, and political interests, which could either foster or prohibit such sharing.

Infrastructure sharing regulations vary across countries. Some countries like Rwanda encourage infrastructure sharing, while others have no regulations beyond those for telecommunications services. In the UK, amendments to the Communications Act in 2011 helped promote efficient investment in infrastructure and innovation, as Ofcom has the power to require infrastructure sharing where it is proportionate and viable (Jones *et al*., 2014).

2.4.1.1 Policy structures

Chanab et al. (2007) argue that through liberalization, the telecommunications industry can enhance the growth of the economy across different sectors, but the success is reliant of policies and regulations that provide environment for competitive development. Establishment of regulatory and economic incentives is considered to be one of the policies with the main aim of encouraging infrastructure sharing among telecommunications companies as a key driver of competition and investment optimization. They further argue that the success of telecommunication programs relies on four major pillars that include efficiency dependency, transparency and non-discrimination. According to the World Bank (2010), the success of the liberalization process requires an effective regulatory regime that promotes full competition while protecting public interests in a transparent manner. The Communication Authority (CA)

is responsible for regulating the telecommunication, broadcasting, multimedia, and e-commerce industries in Kenya. This authority, previously known as the Communications Commission of Kenya, operates under the legal framework of the Kenya Communications Act (No. 2 of 1998), which has been updated by the Kenya Communications (Amendment) Act of 2009. The CA is responsible for promoting competition, protecting consumers, attracting private investment, and developing tariff guidelines. The regulatory framework in Kenya has been largely influenced by the European Commission's framework, as shown in Figure 2.3.

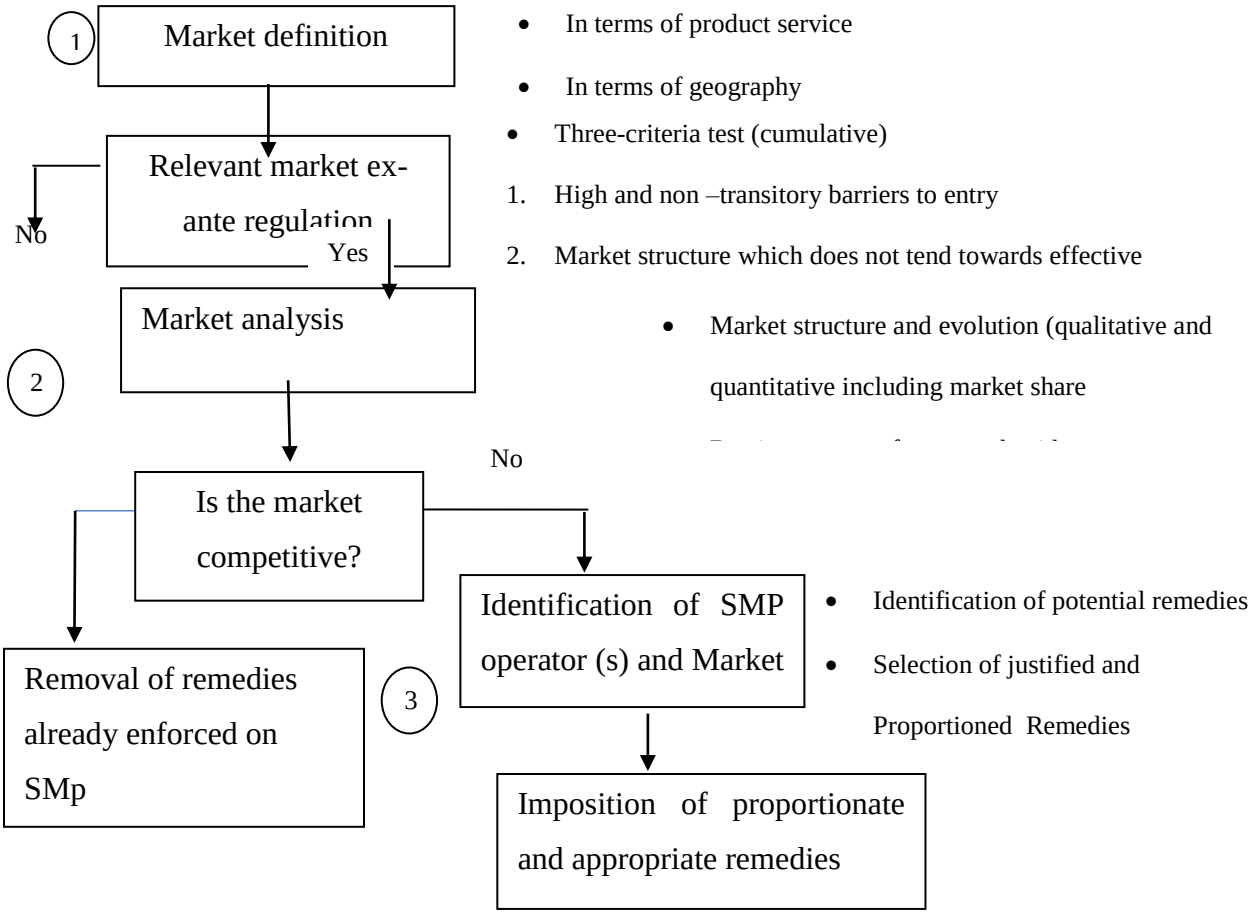

Figure 2.3: Regulatory Framawork Ecosystem

Souce : **Analysis amason (2017**)

Cave (2006) argues that the regulatory regime's objectives that are set out in the framework include the process of encouraging competition, investing and encouraging innovation with the main purpose of providing electronic communication services and the facilities that are associated with service provision. The goal is to create fair competition over time by allowing access to competitors who are appropriately equipped. This approach also motivates rivals to invest in infrastructure by deploying fewer duplicate assets, allowing them to progress up the ladder of infrastructure investment (ERG, 2004).

The telecommunications regulator in Kenya has encouraged sharing of infrastructure among local players arguing that this would increase competition by decreasing the cost of deploying fresh networks and seeing more border regions covered. Kenya's Communications Authority has released rules that would require telecommunications firms to share up to 30% of the new ICT facilities. It is asserted that a shared policy on infrastructure would eliminate asset duplication. The 2016 Kenya Information and Communications Regulations further attempted to limit the implementation of passive infrastructure unless there is no viable co-location alternative or there is no possibility of sharing infrastructure with a current supplier of the infrastructure. Under the model, suppliers wishing to enter the country's frontier markets would have to invest collectively, among others, in building infrastructure such as telecommunications masts, ducts, and physical sites. Furthermore, the laws extend beyond the growth of physical infrastructure to cover intangibles such as partnership agreements, permits, franchises, passage rights and other such concerns (Okuttah, 2016). Service providers wishing to plug into shared infrastructure will be needed to submit a formal application to the infrastructure supplier for both sides to enter into agreements and to provide the CA with an infrastructure sharing contract in less than a month's time. If the two sides disagree in the negotiations, the CA may impose an interim agreement for the sharing of infrastructure that will stay in force until a consensus is reached (CA, 2016).

Malungu and Moturi (2015) conducted a study on sharing ICT infrastructure framework in developing countries. They came to a conclusion that the rates of infrastructure sharing in Kenya were restricted, so ICT stakeholders should explore approaches to encourage higher rates. The study revealed that Safaricom's significant infrastructure and market share is a result of considerable capital investment made over time. Therefore, to increase sharing levels in Kenya, other operators and the government must collaborate with Safaricom to gain greater access to its infrastructure while safeguarding their business interests. They proposed that policies should be taken to offer autonomous companies and operators' incentives such as tax concessions and license fees in order to encourage sharing. According to their assertion, for Kenya to support the growth of the ICT industry, it requires a suitable framework that includes policies such as coordinating planning and network deployment among ICT stakeholders, ensuring fair trade pricing that benefits both buyers and sellers, offering adequate incentives for infrastructure investments to guarantee a reasonable return on investment, and promoting accountability and data sharing. Although sharing had some difficulties, they also proposed that regulatory policies can be introduced to mitigate hazards and encourage the optimization of resources.

2.4.1.2 Tariff Regulation

Previous research on broadband market regulation and investment has been divided into two main areas: the impact of incentive regulation and access regulation on network investment. Incentive regulation refers to an alternative to the traditional cost recovery approach, such as the rate of return, where operators can keep additional revenues or cost savings resulting from their own efforts within a specified period (Armstrong & Sappington, 2006; Cave et al., 2002). In contrast, wholesale regulation pertains to access to both existing and future infrastructures. Economides (1996) notes that there are two types of access or interconnection, "one-way" access with the aim of creating sustainable infrastructure-based competition where possible.

Laffont and Tirole (2000) points out two distinct channels where creative operations can be affected by regulating the telecommunication sectors. The first one is regulating of price (regulation of interconnection fees and retail prices) change earnings from the sector, hence innovative incentives. Second, both pricing and entry laws alter entry conditions and therefore innovation decisions on fresh entry. In addition, regulations that are specific to a particular sector ensure that the market structure evolves into a self-sustaining competitive environment, where companies compete with each other by offering low prices, better quality products, and a wider selection of products, thus gaining a competitive advantage.

2.4.1.3 Market Structures

Jones *et al* (2014) ascertain that the regulatory sphere for infrastructure sharing in most cases is country specific. In addition, Carlo and Yanjan (2009) argue that in certain areas, such as Rwanda, regulators strongly encourage infrastructure sharing where it is reasonably possible. Meanwhile, in other areas, infrastructure sharing is only subject to the typical provisions of telecommunications services without any additional regulation (Jones *et al*, 2014).

According to Mason (2018) Kenya's telecommunication markets is largely based on the principles underpinning the EC regulatory framework for market reviews that is internationally recognized as an example of best practice whose review is based on the standard three steps: market definition, market analysis and identification of appropriate remedies. The Communication Authority of Kenya (2008) implemented a unified licensing framework that is neutral towards both technology and service, which includes three types of licenses: the network facilities provider, the application service provider, and the content service provider. According to the regulations outlined in the CA of 2019, telecommunications companies operating in Kenya are required to hold a specific license and have a minimum of 20% ownership by Kenyan stakeholders, unless they are

publicly listed and have already met the equity participation obligations mandated by the capital markets legislation.

2.4.2 Competition Quality

Shapiro (2012) defines competition in the telecommunications industry as an increased rivalry between firms due to incentives from greater contestability and potentially more appropriable benefits, as well as increased innovation opportunities from synergies. High competition resulting from greater contestability can reduce profit margins on existing products and the costs of innovating new products (Holmes et al., 2012). Shapiro (2012) proposes three guiding principles to simplify the intricate relationship between innovation incentives and competition. These principles aim to evaluate the link between innovation and competition by considering three industry properties, namely contestability, appropriability, and synergies. Contestability refers to the ability of companies to gain or retain profitable sales by providing greater value to their customers. Appropriability evaluates the extent to which a successful innovator can reap the social benefits of their innovation. Meanwhile, synergies involve merging companies and combining complementary assets. Shapiro (2012) argues that these three properties are distinct factors that can positively impact innovation individually or in combination.

2.4.2.1 Competition Policy

The European Commission (EC) passed the 1997/1998 electronic communication liberalization Act which prioritized competition as the main policy objective and imposed wholesale access obligations asymmetrically on former state-owned "incumbent" operators with significant market power due to their monopoly-like legacy infrastructure. This policy allowed new market entrants to provide customers directly with retail narrowband voice and broadband services. The EU legislative framework provides three types of wholesale access commitments: resale, bit stream, and unbundling. Resale involves the entrant selling the incumbent's services without technical differentiation, while bit stream and unbundling require the entrant to construct

their own backbone network or gain physical access to the incumbent's local loop copper lines.

Studies have shown that competition is crucial for the growth and effectiveness of modern telecommunications infrastructure in both developing and developed countries. Opening up the market to more competition and private investors can enhance network development and effectiveness in the sector. Protection of incumbents from competition can lead to decreased investments and lower penetration of telecommunications services. Competition between telecommunications and cable companies has been identified as the most effective catalyst for enhanced broadband penetration in the United States, while competition in both developed and developing countries has a positive impact on broadband development (Waverman, Meschi & Fuss., 2005; Gutiérrez, 2003; Wallsten, 2004; Brown & Lee, 2008; Lee & Marcu, 2007).

Sharing infrastructure with competing operators can potentially harm their competitive edge and control over the infrastructure, but contractual measures can be implemented to alleviate these negative impacts. Joint ventures aimed at sharing infrastructure between major network operators may raise questions around competition and attract the scrutiny of regulators. Accordingly, operators seeking to implement infrastructure sharing should ensure that applicable competition rules are not infringed. However, infrastructure sharing can be structured so as to facilitate access to infrastructure for smaller operators, which will encourage competition, regardless of the whether the network is owned by a more restricted number of operators who form the core of the arrangement (Jones, *et al*, 2014).

Parbat (2005) notes that collaboration among major competitors in the same market is not a straightforward process, as internal rivalries may cause delays in network deployment, particularly if one company feels it can offer superior services than the other. In India, for instance, BSNL owns a comprehensive MRS-based network that is still in use in hilly and flood-prone areas, even though microwave repeaters are outdated

in an era of optic-fiber cables. BSNL has a vested interest in maintaining this infrastructure as it provides them with a captive market, and they are reluctant to share it with new private entrants to avoid competition. The multinational telecommunication players with competing interests across different countries, like those in European nations, are more likely to face such challenges (Total Telecom, 2001). Mugure (2011) researched on the factors that influence the choice of people on mobility of telecommunications network using a case study of BuruBuru shopping center, Nairobi County. The study findings revealed that price is a major factor that affects Kenya's selection of telecommunications network. The research also indicated that telecommunications network selection in Kenya is influenced by network coverage. Furthermore, awareness of customers and service quality influence telecommunications network decision in Kenya

Section 23(2) of the 1998 Kenya Information and Communications Act requires the Commission to encourage efficient competition between service operators involved in telecommunications services-related business operations in Kenya. In addition to encouraging private investment through efficient competition, this is anticipated to promote effectiveness and economic growth in the provision of such services. The act spells out the basis for interconnection charging structure and the principles to be followed in realization of universal access for the communication services

According to a study conducted by Piot, Edmunson and Tchoukriel-Thébaud (2017) on the competition in the telecommunications market in Kenya, it was found through market analysis that Safaricom holds a dominant position in five retail markets which includes the retail mobile communications market, retail mobile money market, retail fixed broadband market for enterprises, leased line market, and the retail fixed broadband market for consumers as well as fixed narrowband market. Based on these finding by Piot et al., (2017) proposed remedies that would remove the serious entry barriers for new and better entrants to telecommunication industry to nurture more

effective competition bases on international best practice. The analysis pointed out that competition law as envisaged has the same objective to facilitate competition for the benefit of consumers everywhere. Consumers in Kenya are no different from consumers in any other countries and the need to facilitate competition by restraining unbridled dominance through ex-ante regulation is a recognised and internationally upheld phenomenon in the telecoms sector (where, given the investment profile and the potential harm for consumers, ex-post intervention is not sufficient). One way to achieve this outcome is through the process of ex-ante market review

2.4.2.2 Service Competition

According to Hoffler (2007), service-based competition is directly dependent on a set of pre-defined access laws and cost-oriented wholesale access fees that enable the fresh entrant to deliver competitive retail services without engaging in the prompt, expensive and dangerous deployment of its own access network infrastructure. A Research conducted by Briglauer Frübing and Vogelsang (2014) revealed that operators of infrastructure bases argue that service based competition through compulsory access regulation restricts their capability of producing adequate income and is therefore harmful to incentives and innovations for ex ante investment. Cambini and Jiang (2009) ascertain that incumbents and entrants were discouraged from investing in fixed networks in distinct types of cost-based access regulation through service-based competition

Briglauer, Ecker and Gugler (2013) asserted that competition based on facilities and services provision resulted in reduced retail prices and enhanced the variety of products, which could also lead to a rise in complete broadband demand. The growing demand effect t also improved incentives for investment for incumbents (Kotakorpi, 2006). From this point of perspective, instead of being a replacement for competitive modes, competition based on services and facilities would complement one another and there would be no inter-temporal trade-off between static and dynamic efficiency. Most

regulators from the telecommunication sectors are trying to provide a structure that allows both types of competition despite trade-offs. It is possible to create competition based on facilities and services by attaining the correct amount of regulation (Oftel, 2003).

According to Briglauer *et al.* (2014), service-based competition can encourage entrants' investment only if multilayer access creates more opportunities for investment than other alternatives. The effect on incumbents' investment incentives is unclear because service-based competition can both deter investment due to access regulations and promote investment by increasing demand. In terms of cost-based access regulations, service-based competition can discourage both incumbents and entrants from investing in fixed networks.

2.4.2.3 Infrastructure Competition

Facility-based competition can be described as a model in which the fresh entrant does not rely on asymmetric wholesale access legislation of any kind but invests in facilities-based access facilities (Briglauer et al., 2014). They also state that the entrant enjoys extra advantages for facility-based competition such as entrepreneurial independence, improved service quality, and avoids paying the incumbent's access fee. A study conducted by Verboven, Bouckaert, and van Dijk (2010) on the factors that determine broadband penetration in 20 OECD countries from 2003 to 2008. Their findings suggest that competition based on infrastructure has a positive impact on broadband penetration, whereas competition based on service has a negative effect. The study also reveals that the Ladder of Investment hypothesis does not provide sufficient evidence to warrant extensive regulations on broadband access. Similarly, Briglauer, Frübing, and Vogelsang (2014) found that competition that focuses on infrastructure has a positive impact on investment, particularly when operators employ pre-emption strategies to gain a first-mover advantage in both retail-level price competitions and infrastructure investments. Furthermore, investment spill-over effects must be significant, and operators must

operate under an open-access framework with high access charges and uncertain demand.

2.4.3 Technology Development

2.4.3.1 Sharing Models

According to Meddour et al (2011), there are a range of alternatives that can be regarded as crucial in evaluating viability and identifying a number of options that are technical and can influence infrastructure sharing. There are four main types of telecommunications network sharing models, namely passive sharing, active sharing, roaming-based sharing, and spectrum sharing. Passive sharing involves sharing physical infrastructure such as building premises, sites, and masts, where separate networks use the same physical space. In contrast, active sharing is a more complex method where mobile network operators share various components of the active layer, including antennas, radio nodes, node controllers, backhaul, and backbone transmission, as well as elements of the core network, such as switches. Roaming-based sharing happens when one operator relies on another operator's coverage for a defined area on a permanent basis. Figure 2.4 shows that infrastructure sharing can occur at various levels.

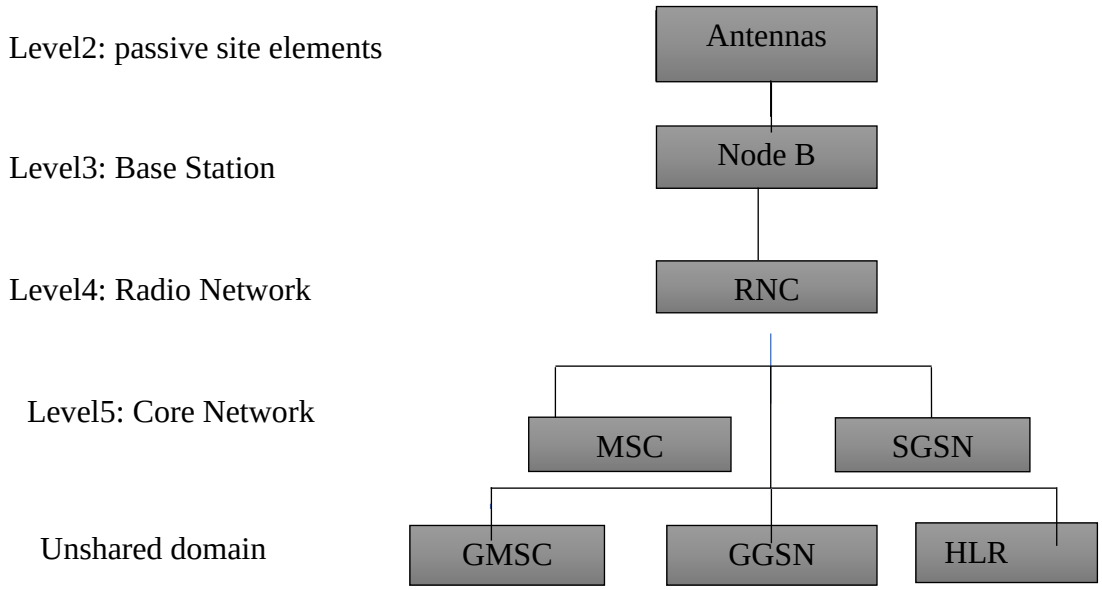

Figure 2.4: The different levels of infrastructure sharing in mobile networks

Source: **Computer Networks (2011**)

Frisanco et al., (2010) suggest that mobile operators are subjected to the sharing of passive infrastructure as the alternatives available if they plan to share passive components in their network of radio access. This kind of sharing has been popular since the year 2000 and does not require active participation among the different operators of the network. The physical components of the radio access network are the passive elements of a telecommunication network that could be shared between carriers and supplied by either one operator or a tower-like company intended to supply such parts (2008). According to International Telecommunication Union (2021), passive equipment assembling in one mobile telecommunications framework is usually referred to as a' site.'

According to Lefevre (2008), site sharing can be a cost-effective solution for operators to reduce both their capital spending (CAPEX) and operating expenses (OPEX). By sharing passive network infrastructure, operators can reduce their investments in site acquisition costs and civil works expenses, which can take up to 40 percent of the initial investment in fixed assets. In terms of recurring costs, site-related expenses typically represent between five and twenty percent of network OPEX, with the higher end of the range applicable to leased sites rather than owned ones. Additionally, sharing electrical equipment, such as air conditioning, can help address power consumption costs, which typically account for around 3% of network OPEX. International Telecommunication union (2021) cited that passive sharing can be used by regulator to meet environmental concerns as mast and antennas interfere with landscape and in addition exposure to electromagnetic fields. The concept of passive sharing has proven to optimise roll out costs hence fostering access to Telecommunication services by large population at affordable rates and encouraging technology upgrade to spur innovation (Leibner, 2014).

When it comes to passive sharing of sites and masts, network operators need to consider certain limitations such as load bearing capacity of the towers, the azimuth angle of other network providers, tilt and height of the antenna, before proceeding with the sharing agreement (Lefevre, 2008). In the case of mast sharing, operators must check if the mast can withstand the additional load and, if necessary, consider constructing a new mast.

Active sharing refers to a more advanced technical model where operators share not only passive infrastructure but also the "active elements" of the network, such as base station equipment, access node switches, and fiber optic network management systems (Meddour et al., 2011). This sharing involves electronic elements such as antennas, feeder cables, Node Bs, radio access networks (RANs), and transmission systems. Active sharing enables faster network roll-out as operators can leverage existing infrastructure, resulting in cost savings on CAPEX and OPEX, such as sharing active

RAN infrastructure like BTS and BSC or Node B in mobile networks. Despite the benefits of active sharing, many countries regulate this practice, fearing it may encourage anti-competitive behavior like agreements on price or service offerings. However, many regulators are becoming more flexible towards active sharing as providers are increasingly competing on the basis of service quality rather than the features of the international telecommunications networks.

National or international roaming refers to a sharing model where customers of a mobile network operator are allowed to use the mobile services of another operator when their own network coverage is unavailable. This has been used since the era of 2G networks to virtually extend the geographic coverage of a network operator by enabling their subscribers to use another operator's network. Roaming is also commonly used on an international level to serve a network operator's customers abroad when they have no license or business in that area (Meddour et al., 2011).

Aside from roaming, there is a concept of a virtual mobile network operator (MVNO) that provides public mobile phone services without owning mobile frequencies or access networks, such as 2G, 3G, 4G, or LTE networks (Sauter, 2010). From a technical modeling perspective, this can be considered as a long-term roaming of MVNO subscribers on the mobile operator's network. However, the success of MVNOs and their business models varies greatly from case to case and from country to country. According to the communication authority quarterly reports, there are three MVNOs in Kenya: Tangaza mobile pay limited, Zioncell Kenya Limited, and Equitel.

2.4.3.2 Innovation Evolution

According to Jones *et al.* (2014), the telecom industry's trend towards infrastructure sharing has led to more efficient growth and innovation, such as quicker implementation of next-gen networks (NGN), as companies combine their investment efforts and reduce the number of telecom assets required. Additionally, sharing towers and equipment

facilitates knowledge exchange among telecom companies and lowers capital and operational expenses (CapEx and OpEx) that can be divided among operators.

The latest mobile technology being rolled out in the in developing world is 5G the fifth-generation technology and 4G Long Term Evolution (LTE) which provides for the high- speed communication of data across networks. However, building 5G and LTE networks requires major investment, meaning that investing in shared infrastructure may often be the only way that network operators can afford to offer 5G and LTE to their customers. Also, in rural areas or in countries where site CapEx and OpEx is high and/or where return on investment can be scarce, sharing may be necessary in order for telecommunications businesses to be viable (Jones, *et al*, 2014).

Cano et al. (2020) stated that infrastructure sharing has disrupted the traditional business model of mobile network operators (MNOs), which involves purchasing a spectrum license, managing and deploying network infrastructure, customizing services for subscribers, and handling billing and accounting. The primary reason for MNOs to share infrastructure is to divide the cost of infrastructure and make their business more profitable. The authors also argue that in the context of telecommunications, infrastructure sharing enables technology migration from 2G to 3G and 3G to 4G due to the high upfront costs associated with these transitions. Additionally, infrastructure sharing is an essential component of 5G networks and serves as a means of cost reduction and an important pillar of 5G architecture. Finally, they conclude that the growth and evolution of sharing infrastructure and commercializing its viability reality in the context of promoting new technologies is key for digital infrastructure development

2.4.3.3 Spectrum Management

According to Prasad et al. (2009), radio spectrum sharing involves multiple radio access networks (RANs) or services using the same frequency band, with or without coordination between the systems. The focus is on the methods and schemes used for

spectrum access. Chanab et al. (2007) propose that market mechanisms can be introduced to facilitate radio spectrum sharing, although technical solutions without trading may also be possible, as defined by specific limitations on spectrum use, equipment density, and output power level. Peha (2009) suggests that spectrum sharing can be categorized based on cooperation or coexistence and primary-secondary or equal sharing models. In a cooperation-based sharing model, devices communicate with each other to minimize interference, while in a coexistence-based sharing model, devices mitigate interference without explicit signalling. International Telecommunication Union (2007) asserts that in mature controlled settings, spectrum sharing was created so that operators can lease their spectrum to other operators on a business basis. The statement emphasizes that spectrum is a limited resource and frequently underutilized by a single operator in a particular area. As a result, sharing is a practical alternative for two or more players.

2.4.4 The concept of Telecommunication Infrastructure sharing

According to Meddour et al. (2011), there are two models for characterizing infrastructure transactions. The first is the business dimension, which refers to the parties involved and their contractual relationship. The second is the geographic dimension, which describes each operator's physical footprint. Additionally, there is a technology model that outlines the technical solution. Frisanco et al. (2008) add that these two models are interconnected.

2.4.4.1 Business Dimension

Meddour et al. (2011) developed a model that outlines the parties involved and contractual relationships in infrastructure sharing. The model suggests that incumbent operators who have comparable roll-out cycles would prefer to either establish a joint venture or have mutual service provision agreements to handle the shared network. In situations where both new entrants and incumbent operators are involved, it is more appropriate to have unilateral service provision. If operators wish to focus on service

development and sales, they may consider delegating network provisioning to a third-party network provider that owns and operates the assets. Additionally, operators can reduce costs by outsourcing operations and tasks, irrespective of whether they have a standalone arrangement, mutual service provision agreements, unilateral agreements, or joint ventures.

2.4.4.2 Geographical Dimension

As stated by Frisanco et al., (2008) this describes describing the physical footprint for each operator's and can be claffied as: -

a) Full Split

Frisanco et al. (2010) stated that in a full split scenario, operators cover distinct and complementary regions, making this approach more suitable for operators with similar capabilities who wish to enter into a mutual service agreement, such as roaming. When it comes to a growth situation, it permits wider coverage or the adoption of novel technology at a reduced total expense. Conversely, in a consolidation situation, it demands a synchronized and optional discontinuation stage among operators, without any need to relocate the equipment.

b) Unilateral Shared Region

Frisanco et al. (2010) explain that the purpose of this model is to merge the roll-out needs of both incumbent and new entrant operators. The model allows the operator with a significant existing subscriber base to use it to increase volume and revenue while easing the burden on the new entrant operator. The new entrant is relieved of the responsibility of investing in a full-coverage infrastructure that may be disproportionate to their small number of subscribers.

c) Common Shared Region

The model proposes that operators of comparable size can collaborate to establish a shared region in which they can physically operate while sharing infrastructure or sites

to minimize capital and operational expenses. This eliminates the need for roaming, and infrastructure vendors can add new technical features without subscribers necessarily noticing the sharing arrangement, unlike roaming. Frisanco et al. (2011) suggest that such sharing solutions allow both players to utilize their unique network identifiers.

d) Full Sharing

Frisanco et al. (2010) argue that with complete sharing, operators can merge all their sites, or even their entire radio or core networks, except for a portion of the core network related to subscriber ownership, such as the home location register (HLR), authentication, and billing systems. A geographical implementation of full sharing is more efficient than a partial sharing approach using the same technology. In a roaming-based solution, the only distinction between full split and full sharing is the regional selection criteria for the former, whereas the latter involves a case-by-case decision on rollout or phase-out without regional criteria. In a growth environment, optimal joint network planning ex-ante is required for full sharing, while in a consolidation environment, operating costs are reduced by concentrating sites and retiring equipment that is no longer needed for capacity purposes.

2.5 Critique of the Existing Literature

Djamal-Eddine, Rasheed, and Gourhant (2012) note that sharing of infrastructure enables developing countries and other emerging economies to exploit market and regulatory developments that contributes to facilitation of affordable access to services related to mobile and broadband operations, thereby promoting universal access to ICTs, which is a key pillar of transforming digitization. Idachaba (2010) studied in infrastructure sharing between operators in Nigeria as a driver for telecommunication cost reduction. The study noted that the use of ducts was found to reduce the build-up of heat in the shelters thereby reducing the cooling required by up to 20%.

Williams (2012) examined infrastructure development by looking at public private partnership path for developing rural telecommunications in Africa. Williams asserted

that it is the government goal to ensure the achievement of a universal access of telecommunication services in ICT sectors. He recommended that to achieve this mandate there is need for partnership between the private sector and governments through feasible models angered on best practised globally. It is all about the public and private sector sharing and managing resources in a way that will help rural areas in third world countries access to affordable and reliable ICTs that will spur digital economy and inclusivity.

2.6 Research Gaps

Previous researches have concentrated their studies in adopting the sharing of infrastructure in the developed countries mostly in America, India and Europe. For instance, the Indian

Telecom Regulatory Authority presented an infrastructure sharing experience. Research by Djamal-Eddine, Rasheed and Gourhant (2012) on the role played by sharing of Infrastructure for the emerging mobile operators revealed that solutions related to sharing of infrastructure had proven to be a very crucial pillar that plays the role of enhancing telecommunication growth. This was achieved mainly though best practices that are subjected to promoting passive competition and active sharing of mobile infrastructure.

Idachaba (2010) studied infrastructure sharing between operators in Nigeria as a driver. Research has revealed that telecommunication infrastructure sharing is a viable business model for reducing costs and generating revenue for telecommunication players in Nigeria and Africa at large. Equally Nyongesa (2010) researched on how to realize market entry and the target roll outs for telecommunication licenses in the local loop. From the study findings, it was revealed that, ICT industry regulator and market forces are key in ensuring independence and transparency to foster confidence, encourage investments, and promote competition, therefore a swift entry into the market, lowering

costs and promotion of innovative products necessary for the realization of information society.

According to Namisiko (2015), the study on the impact of network infrastructure sharing among mobile operators in Kenya showed that the implementation of infrastructure sharing plays a crucial role in significantly decreasing both capital and operational expenditure. This, in turn, accelerates network deployment, enhances coverage, and helps meet the capacity demands resulting from technological advancements and innovations, particularly with the rise of data traffic. On the other hand, Malungu and Moturi (2015) researched the framework for sharing ICT infrastructure in developing nations. The research found that there was low sharing of infrastructure among mobile operators in Kenya owing to different variables. They suggested that the ICT stakeholder's inn realization of the advantage of shared infrastructure should explore measures to encourage higher concentrations.

Amason analysis (2017) conducted a study on Kenya’s telecommunications’ state industries. According to the study, Safaricom's dominant market position necessitates the sharing of its infrastructure with other Tier 1 service providers. The research findings revealed that given the current market share and structure, it is not economically feasible for other Tier 1 providers competing with Safaricom to expand coverage in low-density population areas. To address this issue, it was suggested that non-discriminatory access should be provided, and regulated pricing should be applied for at least five years at each individual site. Mason's analysis presents this situation as a mutually beneficial one for all mobile operators, allowing Telkom and Airtel to expand their reach while Safaricom earns revenue through infrastructure sharing. Thus, this study bridges the research gap by examining the factors that impact the implementation of mobile operator infrastructure sharing in Kenya.

2.7 Summary

This section examined the literature on variables affecting the sharing of telecommunications infrastructure between mobile operations in various aspects; the impact of legislative frameworks; competition on the sharing of telecommunications infrastructure and technology models were discussed. The theoretical framework and the conceptual framework were also covered. The chapter has also examined the literature by scholars who have done research on infrastructure sharing and its critique and identified the gaps to filled by the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter details information on the population of focus and the type of research design that was adopted as far as realization of the formulated objectives is concerned. The details on how selection of representative elements from the population was done and how the information and various views of the respondents were sought are also indicated. The chapter further gives a break down on how the collected views from the respondents were processed statistically.

3.2 Research Design

The research design utilized in this study was descriptive in nature. According to Kothari & Garg (2019), a descriptive study is primarily focused on gathering facts and may result in the development of fundamental principles and solutions to important problems. The study aimed to investigate the factors that influence the sharing of telecommunication infrastructure among mobile operators in Kenya and its impact on the provision of universal access to telecommunication services. The research design involved the collection, classification, measurement, analysis, comparison, and interpretation of data. As per Mugenda & Mugenda (2004), descriptive research design is important in collecting quantitative data related to two or more variables from multiple cases at a single point in time and identifying patterns of association between them. It was through this design that it was possible to gather information in quantitative attributes. Further, the design played an important role as far as establishing a link between the study variables was concerned. A descriptive research design provides several advantages. Firstly, it allows researchers to collect a large amount of data on a particular topic or phenomenon. Secondly, it enables researchers to describe and analyze the data in a systematic and organized manner. Thirdly, it provides researchers with an opportunity to identify patterns, trends, and relationships between variables, which can

be used to make informed decisions. Fourthly, it helps to develop theories and hypotheses for further research. Fifthly, it is a relatively quick and inexpensive research method, making it ideal for exploratory studies or studies with limited time and resources. Lastly, it is easily replicable, and the findings can be compared with other studies on similar topics or phenomena.

3.3 Target Population

Target population refers to items, objects, persons, individuals, events etc with considerably similar/common features (Mugenda and Mugenda, 2019). The target populations were senior management and departmental heads for the three mobile firms in Kenya namely including Safaricom, Airtel and Telkom Kenya at the time of the study.

There were for 100 senior and middle level managers selected in three mobile operators. The top and middle level managers formed the target population for this study specifically because of their wide experience in infrastructure sharing. The split between senior management and departmental heads is shown in the table 3.1.

Table 3.1: Target Population

Class of staff	Target population
enior management	24
Departmental Heads	76
Total	100

3.4 Sample Size and Sampling Technique

As per the definition by Kombo and Tromp (2006), a sample is a limited portion of a statistical population that is analyzed to gather insights about the entire population's characteristics. The study used stratified sampling was used to select the senior and departmental heads for inclusion in the study since they are the ones involved in strategy

formulation especially matters concerning infrastructure sharing. Array, Jacobs and Razavieh (1979) asserts that at least thirty (30) participants are selected for social research. According to Kathuri et al. (1993), the sample size should be large enough to allow an accurate interpretation of findings while ensuring that the information sought is of manageable size. The justification of a reasonable sample size saves on time and limited resources. A census investigation was conducted for all intended participants, which was deemed practical and driven by the desire for more precise results regarding the topics being studied. Table 3.2 illustrates the distribution of the sample size.

Table 3.2: Sample size distribution

MNO	Employee rank	Target population	Percentage
Safaricom	Senior management	9	9%
	Departmental Heads	30	30%
Telkom	Senior management	9	30%
	Departmental Heads	30	30%
Airtel	Senior management	9	6%
	Departmental Heads	6	16%
Total		100	100%

3.5 Data collection Instruments

Mugenda and Mugenda (2008) define data collection tools as instruments utilized to gather the necessary information required to support or substantiate certain facts. For this study, data was collected from both primary and secondary sources. A set of questionnaires played a significant role in collecting primary information, while publications from the relevant firms under investigation were used to gather secondary information. The questionnaire included both structured and open-ended questions, with the structured questions measuring objective responses and the open-ended questions gathering subjective responses, as well as clarifying objective responses to aid in formulating critical recommendations. The use of questionnaires offered an advantage in administration as it provided an equal opportunity for a large number of people to

respond simultaneously, which, as Walker (1985) confirmed, resulted in easy accumulation of data for the researcher.

3.6 Data Collection Procedure

Cooper and Schindler (2003) explain that the process of data collection entails reaching out to the chosen sample of respondents to gather the necessary information for the study. The research in question utilized a self-administered questionnaire that was given to the respondents at their workplace. In addition to this, face-to-face administration of the questionnaire was also conducted, with the researcher providing necessary guidance to ensure accurate data collection. Once completed, the questionnaires were collected either in person or via mail if filled out online. The process of data collection also involved obtaining permission from relevant authorities, including the university, the National Council for Science and Technology, and the service providers

3.7 Pilot Study

To test the research tool's validity and reliability, a pilot study was carried out at Telkom Kenya, one of the mobile service providers in Kenya that is involved in infrastructure sharing to some extent. According to Orodho (2003), piloting the study instruments is necessary to ensure that they are valid and reliable. The data was gathered using questionnaires that were aligned with the study's objectives. The pilot test involved 5 senior managers and 5 heads of department, representing 10% of the total respondents, as recommended by Mugenda and Mugenda (2019). Crewswell (2006) argued that the accuracy of data collected is largely dependent on the data collection instruments' validity and reliability.

3.7.1 Validity

To ensure the validity of the data collection instruments, the questions were reviewed by two educational experts and supervisors from the department of procurement and logistics at Jomo Kenyatta University of Science and Technology. They ensured that the questions aligned with the study's objective of investigating factors influencing

telecommunication sharing among Kenya mobile network operators. The validity of the instruments was assessed using the Content Validity Index (C.V.I), which yielded a score between 0.7 and 1, indicating that the instruments were valid (Orodho, 2003). The study also computed communalities for each variable to determine the proportion of variance each item had in common with other factors. All factors extracted had a coefficient above 0.4, indicating that the acceptable validity of the study tool.

3.7.2 Reliability

Cooper and Schindler (2003) defined reliability as the consistency, stability, or dependability of data. The internal consistency technique using Cronbach's alpha was applied to the gathered data to measure reliability. The study obtained a reliability index of 0.86, which was above the accepted threshold of 0.6 for science research (Mugenda & Mugenda, 2008). A Cronbach's alpha coefficient of 0.6 or higher indicates a relatively high internal consistency and the gathered data can be generalized to reflect opinions of all respondents in the target population (Zinbarg, 2005). Therefore, the study did not modify the measures and indicators in the questions before using them in the main survey.

3.8 Data Processing and Analysis

After the data was collected, it underwent editing to ensure accuracy, consistency, uniformity, and completeness. To analyze the data, the researchers utilized the Statistical Package for Social Sciences (SPSS) software, which was chosen for its clarity, ease of use, and interpretability. Both descriptive and inferential analyses were conducted where the outcomes were presented in terms of tables and figures. Specifically, regression analysis was employed to examine whether the independent variable(s) could predict the dependent variable of interest (Zinkmund, 2003). The regression model used for data analysis and determining the type of connection between the study variables was as follows:

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

Where:

Y = Telecommunication Infrastructure Sharing

X1 = Competition Quality
X2 = Technology
X3 = Regulatory Framework

$\beta 0$, $\beta 1$, $\beta 2$, $\beta 3$ are regression coefficients to be estimated

ε = Error term

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

Once information from the study respondents had been sought, cleaning up of the raw statistics was conducted before being entered into appropriate SPSS. Thereafter, analysis was conducted beginning with the descriptive and later on the inferential.

4.2 Response rate

The determination of the response rate was done on the basis of the issued instruments against those that were returned. Based on this, a total of 100 instruments were issued to study respondents, where the completely filled ones stood at 68 questionnaires. This information is displayed in Table 4.1.

Table 4.1 Response rate

	Frequency	**Percentage**
Actual response	68	68
Non- respondents	32	32
Target Population	100	100

The above response rate was in line with Mugenda and Mugenda (2003) who noted that for adequate presentation, the study should have a response rate of at least 60% and above.

4.3 Respondents Demographic Information

In order to capture the general information of the respondents, questions related to company and personal details were asked. Other questions were on years of experience, whether sharing exists and on what kind of infrastructure were asked. The demographic information was important in confirming the eligibility of ten respondents to take part in the study.

4.3.1 Respondent Companies

Table 4.2 below tabulates the details of distribution of respondents as per the mobile service players in Kenya.

Table 4.2: Distribution of respondents as per Company

Distribution of Respondents Companies		
MNO	**Frequency**	**Percentage**
Safaricom	24	35
Telkom	28	41
Airtel	16	24
Total	**68**	**100**

Findings shows that most 28(41%) of the respondents worked at Telkom Kenya, followed by thirty-five percent from Safaricom and twenty-four percent from Airtel.

Table 4.3: Table of distribution of industry experience

Distribution of Industry Experience		
Period of Experience	**Frequency**	**Percentage**
Below 3 years	0	
4-6 years	10	14.71
7-10 years	10	14.71
Above 10 years	48	70.59
Total	**68**	**100**

To ensure the reliability of the responses, all the respondents had more than four years of experience in the telecommunications industry, indicating a high level of industry expertise.

4.3.2 Level of Infrastructure sharing

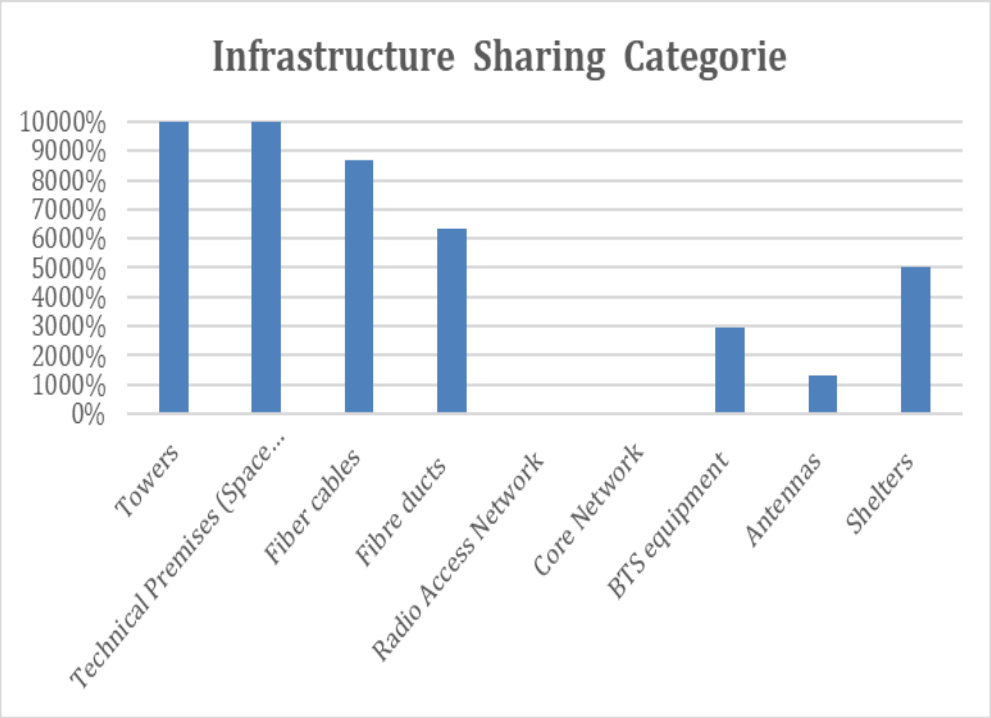

Figure 4.1: Infrastructure sharing categories

As indicated in Figure 4.1, some network categories are shared among different operators within the country. However, there exist differences in these categories of infrastructure sharing on the basis of different network categories. The widely shared infrastructure is what is referred to as passive while minimal sharing occurs for active infrastructure.

4.4 Regulatory Framework

The study sought to establish the connection between the regulations/framework and the telecommunication infrastructure sharing. A summary of the study findings is shown in Table 4.4.

Table 4.4 Regulatory Framework

Variable	Frequency (N)	Percentage
Policy Structures	50	73
Price Regulation	40	58
Quality of service	25	36

The results indicated that majority 50(73%) of respondents believed that policy structures ecosystem influence the uptake of telecommunication sharing. Fifty-eight percent and thirty-six per cent indicated that regulation of prices and service quality impacted telecommunication infrastructure sharing respectively. In addition, a scale of 1 to 5 was used where 1 denoted strongly disagree and 5 denoted strongly agree, the respondents were asked to indicate their level of agreement to the statements below relating to the role of regulatory framework in the telecommunication infrastructure sharing in Kenya. The results are presented in table 4.5 below

Table 4.5: Regulatory Framework

Statement of Opinion	Mean	Std. Deviation
Inadequate policy guideline on infrastructure sharing have affected telecommunication sharing in Kenya	4.5000	.70181
Optimization of scarce resources like land and spectrum has affected telecommunication infrastructure sharing in Kenya	4.0147	.85506
Government regulation of quality of service has affected telecommunication infrastructure sharing in Kenya	3.5147	.70165
Government regulation of environment impact assessment has affected Telecommunication sharing in Kenya	3.2794	1.07683
Government regulation of spectrum management has affected infrastructure sharing in Kenya	3.0147	1.11292
Effectiveness of government regulation has affected telecommunication infrastructure sharing in Kenya	3.0147	1.12625
Government National broadband strategy has affected telecommunication infrastructure sharing in Kenya	2.8971	1.38370
Transparency in regulation of the telecommunication sector has affected telecommunication infrastructure sharing in Kenya	2.8529	1.36332
Government regulation of universal service obligations has affected telecommunication infrastructure sharing in Kenya	2.5147	1.01471
Government regulation of terminal charges has affected telecommunication infrastructure sharing in Kenya	2.5000	.98496
Government regulation of interconnection charges has affected telecommunication infrastructure sharing in Kenya	2.5000	1.12635

The results in table 4.5 above show that the respondents agreed that inadequate policy guideline on infrastructure sharing affected telecommunication sharing in Kenya (Mean=4.5000) and that optimization of scarce resources like land and spectrum had affected telecommunication infrastructure sharing in Kenya (Mean=4.0147). In addition, the respondents agreed that government regulation of quality of service had affected telecommunication infrastructure sharing in Kenya (Mean=3.5147). Moreover, the respondents moderately agreed that government regulation of environment impact assessment affected telecommunication sharing in Kenya (Mean=3.2794) and that government regulation of spectrum management has affected infrastructure sharing in Kenya (Mean=3.0147). Further, the respondents disagreed that government national broadband strategy affected telecommunication infrastructure sharing in Kenya (Mean=2.8971) and that transparency in regulation of the telecommunication sector affected telecommunication infrastructure sharing in Kenya (Mean=2.8529). Also, the respondents disagreed that government regulation of universal service obligations affected telecommunication infrastructure sharing in Kenya (Mean=2.5147); Government regulation of terminal charges affected telecommunication infrastructure sharing in Kenya (Mean=2.5000) and that government regulation of interconnection charges affected telecommunication infrastructure sharing in Kenya (Mean=2.5000). The respondents were aware of the effects of the various aspects of regulatory framework influencing the telecommunication infrastructure sharing in Kenya.

4.5 Competition Quality

The study aimed at establishing the link between the competition quality and telecommunication sharing in Kenyan context. In the process of establishing this objective, the respondents' views were summarized in the table 4.6

Table 4.6: Competition Quality Frequency

Variable	Frequency (N)	Percentage
Competition policy	55	80
Service completion	20	29
Infrastructure Competition	34	50

As illustrated in table 4.6, 80 percent of the correspondents were of the view that competition policy ecosystem has the highest impact on telecommunication infrastructure sharing. Fifty-eight percent view infrastructure competition model as another factor that influence resource sharing among Kenya mobile operators while twenty-nine percent view service competition model as critical but to a low extent factor. Moreover, a 5-point scale was used for the respondents to indicate the level of agreement to the statements below relating to the competition quality in the telecommunication infrastructure sharing in Kenya. The results are presented in table 4.7 below;

Table 4.7: Competition Quality

Statement of Opinion	Mean	Std. Deviation
The cost of infrastructure development in Kenya affect telecommunication infrastructure sharing	4.1471	.77776
Levels of mobile market penetration in the country affect telecommunication sharing in Kenya	3.9853	.50350
The number of firms operating within the telecommunication industry have affected telecommunication infrastructure sharing in Kenya	3.8676	80862
Firms market preposition affect telecommunication infrastructure sharing in Kenya.	3.8235	.92947
Need for operating efficiency affects telecommunication infrastructure sharing in Kenya	3.7647	.67177
Downward pressure on ARPU in the mobile sector influence infrastructure sharing in Kenya	3.6618	1.21692
The market share enjoyed by telecommunication companies affect telecommunication infrastructure sharing	3.6324	.94481
The range of services offered by telecommunication companies in Kenya affect telecommunication infrastructure sharing	3.5000	.87246
Fees charged to allow infrastructure sharing affects infrastructure sharing in Kenya	3.3971	1.12156
Customers' demands like strict Service level agreement influence telecommunication infrastructure sharing in Kenya	3.1471	.77776
Increased consumer choice influences telecommunication sharing in Kenya	2.8235	89678
Termination rates prevailing in the market affect telecommunication infrastructure sharing in Kenya	2.3676	.92888

The outcomes presented in table 4. 7 above shows that the respondents agreed that The cost of infrastructure development in Kenya affect telecommunication infrastructure sharing (Mean=4.1471) Levels of mobile market penetration in the country affect telecommunication sharing in Kenya (Mean=3.9853) The number of firms operating within the telecommunication industry have affected telecommunication infrastructure sharing in Kenya (Mean=3.8676) Firms market preposition affect telecommunication

infrastructure sharing in Kenya (Mean=3.8235) Need for operating efficiency affects telecommunication infrastructure sharing in Kenya (Mean=3.7647) Downward pressure on ARPU in the mobile sector influence infrastructure sharing in Kenya (Mean=3.6618) The market share enjoyed by telecommunication companies affect telecommunication infrastructure sharing (Mean=3.6324) The range of services offered by telecommunication companies in Kenya affect telecommunication infrastructure sharing (Mean=3.5000) Fees charged to allow infrastructure sharing affects infrastructure sharing in Kenya (Mean=3.3971) Customers' demands like strict Service level agreement influence telecommunication infrastructure sharing in Kenya (Mean=3.1471) Increased consumer choice influences telecommunication sharing in Kenya (Mean=2.8235) Termination rates prevailing in the market affect telecommunication infrastructure sharing in Kenya (Mean=2.3676).

4.6 Technology Development

The resrcher sought to determine the influence of technology development on sharing of infrastructures in the telecommunication industry in the Kenyan telecommunication industry. The results in Table 4.8.

Table 4:8 Technologies Development Frequency

Variable	Frequency (N)	Percentage
Sharing structures	43	63
Innovation Evolution	30	44
Spectrum management	28	41

Sixty-three percent indicated that sharing structures impact telecommunication infrastructure sharing. Forty-four percent and forty-one percent were of the view that spectrum management and technological innovation evolution factors also influence sharing of the telecommunication infrastructure respectively. Additionally, the study employed the likert scale of 1- Strongly disagree and 5- strongly agree where the respondents were asked to indicate their level of agreement with the statements on the

roles played by technologies in the telecommunication infrastructure sharing in Kenya as presented in table 4.9 below;

Table 4.9: Technologies Development

Statement of Opinion	Mean	Std. Deviation
Perceived benefits and risks by mobile operators affect telecommunication infrastructure sharing in Kenya	4.0147	85506
Technology rolled out by mobile operators affects telecommunication sharing in Kenya	3.7794	.82581
Need for continuous innovation among telecommunication companies affects telecommunication infrastructure sharing	3.6324	84473
The costs associated with net technology acquisition affects infrastructure sharing in Kenya	3.3676	.99107
Compatibility of existing systems by mobile operators influences infrastructure equipment density affects infrastructure sharing in Kenya	3.2941	1.07978
Spectrum management affect telecommunication infrastructure sharing in Kenya	3.1176	1.26408
The compatibility of technologies used by different telecommunication companies affects infrastructure sharing in Kenya	3.0441	1.21476
Asset valuation and management affect telecommunication infrastructure sharing in Kenya	3.0294	.99207
Technical considerations differentiated according to the sharing category affect telecommunication infrastructure sharing in Kenya	3.0000	1.00744
Rapid diffusion of new technologies has affected telecommunication sharing in Kenya	2.8824	80167

As presented in table 4.9 above majority of the respondents strongly agreed that perceived benefits and risks by mobile operators affect telecommunication infrastructure sharing in Kenya (Mean=4.0147); technology rolled out by mobile operators affects telecommunication sharing in Kenya (Mean=3.7794) and that the need for continuous innovation among telecommunication companies affected telecommunication infrastructure sharing (Mean=3.6324). In addition, respondents moderately agreed that the costs associated with net technology acquisition affects infrastructure sharing in Kenya (Mean=3.3676) and that the compatibility of existing systems by mobile operators' influences infrastructure equipment density affects infrastructure sharing in Kenya (Mean=3.2941). Also in moderation the respondents agreed that spectrum management affect telecommunication infrastructure sharing in Kenya (Mean=3.1176) and that the compatibility of technologies used by different telecommunication companies affected the infrastructure sharing in Kenya (Mean=3.0441). Additionally, the respondents moderately agreed that the asset valuation and management affected telecommunication infrastructure sharing in Kenya (Mean=3.0294) and that practical deliberations distinguished rendering to the distribution grouping affected the telecommunication infrastructure sharing in Kenya (Mean=3.0000). Finally, the respondents disagreed that the rapid diffusion of new technologies had affected telecommunication sharing in Kenya (Mean=2.8824). The respondents aware of the aspects of technological development in the telecommunication infrastructure sharing.

4.7 Telecommunication Infrastructure Sharing Dimensions

The study employed a 5-point scale to establish the opinion on the level of agreement on statements regarding the telecommunication infrastructure sharing. The results are presented in table 4.10 below;

Table 4.10: Telecommunication Infrastructure Sharing models

	Mean	Std. Deviation
Business Dimension	3.71693	0.51366
Promotes joint ventures in business	3.4118	0.49581
Promotes 3rd party service provisions	4.2059	0.40735
Enhances mutual service provisioning	3.8824	0.32459
Promotes unilateral service provisioning	3.3676	0.82687
Geographic Dimension	3.7647	0.6769
Full splitting is enhanced	3.5588	0.81739
Full sharing ibn promoted	3.5882	0.49581
The common shared region is promoted	4.2059	0.72398
Enhances unilateral shared region	3.7059	0.67046

Presented in table 4.10, the **r**espondents agreed that business dimension sharing was enhanced (mean=3.71693) where joint venture was moderately enhanced (Mean=3.4118) while majority agreed that Mutual service provisioning was promoted (Mean=3.8824); Further, the results depict that the infrastructure sharing moderately promoted unilateral service provisioning (Mean=3.3676) and 3rd party service provisions were enhanced (Mean=4.2059). Additionally, the geographic dimension was enhanced (Mean=3.7647) where full splitting was promoted (Mean=3.5588); full sharing ibn promoted (mean=3.5882); the common shared region was promoted (Mean=4.2059) and that unilateral shared region was promoted (Mean=3.7059). The respondents were informed on the aspects of the telecommunication infrastructure sharing and how the sharing impacted their businesses or companies and their operations.

4.8 Hypothesis Testing

The study employed the one-sample test in testing the study hypothesis for the hypotheses below;

4.8.1 Regulatory framework

H_0: Regulatory framework has no significant effect on telecommunication infrastructure sharing in Kenya

H_1: Regulatory framework has a significant effect on telecommunication infrastructure sharing in Kenya.

Table 4.11: One-Sample Test for Regulatory Framework

	Test Value = 1					
	T	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Regulatory framework	26.682	67	.000	3.14572	2.9104	3.3810

In table 4.11 above, the p-value is .000 which is less than or equal to your significance level(p=.05). Thereby rejecting the null hypothesis and the sample data favours the alternative hypothesis (H1) which suggest that the regulatory framework effect is possible in the population of the study.

4.8.2 Competition Quality

H_0: Competition quality has no significant effect on telecommunication infrastructure sharing in Kenya.

H_2: Competition quality has a significant effect on telecommunication infrastructure sharing in Kenya.

Table 4.12: One-Sample Test for Competition Quality

	Test Value = 1					
	T	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Competition	37.442	67	.000	3.50980	3.3227	**3.6969**

In table 4.12 above, the p-value is .000 which is less than or equal to significance level (p=.05) and therefore rejecting the null hypothesis as the sample data favours the alternative hypothesis (H2) which suggest that the competition quality effect on infrastructure is possible in the population of the study.

4.8.3 Technology Development

H_0: Technology development has no significant effect on telecommunication infrastructure sharing in Kenya.

H_3: Technology development has a significant effect on telecommunication infrastructure sharing in Kenya.

Table 4.13: One-Sample Test for Technology Development

	Test Value = 1					
	T	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Technology	29.951	67	.000	3.31618	3.0952	3.5372

In table 4.13 above, the p-value is .000 which is less than or equal to the set significance level (p=.05) and therefore rejecting the null hypothesis as the sample data favours the

alternative hypothesis (H3) which suggest that the competition quality effect on infrastructure is possible in the population of the study.

4.9 Correlation Matrix

The study employed the Pearson correlations with the aim of determining the direction and size of the relationship that exists between the study variables; The results are tabulated in table 4.14 below

Table 4.14: Correlation Matrix Regulatory Infrastructure Competition Technology framework sharing

Competition	Pearson Correlation	1	.983**	.985**	.945**
	Sig. (2tailed)		.000	.000	.000
	N	68	68	68	68
Technology	Pearson Correlation	.983**	1	.995**	.955**
	Sig. (2tailed)	.000		.000	.000
	N	68	68	68	68
Regulatory framework	Pearson Correlation	.985**	.995**	1	.957**
	Sig. (2tailed)	.000	.000		.000
	N	68	68	68	68
Infrastructure sharing	Pearson Correlation	.945**	.955**	.957**	1
	Sig. (2tailed)	.000	.000	.000	
	N	68	68	68	68

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

The correlation matrix presented in Table 4.14 was used to examine the relationship between the dependent variable and the independent variables. The Pearson correlation coefficient (r) ranges from -1 to +1, with values above -/+ 0.50 indicating strong positive or negative correlation. The findings indicate a strong positive and significant correlation (r= 0.983, p=0.000) between competition and technology. The outcomes

further show that the competition and regulatory framework had a strong and positive correlation of r=.985 (p=0.000). In addition, the findings show that competition and telecommunication infrastructure sharing had a strong and positive correlation with a value of r=.945 (p=0.000). Moreover, the results show that technology and regulatory framework had a positive and strong correlation with a value of r=.995. Finally, the results indicated that regulatory framework and infrastructure sharing had a strong and positive correlation with a value of r= .957. The correlation results show that the study competition, technology and regulatory framework with the infrastructure sharing.

4.10 Principal Component Analysis

The alignment variables underwent a varimax principal component analysis, and three factors were extracted using a Screen test to evaluate the Eigen values. Figure 4.2 displays the graph of the Eigen values obtained.

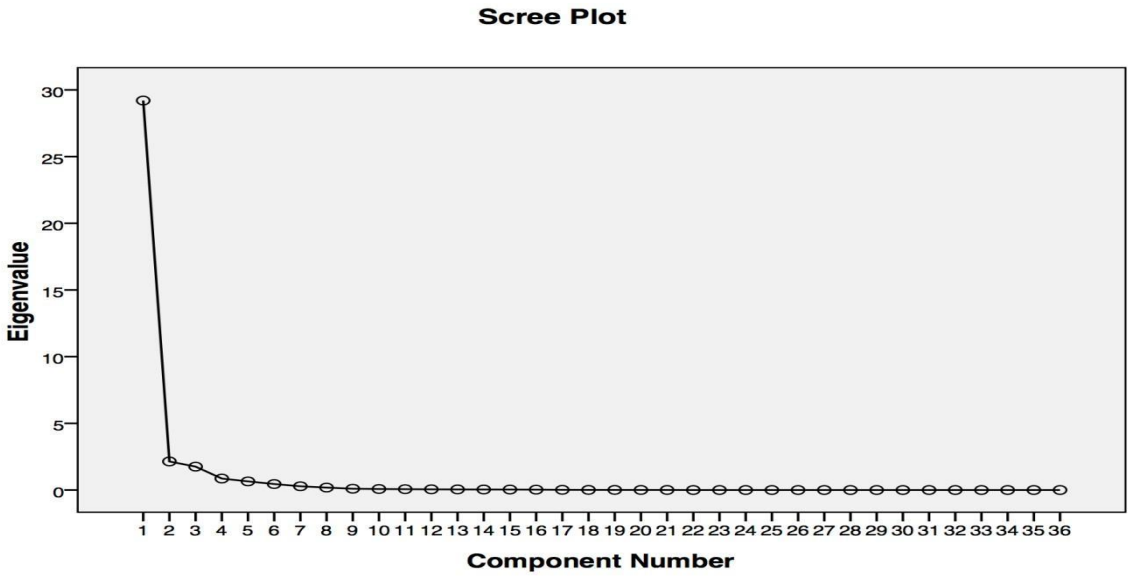

Figure 4.2: Scree Plot

Figure 4.2 above displays the rotated factor matrix that resulted from the principal components matrix analysis. The analysis revealed three factors which were labelled as

technology, competition and regulation. These three factors accounted for around ninetytwo percent of the total variance, as detailed in Table 4.15.

Table 4.15: Total Variance explained

Component	Total Variance Explained		
	Rotatio n Sums of Squared oadings L		
	Total	% of Variance	Cumulative %
1	12.553	34.870	34.870
2	11.964	33.233	68.103
3	8.578	23.829	91.932

To simplify the variables and create a concise and independent set, factor analysis was used. Table 4.16 indicates the variables that have high loadings and are significant in explaining the factors that affect network infrastructure sharing among mobile operators.

Table 4.16: Rotated Component Matrix

	Component		
Variable	1	2	3
VAR01	.492	.191	.812
VAR02	.596	.653	.333
VAR03	.227	.838	.301
VAR04	.411	.704	.487
VAR05	.246	.687	.645
VAR06	.572	.631	.333
VAR07	.513	.717	.285
VAR08	.694	.591	.237
VAR09	.336	.887	.209
VAR10	.560	.315	.661
VAR11	.596	.653	.333
VAR12	.383	.297	.809
VAR13	.061	.783	.500
VAR14	.776	.511	.058
VAR15	.645	.294	.672
VAR16	.647	.625	.367
VAR17	.658	.488	.490
VAR18	.422	.352	.779
VAR19	.866	.258	.395

VAR20	.683	.544	.441
VAR21	.661	.617	.333
VAR22	.773	.469	.297
VAR23	.678	.451	.520
VAR24	.663	.246	.632
VAR25	.378	.334	.814
VAR26	.278	.562	.748
VAR27	.622	.338	.686
VAR28	.384	.308	.832
VAR29	.268	.545	.755
VAR30	.468	.540	.668
VAR31	.607	.341	.693
VAR32	.422	.352	.779
VAR33	.537	.330	.744
VAR34	.350	.515	.739
VAR35	.386	.276	.869
VAR36	.273	.567	.745

4.11 Inferential Statistics

To determine the extent to which independent variables can predict mobile telecommunication infrastructure sharing in Kenya, the study utilized a linear model that incorporated the Model, Analysis of Variance of regression, and coefficient of determination. The analysis was conducted using SPSS version 25.0, chosen for its clarity, precision, ease of use, and interpretation. Table 4.17 provides a summary of the model analysis.

Table 4.17: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.753a	.567	.547	.24834

a. Predictors: (Constant), Regulatory framework, Competition, Technology

The study reveals that the R2 represents 56.7% of the mobile telecommunication infrastructure sharing in Kenya, which is affected by three independent variables.

However, the remaining 43.3% may be influenced by external factors not covered by this study. Therefore, further investigation is warranted to identify these factors and their impact on mobile telecommunication infrastructure sharing in Kenya.

4.11.1 Analysis of Variance (ANOVA)

ANOVA established the relationship existing between study variables. The results are presented in table 4.18 below;

Table 4.18: ANOVA of Regression

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	5.171	3	1.724	27.947	.000[b]
Residual	3.947	64	.062		
Total	9.118	67			

a. Dependent Variable: Telecommunication Infrastructure sharing

b. Predictors: (Constant), Regulatory framework, Competition, Technology

The p-value (sig.) was 0.000 ($p<0.05$) indicating that regulatory framework, competition and technology had statistically significant effect on the mobile telecommunication infrastructure sharing in Kenya at 95% confidence level. The F critical at 95% level of significance was 27.947 which was above .05 hence the null hypothesis was rejected

4.11.2 Coefficient of Determination

In order to determine the impact of independent factors on mobile telecommunication infrastructure sharing in Kenya, multivariate regression analysis was utilized in the study.

The findings have been outlined in table 4.19 as follows:

Table 4.19: Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.686	.270		5.009	.000
Competition		.663	.232	.552	1.199	.002
Technology		.456	.336	.386	1.786	.008
Regulatory framework		.523	.330	.588	1.647	.004

a. Dependent variable: Telecommunication Infrastructure Sharing

The generic regression model as per chapter three is given as

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

As per table 4.19, the estimated regression model is therefore

$$Y = 2.686 + .663X_1 + .456X_2 + .523X_3$$

Where Y is the telecommunication infrastructure sharing (the dependent variable)

X1 = Competition Quality; X2 = Technology and X3 = Regulatory Framework

$\beta_0, \beta_1, \beta_2, \beta_3$ are regression coefficients estimated

The error ε has been elimated where $\sum \varepsilon = 0$ in the minimization

According to the regression equation, taking all factors (Regulatory framework, Competition, Technology) to be constant at zero, telecommunication infrastructure sharing would be 2.686. The results also indicate that with the three variables, a unit rise in competition would lead to a .663 rise in telecommunication infrastructure sharing in Kenya. A unit rise in technology would lead to a .456 increase in the telecommunication infrastructure sharing in Kenya whilst a unit increase in regulatory framework would lead to a .523 increase in telecommunication infrastructure sharing in Kenya.

At the significance level of 95%, competition, technology and regulatory framework were the only significant factor in influencing telecommunication infrastructure sharing in Kenya with significance values of .002, .008 and .004 respectively. Competition was the most significant determinant of telecommunication infrastructure sharing in Kenya with significance value of .002 followed by regulatory framework and finally the technology with significance values of .004 and .008 respectively.

4.11 Discussion of the Findings

According to the research, technology was a crucial factor in determining telecommunication infrastructure sharing in Kenya (p=.008). This aligns with the assertion made by Malungu (2015) that telecommunication companies have the required technology for communication, including through the internet, phone, airwaves, cables, wires, or wirelessly. These companies have also established the necessary infrastructure to transmit voice, words, video, and audio across these channels to any location globally.

In addition, the study established that regulatory framework significantly influenced the telecommunication infrastructure sharing in Kenya. The findings agreed with the findings of Herrera-González and Castejón-Martín (2019) that there is endless need for relations in the telecommunications aimed at promoting mutual coexistence of the mobile operators within a jurisdiction. Also the results agree with the view of Sabat (2010) that most countries regulate network sharing to protect the interests of social, economic and political goals of the country.

Further, the study found that competition was a significant determinant of telecommunication infrastructure sharing in Kenya with significance value of .002. The findings agree to the findings of Briglauer et al. (2016) that operators of infrastructure bases argue that service-based competition through compulsory access regulation restricts their capability of producing adequate income and is therefore harmful to incentives and innovations for ex ante investment. Also the findings agree to the findings of Bouckaert, Van Dijk,and Verboven,. (2010). that for the broadband penetration

determinants competition based on infrastructure has a beneficial effect on the penetration of broadband, while competition based on service is an impediment to penetration.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Once data has been analyzed, the resultant findings are summarized in this chapter as informed by the formulated objectives. The conclusions as informed by the study specific objectives are also presented in this chapter. The recommendations of the study are provided with relevant implications on policy makers and the management.

5.2 Summary

Sharing of network infrastructure by mobile operators plays an important role as far as reduction of costs and enhancing effectiveness and efficiency is concerned. This tool is particularly important to mobile operators facing performance challenges hence inability to effectively compete within the industry of operation. Through sharing of networks, various operators are able to ensure that customers get better services since the network rollout is faster to promote universal access to telecommunication services that play a key role in digital transformation.

However, the policy guideline for shared infrastructure to rely on regulatory, market and technological advancement which have resulted into accessibility to ICT and mobile services has not been adequately exploited in Kenya. The study was broadly interested at determining the key factors that shape and influence sharing of network infrastructure with reference to Kenya's network operators in the mobile telephony industry.

The study was led by three research questions with corresponding hypothesis and the following is the summary of findings that this study identified as key factors shaping the sharing of infrastructures among the operators in the mobile telephony industry. The key variables that were seen to have an influence on sharing of infrastructures include regulatory framework, technology development as well as competition quality. It was established Kenya has a low level of sharing of infrastructure among the operators.

Despite this low infrastructure sharing, there existed some demand for infrastructure sharing largely brought about by new industry players who are interested in launching as well as ensure that the products are marketed at a faster pace. The other drivers for existence of infrastructure sharing include the need to optimize on costs (generation of revenues, opex or capex), the desire to conserve the environment, the need for operators to have focus on core business activities. Passive sharing was the most evident form of infrastructure sharing among the mobile telephony operators.

It was shown that there was inadequacy and relevance of the regulatory and policy frameworks which affected the ability and need for mobile operators to share infrastructures. This has resulted in operators investing on own infrastructure deployment and service expansion despite being capital intensive initiative and existing of economically feasible options through shared infrastructure. Inadequate regulatory and policy framework results into a state where the available network infrastructures are duplicated hence affecting how the networks are shared among the various operators and this acts as an impediment to digital transformation.

The study was interested at establishing the role played by competition quality on the ability to share network infrastructures. It was shown that the Communication Authority of Kenya has played an important role as far as sharing of network infrastructure is concerned. The rationale for infrastructure sharing according to CAK is to ensure that there is reduction in costs in deployment of new networks while ensuring that there is more coverage within all areas in the country. This is an important step towards ensuring that there is universal accessibility to ICT. It was shown that competition within the networks increased the speed and the area of coverage. However, without proper regulations, sharing of networks could slow down the degree of competition within the industry.

When asked about the degree to which technology has enhanced sharing of infrastructures, it was that this step would by default increase the opportunities and need

for more sharing of infrastructures to a large extent in future. It was however indicated that majority of the operators in the mobile telephony industry have strong preference of investing in relatively new forms of technologies while owning ICT infrastructures and this is key in enhancing their competitive positioning within the industry of operation.

5.3 Conclusion

It has been established that sharing of infrastructures is a key factor as far as the growth and development of the entire telecommunication sector is concerned. In fact, sharing of infrastructures has been recognized as a pillar in creating a digital world and digitally transforming the world in general. It was shown that there is low adoption of the need to share infrastructures by mobile network operators in Kenyan context. This creates the need for measures and efforts to stimulate and promote sharing of infrastructures among mobile operators. The study majorly focused on predicting key issues that influence sharing of infrastructures among mobile operators. From the findings, it was shown that there actually exists a significant link between the identified factors and sharing of infrastructures.

Thus, the study came to a conclusion that technology, competition quality as well as regulatory framework are key as far as success in sharing on infrastructures is concerned. In essence, mobile operators rely on developments within the market and regulatory frameworks to ensure that there is affordable accessibility to ICT as well as mobile services. This is geared towards digitally transforming the world as a whole.

The study comes to the conclusion that adopting policies that encourage and enhance sharing of infrastructures is an important factor as far as the general growth and development of the economy is concerned. The benefits associated with sharing of infrastructures among the operators in the telecommunication include the need to grow the level of revenues, enhance the level of efficiency, and optimize the costs, greater profit margins and the possibility of gaining competitive advantage. On this basis, the

operators in the telecommunication industry may realize the potential benefits of infrastructure sharing and thus jointly embrace a collaborative approach.

5.4 Recommendation

Information, communication Technology (ICTs) has been cited by the Government of Kenya as a strategic enabler to the attainment of Vision 2030 and its aspirations aimed at transforming Kenya into a digital driven economy by facilitating universal access to quality, affordable and reliable access to ICT services. ICT provides bedrock platform for raising the level of digital transformation where the steps involved to produce, distribute and consumer are informed by services and broadband networks. All these play an important role as agents and catalysts of sustainable growth and development of the economy. Sharing of infrastructure is geared towards improving wider broadband coverage in extended geographical areas to promote universal access to ICT hence foster economic development. This study and others have shown that there is low sharing of infrastructures among telecommunication mobile operators in Kenya's context. The key factors explaining this low sharing of infrastructures among mobile operators include evolution of new technologies, competition as well as the regulatory environment.

a) There is need for National Government to formulate and pass regulations and policies that drive and foster sharing of infrastructures among telephone operators. These regulations could cover the need to come up with economic incentives that spur and enhance the need to share infrastructure among different mobile operators. Such efforts will act as platforms for fostering optimization of investment returns and strengthening the available level of competition. This will also be an important step towards increasing the broadband penetration within the country.

b) The telecommunication is largely regulated by Communication Authority (CA) with responsibility of formulating regulations and policies for the operators.

Thus, the study recommends that CA as a regulator in the telecommunication industry should come up with sound regulations that negatively affect sharing of infrastructures.

c) The government has an important role to play in encouraging and fostering sharing of infrastructures that price adjustment mechanisms and enforcing of interoperability. This will play an important role towards levelling the playground for industry participants and operators in the telecommunication industry.

5.5 Areas for Further Research

The focus of the study was on operators in the mobile and telephony industry with the aim of getting an understanding of the factors that shape and bring about sharing of infrastructures. It is therefore important that studies are carried out to other operators in the ICT sector for instance the media and broadcasting entities and utility business organization so as to bring out the factors influencing sharing of infrastructures. Another study could also focus on regulatory mechanisms to propel mobile operators to work together. Initiates geared towards healthy cooperation between operators to find optimal partnership models, would also be a key area of research. Investigation of factors that promote fair competition in the ICT industry through regulatory interventions would also extend the findings of this study.

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APPENDICES

Appendix 1 – Letter of Introduction

Introduction

As a postgraduate student at JKUAT, my current research focuses on examining the factors that influence mobile infrastructure sharing among telecom providers in Kenya. Given the sensitive nature of this research, I have taken measures to ensure anonymity for survey participants, and I can assure that the information collected will not be used unethically for the advantage of any specific telecommunication company.

Appendix II- Questionnaire

SECTION A: Demographic Information

1. Company Name (Optional): .....

2. Position in the organization: .....

3. Number of years worked with the organization

Below 3 years	[ ]	4-6 years	[ ]
7-10 years	[ ]	Above 10 years	[ ]

4. Number of years worked in the telecommunication industry

Below 3 years	[ ]	4-6 years	[ ]
7-10 years	[ ]	Above 10 years	[ ]

5. Presently what kinds of infrastructure does your organization share with another telecommunication Company(ies)? Kindly select all that apply

Towers	[ ]	Fibre (Right of Way)	[ ]
Technical Premises (Space in buildings)	[ ]	Electric generators	[ ]
BTS equipment	[ ]	Switches	[ ]
Trenches	[ ]	Shelters	[ ]
Microwave equipment	[ ]	Antennas	[ ]
Others (Please specify)	[ ]		

_____

_____

Section B: Influence of competition on Telecommunication Infrastructure Sharing

6. Below are several statements on the influence of competition on telecommunication infrastructure sharing. On a scale of 1-5 where 5= strongly agree, 4= agree, 3= neutral, 2= disagree and 1= strongly disagree, please indicate by ticking (√) the extent of your agreement with each statement.

	1	2	3	4	4
The number of firms operating within the telecommunication industry have affected telecommunication infrastructure sharing in Kenya					
The range of services offered by telecommunication companies in Kenya affect telecommunication infrastructure sharing					
The market share enjoyed by telecommunication companies affect telecommunication infrastructure sharing					
Termination rates prevailing in the market affect telecommunication infrastructure sharing in Kenya					
Need for continuous innovation among telecommunication companies affect telecommunication infrastructure sharing					
Need for operating efficiency affect telecommunication infrastructure sharing in Kenya					

Network infrastructure sharing has improved cost efficiency of our company hence competitiveness					
Network infrastructure sharing has improved asset utilization					

7. In your opinion, in what other ways has competition affected telecommunication infrastructure sharing in Kenya?

_____

_

8. In your opinion, to what extent does completion among telecommunication companies affect telecommunication infrastructure sharing in Kenya?

Very great extent	[ ]
Great extent	[ ]
Moderate extent	[ ]
Little extent	[ ]
No extent	[ ]

Section c: Influence of Technology on Telecommunication Infrastructure Sharing

9. Below are several statements on influence of technology on telecommunication infrastructure sharing. On a scale of 1-5 where 5= strongly agree, 4= agree, 3= neutral, 2= disagree and 1= strongly disagree, please indicate by ticking (√) the extent of your agreement with each statement.

	1	2	3	4	4
The load bearing capacity of towers installed affects telecommunication infrastructure sharing in Kenya					
Technical considerations differentiated according to the sharing category affect telecommunication infrastructure sharing in Kenya					
The ability of masks bearing additional load affects telecommunication infrastructure sharing in Kenya					
spectrum limitations affect telecommunication infrastructure sharing in Kenya					
output power level affects telecommunication infrastructure sharing in Kenya					
Infrastructure equipment density affects infrastructure sharing in Kenya					
The compatibility of technologies used by different telecommunication companies affect infrastructure sharing in Kenya					
The costs associated with net technology acquisition influence infrastructure sharing in Kenya					
Rapid diffusion of new technologies has affected telecommunication sharing in Kenya					

10. In your opinion, in what other ways has technology affected telecommunication infrastructure sharing in Kenya?

_____

11. In your opinion, to what extent does technology affect telecommunication infrastructure sharing in Kenya?

Very great extent	[ ]
Great extent	[ ]
Moderate extent	[ ]
Little extent	[ ]
No extent	[ ]

Section D: influence of Regulatory Framework on Telecommunication Infrastructure Sharing

12. Below are several statements on influence of regulatory framework on telecommunication infrastructure sharing in Kenya? On a scale of 1-5 where 5= strongly agree, 4= agree, 3= neutral, 2= disagree and 1= strongly disagree, please indicate by ticking (√) the extent of your agreement with each statement.

	1	2	3	4	4
Government regulation of terminal charges has affected telecommunication infrastructure sharing in Kenya					
Government regulation of the number of players in the telecommunication industry has affected telecommunication infrastructure sharing in Kenya					
Government regulation of service quality has affected telecommunication infrastructure sharing in Kenya					
Government limitation of market access to all forms of telecommunications, including voice telephony, and infrastructure investment has affected infrastructure sharing in Kenya					
Effectiveness of government regulation has affected telecommunication infrastructure sharing in Kenya					
Transparency in regulation of the telecommunication sector has affected telecommunication infrastructure sharing in Kenya					
Government regulation of foreign ownership in the telecommunication sector has affected telecommunication infrastructure sharing in Kenya					
Government regulation of interconnection charges has affected telecommunication infrastructure sharing in Kenya					
Government entry regulations of the telecommunication sector has affected telecommunication infrastructure sharing in Kenya					

13. In your opinion, in what other ways has government regulation affected telecommunication infrastructure sharing in Kenya?

Section F: Telecommunication Infrastructure Sharing

14. In your opinion, to what extent does government regulation affect telecommunication infrastructure sharing in Kenya?

Very great extent	[ ]
Great extent	[ ]
Moderate extent	[ ]
Little extent	[ ]
No extent	[ ]

Please use a rating system from 1 to 5, where 1 signifies "strongly disagree," 2 represents "disagree," 3 indicates "moderately agree," 4 denotes "agree," and 5 represents "strongly agree." Use this rating system to indicate your level of agreement to statements that relating to Telecommunication Infrastructure Sharing.

Statements	1	2	3	4	5
Promotes joint ventures in business					
Promotes 3rd party service provider					
Enhances mutual service provisioning					
Promotes unilateral service provisioning					
Full splitting is enhanced					
Full sharing ibn promoted					

The Common shared region is promoted					
Enhances unilateral shared region					

THANK YOU.