A STUDY ON TELECOMMUNICATION TOWER SHARING AMONG MOBILE NETWORK OPERATORS IN ZAMBIA

By

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DECLARATION

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APPROVAL

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ABSTRACT

Mobile Network Operators (MNOs) Airtel, MTN, and Zambia Telecommunication (Zamtel) in Zambia adopted a tower-sharing model practised in developed countries such as the United States, Canada. At network roll-out, the operators retained ownership of the towers and at the same time provided telecommunication services. As the cost of providing network services to the growing active subscribers increased, recognized revenues dropped. To cut down on costs and improve their services, quality, pricing, and incentives offered, operators sold their towers to IHS Towers and began to lease back space on the towers. The capital recovered from the sale was then invested in new technologies to not only improve services but also to retain and attract more customers. Within this research study, the adoption and effects of the models used during the infrastructure sharing was investigated.

Quantitative research was conducted on the telecommunication tower industry and mobile network operations. The research found that all network operators share infrastructure passively through IHS Towers and Zamtel, and no active infrastructure is shared. Among these, 75% of the towers are self-supporting used for voice and data. 54% of these towers are being shared while 46% of the towers share only the sites. The tower-sharing business model was mainly adopted to reduce capex. It is likely that potential entrants could adopt this model as they enter the market. The main effects of infrastructure sharing were found to be: improvement of quality of service, price reduction, encouragement of competition, and expansion of service at a cheaper rate.

Keywords:
Infrastructure Sharing, Tower Sharing, MNO, Passive Infrastructure, Infrastructure Sharing Models

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ABBREVIATIONS

LTE	Long-Term Evolution
GPRS	General Packet Radio and Service
ZICTA	Zambia Information and Communications Technology Authority
GSM	Global System for Mobile
BTS	Base Transceiver Station
EDGE	Enhanced Data rates for GSM Evolution.
3G	3rd Generation GPRS
ZAMTEL	Zambia Telecommunications
Telecom	Telecommunications
MNO	Mobile Network Operator
MNS	Mobile Network Sharing
RAN	Radio Access Network
OPEX	Operational Expenditure
CAPEX	Capital Expenditure
CUTS	Consumer Unit and Trust Society
MVNO	Mobile Virtual Network Operator
ITU	International Telecommunications Union
SMS	Short Message Service

CHAPTER 1: INTRODUCTION

Traditionally, Mobile Network Operators (MNOs) operations involved the provision of services such as voice, short message service (SMS), and low-capacity data services (Habeenzu, 2010). When a network operator was rolling out their services for the first time, they built infrastructures that housed the base stations required for transmission. Competition among network operators was infrastructure-based and aimed at growing service coverage and improving network capacity and quality (Capgemini, 2015). Thus, mobile operators around the world established their own mobile networks offering nationwide coverage. Consequently, mobile communication service revenues grew at a rapid pace and deployment of new networks resulted in a fast return on investment (Ehiagwina & Offa, 2015); (Capgemini, 2015).

Today the focus is on new mobile services – broadband services, LTE, and 4G, which satisfy the demand for high-speed data (Malungu & Moturi, 2015). The rise in demand for high-speed data connections demands an increase in investments in the deployment of broadband networks to serve consumers, as well as capacity upgrades of existing mobile networks to cope with the rapid surge in mobile data traffic (Global System for Mobile Communications, 2015). However, mobile operators report that there has been only marginal growth in revenue, and that this does not support the required network investment costs as the market has hit a point of saturation (Global System for Mobile Communications, 2014).

The past decade has shown tremendous telecommunication services growth, particularly in developing countries where mobile telephony has provided cellular services to populations that did not have access to such services in the past (Global System for Mobile Communications, 2014). However, to increase penetration into rural areas of developing countries, an even greater investment in telecommunication infrastructure is required. “The roll-out of mobile networks requires high sunk investments and the need to recover those by charging the user heavily for accessing mobile services” (Ehiagwina & Offa, 2015).

Telecommunication infrastructure, e.g., structures where MNOs place antennae needed to serve the high demand of consumers, is an important asset of any mobile operator (Ehiagwina & Offa, 2015). Cell towers are "tall structures usually designed for supporting parabolic antennas which are used for microwave transmission for communication" (Bhosale et al., 2012. They usually consist of mechanical structures and electronic signal-processing units like transceivers (device that can receive and transmit communication signals, e.g., a radio transmitter) (Dehkordi et al., 2013).

(Global System for Mobile Communications, 2014) estimates over 240,000 towers span across the sub-Saharan region of Africa alone, and this number is expected to grow to over 325,000 by 2020. The size of the tower sites in Africa grew to support the growth in coverage levels across the region (International Finance Corporation, 2014). This growth raises concerns for mobile operators as fast roll-out is not being attained because of increasing competition, falling revenues per user, and the need to reduce operating costs and capital expenditures (International Finance Corporation, 2014). Thus, mobile operators are forced to raise prices to obtain a decent return on their investments. To avoid incurring even greater financial costs, mobile operators around the world including those in Zambia have adopted an infrastructure-sharing business model (Capgemini, 2015) and (IHS Towers, 2015).

Infrastructure sharing can be implemented in two ways. The first way is via inter-operator sharing, where an agreement is made between two or more operators to share infrastructure. The second option is third-party tower sharing, where an independent tower company builds and rents spaces to MNOs (Global System for Mobile Communications, 2014); (Ehiagwina & Offa, 2015). The tower company is an independent player, not a mobile operator, and provides services consequently allowing MNOs to focus on core businesses such as improving quality of service and market penetration rather than managing infrastructure. This becomes an advantage for the operator because it provides an opportunity to increase coverage and capacity quickly without bearing additional operational risk or long-term capital requirements and cost at first roll-out. (Smith, Infrastructure Sharing, 2014) advises that infrastructure sharing or Mobile Network Sharing (MNS) removes infrastructure-based competition among operators and allows them to save on operational costs by avoiding duplication of network assets.

MNS is a proven business model in the United States of America (USA), India, Indonesia, and increasingly Africa (Eaton Towers, 2016), and it has been in existence in America and Europe for the past decade (Smith, Passive Infrastructure Sharing in Telecommunications, 2011). However, it is only emerging on the African continent because tower companies are only just beginning to build, acquire, manage and lease passive telecoms infrastructure (i.e., towers, sites, and power) to mobile operators now.

(Eaton Towers, 2016) report shows Africa has the world's fastest-growing telecoms market, which is fuelling the rush to gain market share by tower companies. The African market is also notably starting to evolve as it did in India, where tower companies now control much of the country's infrastructure on behalf of operators (Global System for Mobile Communications, 2014). The Indian telecom tower industry evolved from a 100% operator-captive model in 2006 to an 85% operator-independent model as of 2010 (Eaton Towers, 2016). Both the US and India have mobile operators outsourcing more than 50% of the telecommunication infrastructure management from independent tower companies (Mulupi, 2012).

In Zambia, cell towers owned by the private mobile firms MTN Zambia and Airtel Zambia were sold to a third-party tower company called IHS Towers in 2015, while Zambia Telecommunication Ltd (Zamtel) and in 2016 Zambia Information and Communications Technology Authority (ZICTA) have retained ownership of theirs (Zambia Information & Communications Technology Authority, 2015). IHS Towers, a Nigerian based company founded in 2001, leads the telecom tower infrastructure industry in Zambia and the rest of Africa with services such as tower site ownership, managing tower services, and deployment (IHS Towers, 2015).

Several studies have been conducted on infrastructure sharing in countries such as USA, Canada, and developing countries in Europe and Africa (Markendahl & Mölleryd, 2012). (Ehiagwina & Offa, 2015) advise that infrastructure sharing is "useful in start-up phase to build coverage quickly and in the longer-term scenario to build more cost-effective coverage, especially in rural and less populated or marginalised areas." Equally, a study by (International Telecommunication Union, 2008) suggests that "mobile infrastructure sharing is an alternative for lowering the

cost of network deployment, especially in rural and less populated or marginalised areas."

More studies have been conducted on types of tower-sharing models that can be easily adopted in developed markets (Markendahl & Mölleryd, 2012). These should be considered by regulators and governments when determining the viability of infrastructure sharing in a country. These varieties are broken down into broad categories such as: (i) passive and (ii) active sharing (International Telecommunication Union, 2008).

In a review of the literation, studies on issues that address infrastructure sharing and effective sharing models to be adopted in a regulation present developing country such as Zambia were minimal and inconclusive. This research therefore attempts to address the gaps left in the developing markets. Additionally, the research attempts to 1) uncover the effect of the introduction of infrastructure sharing in reducing network investment requirements for mobile operators, and 2) establish the benefits for firms such as new entrants, existing MNOs, and tower operators in Zambia. Also, it seeks to establish the models adopted for infrastructure sharing and determine their effects in the country and on competition among mobile operators.

The MNOs included in the study are Airtel, MTN, and Zamtel, as they are the only mobile network operators in the country, and IHS Towers as it is the only independent tower company leasing out towers to MNOs in Zambia.

1.1 Problem Statement

Mobile operators have always invested in telecommunications infrastructure even when there has been an availability of excess capacity from other operators (Malungu & Moturi, 2015). This has led to infrastructure duplication and underutilisation of resources that could have been used to serve a section of the population living in remote geographical regions (Garcia & Kelly, 2015). Thus, mobile network operators have resorted to infrastructure sharing to reduce costs, avoid duplication, and improve utilisation of infrastructure. Infrastructure sharing as a business, on a large scale, was only introduced in 2014 in Zambia. It is an activity that requires academic study as it is new in Zambia. Airtel and MTN, the biggest private telecom companies in Zambia, respectively, believe infrastructure sharing

allows MNOs to concentrate on improving their core business operations while infrastructure operations are outsourced at a lower cost.

The research will 1) investigate the models used in infrastructure sharing, 2) address the concerns and effects, and 3) identify the benefits of this new activity. The research also seeks to uncover the major drivers of this business model and investigate the considerations that affect network operators' final choices, driving them to consider infrastructure sharing. This consideration will assist future operators to know whether infrastructure sharing is worthwhile in improving their current financial situation.

1.2 Research Scope

Network operators (Airtel, MTN, and Zamtel) and independent tower companies (IHS Towers) are the main actors in this research. These actors can provide and receive infrastructure – some only receive infrastructure while others can only provide it. The last set of actors the research will consider are prospective operators. These do not have any market share and are not providing anything, but they do seek to launch a service on the market. Currently in Zambia, there is no prospective operator hence the research will only focus on the first two actors.

Infrastructure sharing is a broad and vague term and can refer to more than one element in the mobile industry. Therefore, the focus will be on telecommunication tower sharing and its positive and negative effects on the incumbent network and tower operators. Additionally, the research does not focus on types of technologies such as 2G, 3G or 4G but types and models used in infrastructure sharing.

1.3 Research Objectives

1.3.1 Determine the tower-sharing models in Zambia.

1.3.2 Determine the effect of infrastructure sharing on network operators in Zambia.

1.3.3 Investigate the role of the regulator in in tower sharing.

1.4 Research Questions

1. Analyse the types of telecommunication towers in Zambia

2. Investigate the tower-sharing models used by MNOs in Zambia
3. Investigate the effects of tower sharing among MNOs in Zambia
4. Analyse the factors leading to the sharing of infrastructure by MNOs
5. Examine the barriers of entry for potential players on infrastructure sharing
6. Examine the role of the regulator in tower sharing.

1.5 Significance of Study

Infrastructure sharing is a strategy used to address issues concerning utilisation of scarce resources in delivering quality services to subscribers. It allows competing mobile operators to co-operate and shift focus to service innovations as well as improve their high capital and operational expenses. This enhances competition in the mobile sector and increases the penetration of mobile services in rural areas in developing countries.

The findings of this research will be of importance to any segment of the telecommunication sector in Zambia. That is, the operators will be aware of the effects of sharing in the long run.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Mobile communication infrastructure sharing levels differ globally, with high levels more evident in Europe, USA and India (Capgemini, 2015). The researcher chose to refer to telecommunication tower sharing as infrastructure sharing and the reason for this is given later. The viability of infrastructure sharing comes with many options but is categorised in two forms; sharing of towers and other infrastructure sharing, and sharing an entire network. Since sharing of towers and other infrastructure sharing fall under the same broad category, it is for this reason that the researcher sees telecommunication tower sharing as a synonym of infrastructure sharing.

Telecommunication involves "carrying voice, data, or image signals between different users along networks," and consists of "transmission equipment and switching technology" that allows for two objects to communicate (Shields, 2014). The characteristics of these components play an important role in determining the kind of services that can be provided over networks, and their costs (International Finance Corporation, 2014).

Transmission equipment is a key component of telecommunication infrastructure; it is set up at the point when the operators are about to roll-out their network services to the market (Fullbright, 2013). According to Fullbright, (2013), towers make up a large amount of capital investments for telecoms operators and, in emerging markets, most of their operating costs.

Infrastructure sharing, per (Global System for Mobile Communications, 2014) and (Ehiagwina & Offa, 2015), is grouped into two categories: active and passive infrastructure sharing. Active infrastructure sharing involves the designing of complex algorithms and sophisticated forms of collaboration among operators to facilitate network sharing (Koumadi et al., 2013).

Passive infrastructure sharing involves "non-intelligent" portions of the mobile network such as space, towers, sites, and power (Koumadi et al., 2013). It refers to the "sharing of space in passive infrastructure, such as building premises, sites and masts, where there are still separate networks that simply share physical space"

(Ehiagwina & Offa, 2015). Operators in developed markets such as the United Kingdom share both passive and active infrastructure for the benefit of all operators involved (Koumadi et al., 2013). Operators and regulators are more inclined to passive sharing in the telecom industry because it presents more practical implementation advantages, for example it does not involve complex algorithms (Capgemini, 2015).

2.2 Telecommunication Towers

A telecommunication tower is a "pole, mast or similar structure that is used to supply a carriage service by means of radio communications" (Australian Communications Authority, 2016). "Cell Towers and Masts are important infrastructure of operations of GSM communication companies" (Oladokun, 2011). Cell towers are specifically built to house wireless communications tenants which use the towers to deploy various technologies such as "telephony, mobile data, television, and radio" (Maheshwari et al., 2013). Cell towers are typically built by tower companies or mobile operators deploying mobile and data services.

There are many types of towers. However, most of them fall under these categories: monopole, lattice, guyed, concealed, and broadcast towers (Savio, 2015) and (Maheshwari et al., 2013). Figure 1 below shows the three most common types of towers which are Monopole, Self-Supporting and Guyed towers (Savio, 2015).

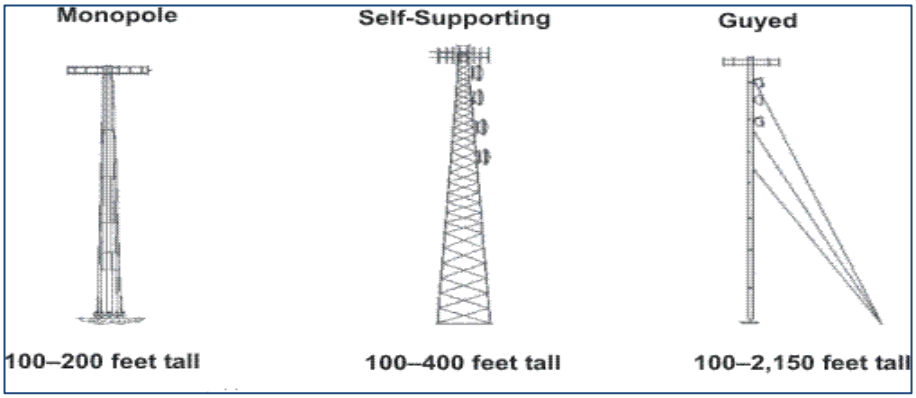

Figure 1: Types of Tower. ***Source (Savio, 2015).***

The Monopole Tower is a single tube tower primarily built for telephony and stands to heights between 30-60 m. It contains antennas mounted on the exterior of the tower (Savio, 2015) and (Maheshwari et al., 2013).

The Lattice Tower is known as "self-support" or a free-standing tower with heights ranging from 30m to 80m (Maheshwari et al., 2013). Lattice type masts are "appropriate design solution where there are already other similar structures." An example is the Eiffel Tower (Crawley Borough Council, 2002). Self-supporting towers are the most commonly used telecommunication towers (Savio, 2015). The Guyed Towers are used for telephony, radio, and television and are usually "rods that are supported by a lot of wires attached to the ground" (Maheshwari et al., 2013) and are one of the tallest independent towers as they reach as high as 600m, and they cost less to construct than other towers (Savio, 2015).

Concealed and Stealth Towers are expensive to construct, provide the least capacity to tenants in comparison to other towers and are deployed as camouflage or to fulfil the surroundings regulation (Maheshwari et al., 2013). The size of these towers depends on the surroundings (Savio, 2015). There are several buildings in Lusaka which house transmission equipment that is usually found at a tower site. For example, the Zambia Postal Services building, FINDECO house, and INDECO building have antennas on top of their buildings and are visible to the public but the building itself is used as a stealth tower.

Broadcast Towers are mainly used by many broadcast service providers who mount antennas for FM radio, AM radio, and Television (TV) (Maheshwari et al., 2013). The sizes of the antennas depend on the type of service being provided, and demand huge pieces of land, about 300 acres, thus they are usually found in rural areas or mountain tops where elevation provides the means of transmitting signals (Savio, 2015).

Cell towers come in three sizes: small, medium, and large sizes (as seen in Table 1). The heights of the towers depend on the site where they are built, whether it is high land or plain. The large towers are referred to as Macro cells and cover very wide bases ranging over 15 kilometres mainly used in rural areas. The medium-sized towers are called Microcells covering about 1.6 kilometres and frequently used in urban areas. Lastly, the smaller ones are Piccocells which cover a little over 230 metres, used in places such as office buildings and airports; Femtocells are tiny and intended for use in homes and smaller offices. A complete working tower site

consists of: tower/mast, an antenna array, microwave dish, ground space, base transmitter, generator/power source, and land (Maheshwari et al., 2013).

Table 1: Cell Tower Types.

Tower Type	Meaning	Description
Macro cells	15 Kilometres	Stand-alone or structure-attached
Microcells	1.6 Kilometres in diameter	Urban and suburban
Piccocells	230 meters	Office buildings, airports, campuses, etc.
Femtocells	Limited in building	Personal device for home/office.

Source: (Harris, 2016).

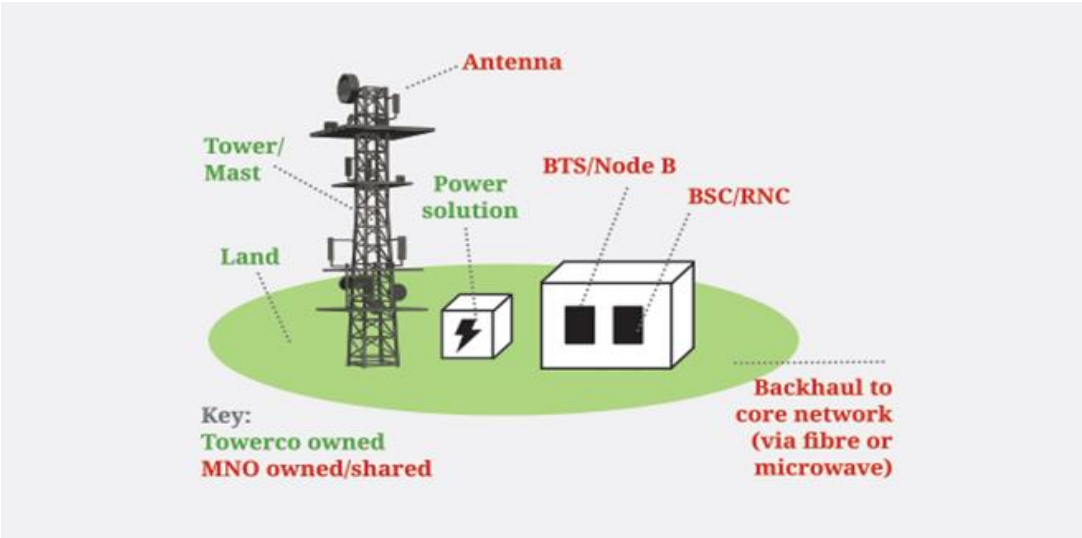

Figure 2: Complete Working Tower Site[1].

An Antenna Array provides a specific platform for mounting antennas used for sending or receiving signals to all devices connected within the specific area that it covers (Maheshwari et al., 2013). The number of antennas that can be on one platform depends on the following factors; number of wireless carriers; type of services, i.e., voice or data and volume of transmission; the technology being used (4G, Long-Term Evolution LTE, etc.): and the spectrum frequency being utilised (Savio, 2015).

The Microwave Dish is a type of antenna that is round and has a specific use for transmission and backhaul – all core network elements such as switching centres; GPRS service nodes, transmission equipment and all links connecting elements of the core network (Maheshwari et al., 2013). The Ground Space is the area where the

[1] https://www.towerxchange.com/wp-content/uploads/2014/05/EY-feature-image.png)

tower companies or cell providers lease and build their towers. The place also houses important equipment such as generators.

The Base Transmitter Station or BTS houses and protects communications, radio and network equipment. It consists of transceivers, signal amplifiers, combiners and a system controller (Savio, 2015). Wires run from the antennas at the top to base station equipment at ground level in sealed telecom equipment cabinets. The usage and importance of a telecom tower extend to several applications utilising it such as mobile, internet, television, navigation, and radio signal transmissions. ***Table*** 2 below gives a summary of the components of a tower site and the broad category in which they fall:

Table 2: Components Found at A Tower Site.

Passive Infrastructure	**Active Infrastructure**
Tower	Antenna
Ground Space	Microwave Dish
Shelter	Base Transmitter Station
Generator	Radio Equipment
Restrooms	Transceivers
Ducts	
Cable Passageways	

Source (Ehiagwina & Offa, 2015).

2.3 Sharing Models

As noted in Chapter 1, telecommunication infrastructure is broadly grouped into two categories: (i) active and (ii) passive infrastructure (Ehiagwina & Offa, 2015). Active infrastructure includes: spectrum, switches, antennae, transceivers and microwave equipment while passive infrastructure includes: steel towers, BTS shelters, power supplies, generators, batteries, air-conditioners, and fire extinguishers (Bhawan & Marg, 2007). The third type, backhaul, has not been included because it is considered to be under active infrastructure sharing.

2.3.1 Active Sharing

"*The active infrastructure sharing is a complex mode of sharing and needs thorough technical skills*" to facilitate network sharing (Bhawan & Marg, 2007). Operators are mutually dependent while sharing such infrastructure. "The exit path from active infrastructure sharing is difficult in case of dispute between service providers." (Bhawan & Marg, 2007). Active infrastructure is also referred to as network sharing because core network operations are shared during the runtime of this network. MNOs "share electronic infrastructure such as sharing BSCs, and sharing common networks, both circuit-switched and packet-oriented domains. Each operator, however, has its own individual network that contains the independent subscriber databases (such as HLR, AUC, etc.) services, subscriber billing and connections to external networks" (Ehiagwina & Offa, 2015).

> *"Active sharing includes mobile roaming, considered the most far-reaching option for sharing infrastructure, since one operator would make use of another operator's network in a certain geographical area where it has no coverage or no infrastructure"*

(International Telecommunication Union, 2008).

Active mobile sharing imposes some risks to both the provider and the receiver, these include: difficulties in distinguishing services between the two MNOs because the network quality of two is very similar.

"*Backhaul is the communication link between a base station and the associated mobile switching nodes*" (Chia et al., 2009), simply put, it is transmitting data from the core network to the edge network. EDGE is an abbreviation for Enhanced Data rates for GSM Evolution. All network providers and smartphones support EDGE, but rarely actually make use of it. It's an ancient technology which came before 3G, 4G, and LTE, and is usually classified as a 2.75G network.

The base stations serve to provide radio coverage over a geographical area, supporting radio communications with individual mobile handsets over the radio interface. Signals at the base station are transported to and from the mobile switching nodes for interconnecting into the public switched telephone system or the public

data network. There are different types of backhaul network connection. The most used are wired connection through either copper or fibre optic cables. Most recently, MNOs have started using wireless backhaul because equipment required and installations are cheaper, no permit is required to install, and the equipment can be rapidly installed. Backhaul wireless connectivity allows MNOs to get bandwidth from one place to another. In cellular applications, organisations use microwave backhaul to get bandwidth from a data centre location owned by one MNO or Internet Service Provider (ISP) to a tower location or to an LTE/3G/4G antennae.

2.3.2 Passive Sharing

Passive infrastructure sharing involves sharing of space or physical supporting infrastructure which does not require active operational co-ordination between network operators (Global System for Mobile Communications, 2014), (Ehiagwina & Offa, 2015). When backhaul is shared under passive infrastructure, then all elements of the site are shared, including backhaul links such as cables, leased lines and microwave as seen in Figure 2. “In rural areas where traffic from Base Transceiver Station (BTS) to Base Station Controller (BSC) is low, backhaul sharing will be both cost-effective and boost coverage” (Bhawan & Marg, 2007).

Passive infrastructure sharing necessitates reflection of several technical, practical and logistical aspects such as “load-bearing capacity of tower, azimuth angle of different service providers, tilt of the antenna, and height of the antenna, before agreeing to conduct infrastructure sharing” (Global System for Mobile Communications, 2014). Potential advantage includes cost sharing when acquiring the site, infrastructure, lease, maintenance, and power (Markendahl & Mölleryd, 2012). New entrants face the challenge of not benefiting because they do not have anything to offer (Global System for Mobile Communications, 2014).

Passive sharing is appropriate for areas that have huge count of active subscribers, rural areas where power costs are high and transmission of the service may prove difficult, and expensive sites. “The key challenges in this model are for incumbent operators to accept the opening of the infrastructure to other operators and for new operators to trust that incumbents will provide them with the appropriate access to prevent them from rolling out their network effectively” (Ehiagwina & Offa, 2015).

2.4 Business Sharing Models

Types of infrastructure sharing structures and agreements vary with each government and regulations in each nation (Malungu & Moturi, 2015). The structure chosen may depend on varying reasons such as market maturity level, network symmetry or architecture, market conditions, and legal and regulatory obligations (Garcia & Kelly, 2015).

Passive infrastructure is the most frequently shared type of infrastructure among MNOs and tower companies. This is because it does not require complex algorithms to be designed (International Finance Group World Bank Group, 2014). Tower business models can be structured in several ways. This research concentrates on two basic business models given by (Global System for Mobile Communications, 2014): inter-operator tower-sharing model, and third-party tower-sharing model.

2.4.1 Inter-operator

Inter-operator tower sharing allows MNOs to operate on a "bilateral arrangement" to execute sharing of passive infrastructure (Smith, Passive Infrastructure Sharing in Telecommunications, 2011). Bilateral agreements are based on 'in-kind' operations, requiring no payments between the participating parties (Global System for Mobile Communications, 2014). The participating parties install BTSs on each other's towers as agreed, helping each other to reduce operational and network costs by: reducing network deployment costs; reducing roll-out time, creating the potential for generating additional income through rentals (Capgemini, 2015). This type of model tends to benefit operators who already have established networks and not new market entrants (Smith, Infrastructure Sharing, 2014). The initial structures supporting infrastructure sharing in the early stages of network development are commonly roaming and inter-operator site-sharing agreements, allowing incumbent operators to obtain an additional source of revenues from their assets (if the agreement is not cash-neutral, i.e., if the value of sites of one of the operators or the portfolio of sites is greater) while potentially fostering new entrants' penetration of the market.

2.4.2 Third-Party

This model involves an independent tower company that takes up responsibilities of tower deployment, maintenance, and management (Global System for Mobile Communications, 2014). The tower companies and MNO enter an agreement that

allow MNOs, and other companies to install their radios and anything needed for transmission on their towers. In this model, passive infrastructure ownership remains with the tower company, and operators take the opportunity to use the extra resources gained to focus on service innovation and improving customer experiences, which is a critical aspect in very competitive markets (Smith et all, 2011).

Third-party tower companies can be one of two types: Joint venture, which is tower sharing between operators, and Third-party vendor tower companies, which allows for towers to be shared via a tower company (Smith et al, 2011). Third-party companies give an option of "build to suit" facility, by which they build new towers for an operator, with operator input into location, specifications and timing; this brings equal benefits to operators.

However, new entrants must still set up their own transceivers and other transmission equipment and place them on the towers (Global System for Mobile Communications, 2014). A transceiver is a device that can receive and transmit communication signals, for example a radio transmitter. This model allows new operators without tower network or those in search for growth to develop and grow their networks on a considerably accelerated basis (Capgemini, 2015).

Tower sharing trends are highlighted in Figure 3. The figure highlights the "evolution cycle of network assets ownership, depicting the scope for tower sharing and outsourcing in developing markets" (Capgemini, 2015). Operators have moved from phase I, where they shared no infrastructure, through phase II, III to phase IV where they are now sharing both active and passive infrastructure and services to save network costs.

Table 3: Advantages and Disadvantages of Tower-Sharing Models

Operational Model	Advantages	Disadvantages
Inter-operator tower sharing	1. Simple to implement	1. Limited to sharing of towers owned by the respective operators.
	2. Tower ownership still lies with the operator leasing out the space.	2. Dependency of lessee on leaser.
Joint Venture (JV) (for assets) between operators	1. Reduces operational risk and provides full visibility to working of tower companies	1. Difficulties in coordinating operations teams (both companies have equal representation on JV)
	2. Easy to finance as operators only need to transfer assets into the JV	2. How to coordinate and agree new tower setup
	3. Margins of tower companies less of an issue.	3. Not suitable for more extensive sharing
Vendor-led network sharing and operations and maintenance outsourcing	1. Higher savings from consolidation of assets, operations, and teams.	1. Reliance on third-party vendor
	2. Vendors guarantee a certain level of savings from outsourcing and enabling sharing	2. Reduced control
	3. Third-party can provide objective avenue for resolving issues.	3. Partners must share savings with vendor

Source: (Smith, Infrastructure Sharing, 2014)

Capgemini (2015) suggests that "mobile operators have typically followed a phased approach when it comes to the adoption of tower infrastructure sharing/outsourcing initiatives."

Specialised tower company business model has developed and flourished because operators continue to seek to reduce costs and fast-track expansion into rural areas. The general tower-sharing model itself has been adopted in other jurisdictions such as the US, India and Indonesia. Now seemingly accepted, the model is set for a huge expansion across the African continent (Fullbright, 2013), Zambia included.

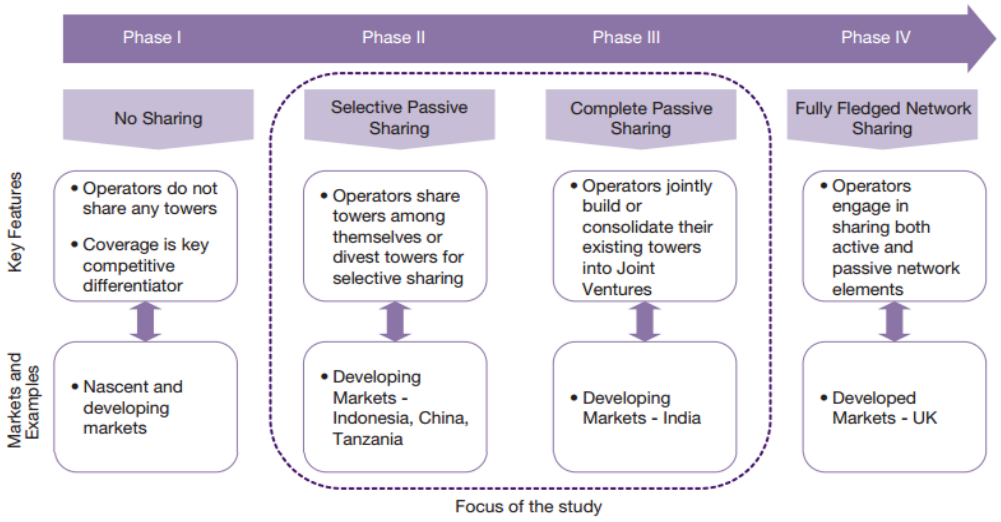

Figure 3: Evolution Cycle of Network Asset Ownership. ***Source: (Capgemini, 2015)***

Globally, the two tower-sharing models (operator-to-operator and third-party) have been hugely accepted by governments because of their environmental positive impact (Allen & Overy, 2012). ***Figure*** 4 below shows examples of sharing models accepted by international companies. The sharing models mean fewer towers are required to service the needs of the operator groups in any country, which has positive implications for the overall carbon footprint of the telecoms infrastructure. Given the unreliability of electricity grid supply across Africa, towers are typically powered by noisy and acrid-smelling diesel generators, so a consolidation of the market in this regard also has significant benefits on the ground (Fullbright, 2013).

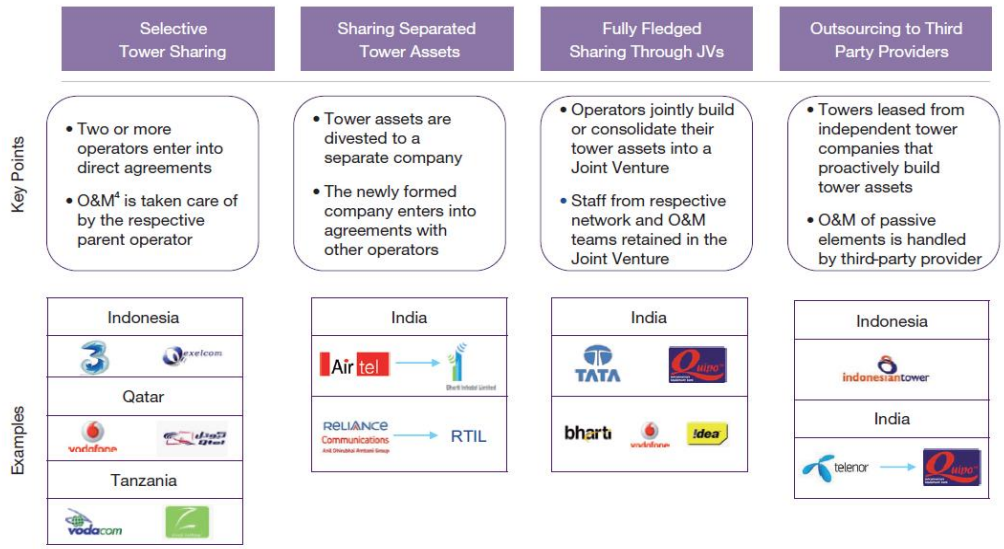

Figure 4: Approaches to Sharing Passive Infrastructure. Source: (Capgemini, 2015).

2.5 Sharing Categories

Infrastructure sharing is classified into five categories: Site sharing, Mast (Tower) sharing, Radio Access Network (RAN) sharing, Network Roaming, and Core Network sharing (Global System for Mobile Communications, 2014). Site and mast sharing are forms of passive sharing while the others are a form of active sharing as they "require operators to share elements of the active network layer including, for example, radio access nodes and transmission" (Global System for Mobile Communications, 2014).

Figure 5 below shows the multiple scenarios in which sharing is achieved among mobile operators. "Deeper sharing increases potential savings, but reduces individual control over the network" (Leza, 2014).

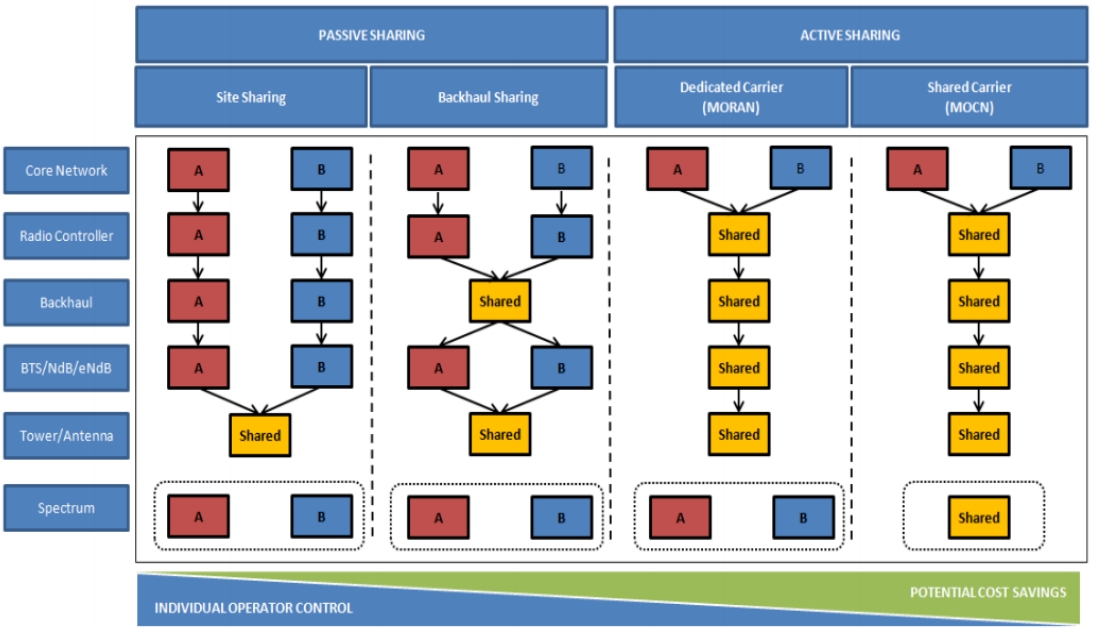

*Figure 5: Tower-**Sharing Alternatives among** MNOs. **Source: (Leza, 2014).***

2.5.1 Site Sharing

Site sharing is the easiest, least extensive, and commonly implemented form of tower sharing (Global System for Mobile Communications, 2014). It involves collocation of sites where operators share the same physical compound but install separate site masts, antennas, cabinets and backhaul as shown in Figure 6 below (Capgemini, 2015).

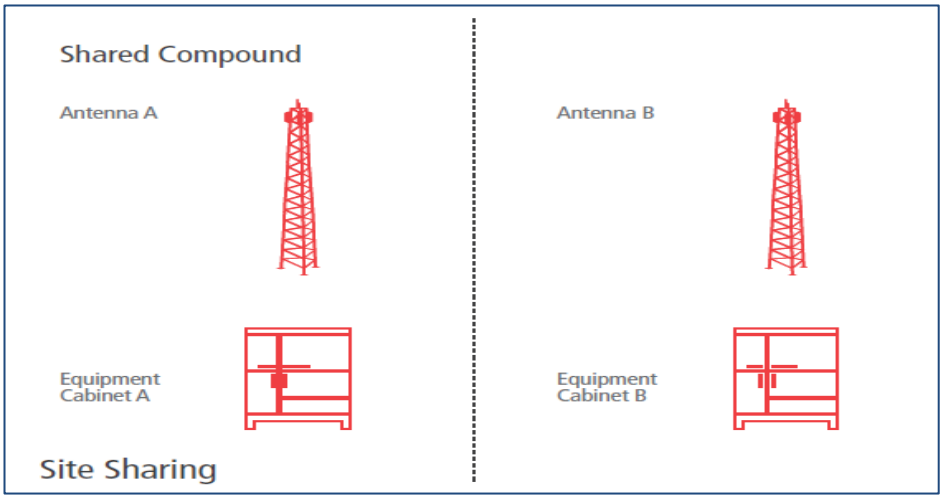

*Figure 6: Site Sharing**. Source: (GSMA, 2014)***

The solid line represents fenced space where each operator usually installs their own infrastructure separately from that of other operators. Site sharing can yield capital

expenditure (CAPEX) savings of up to 20% and operational expenditure (OPEX) savings of up to 15 to 20% in Europe (Norman & Viola, 2010).

At times, the operators can decide to share support equipment, including shelters, power supply and air conditioning. “The mechanism of site sharing is not an easy practical condition, because MNOs usually will have one on one agreement for this site sharing mechanism and if MNO counterpart has no right candidate to choose, it may delay roll-out progress of the other MNO” (International Finance Corporation, 2014).

This system of site sharing is frequently preferred in urban and suburban areas where there is a shortage of available sites or complex planning requirements (Global System for Mobile Communications, 2014). GSMA (2014) also suggest that site sharing is done because of commercial conditions. It is less likely that MNOs focus on deployment than service satisfaction. They would like to reduce on operation costs as much as they can while improving the quality of their service.

2.5.2 Mast (Tower) Sharing

Mast, or tower, sharing is a step up from site sharing where operators co-locate a tower and not just a site (site sharing). It involves sharing the same mast, antenna frame or rooftop (Bhawan & Marg, 2007), (Global System for Mobile Communications, 2014).

***Figure* 7** shows how mast sharing is implemented by operators or tower companies. It shows a fenced-off space within which operators install their individual infrastructure, extending from antennas to BTS cabinets. Though they share the tower, each operator must provide their own antennas and install them. The mast can be strengthened or made to accommodate more antennas should the need arise, such as when the number of operators increases. Site sharing category operators have the option of sharing support equipment while operator coverage remains separate (Global System for Mobile Communications, 2014).

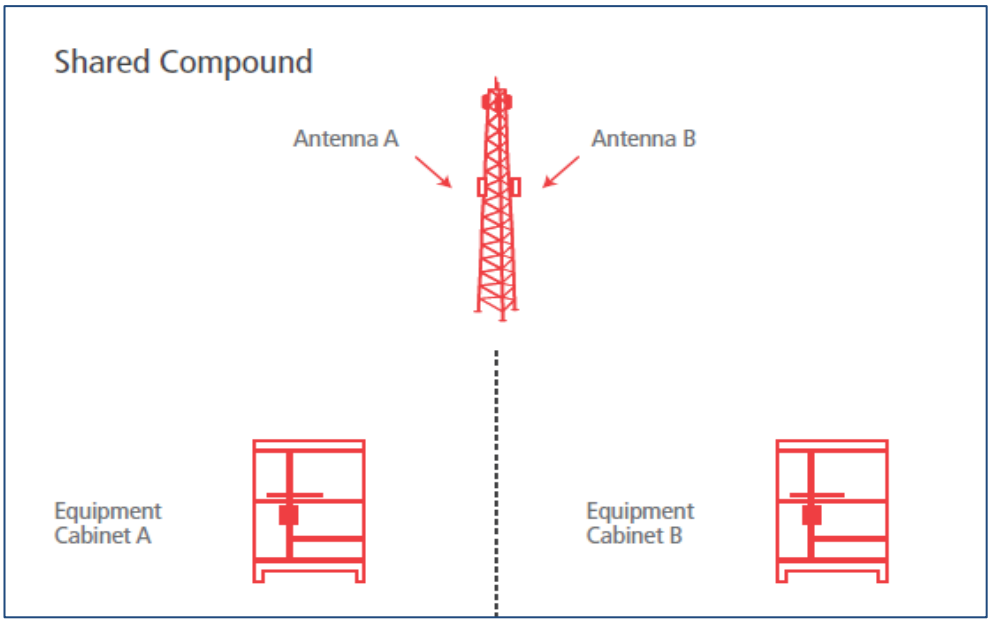

Figure 7: Tower Sharing. ***Source: (Global System for Mobile Communications, 2014).***

An alternative option for operators is to use third-party structures, such as steel power pylons, which provide the "required height and load bearing capacity" (Global System for Mobile Communications, 2014). Third-party infrastructure providers like the Zambia Electricity Supply Corporation (Zesco) can enter the market specifically to provide shared antenna sites to telecoms and broadcasters.

2.5.3 Radio Access Network (RAN) Sharing

This is the most complete tower sharing category as it involves all access network equipment sharing such as radio equipment, masts, site compounds, and backhaul equipment (Global System for Mobile Communications, 2014). Here, the RAN is combined into one single network and then split at the point of connection into separate networks. "MNOs continue to keep separate logical networks and spectrum and the degree of operational coordination is less than for other types of active sharing" (Global System for Mobile Communications, 2014), (Ehiagwina & Offa, 2015).

Figure 8 is an image of how RAN sharing can be adopted between two operators. Operators can share all elements in the access network to the point of connection with the core network, and at this point of connection an individual operator can then "split out the traffic from its respective customers on its own core network ring for processing by its own core network elements and infrastructure" (Global System for

Mobile Communications, 2014). Implementation may differ among all the different operators depending on operators' local network. New entrants on the market or operators who have never entered a sharing agreement before may face challenges in implementing a shared RAN, as the architectures of existing networks have evolved independently to date. For example, complications may arise when linking equipment procured from differing vendors which have different operational procedures and control mechanisms.

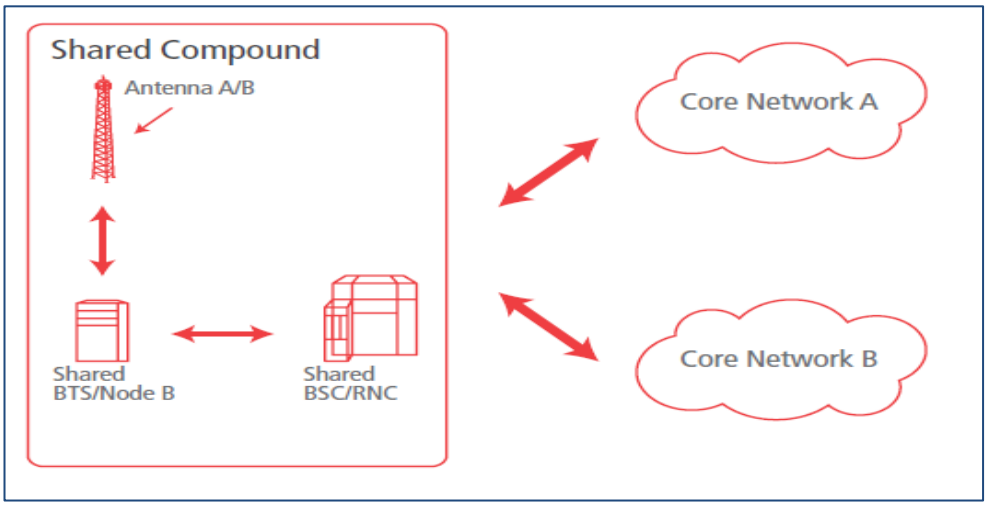

Figure 8: RAN Sharing. ***Source: (GSMA, 2014).***

2.5.4 Core Network Sharing

The two levels at which the core networking sharing category is shared include: transmission ring and core network logical entities (Global System for Mobile Communications, 2014). These levels must be explained further to illustrate how this model could work. "At a very basic level, core network consists of: core transmission ring, switching centre (with the home location register), billing platform, Value Added Systems (VAS) that represent logical entities and may also form part of the core network" (Global System for Mobile Communications, 2014).

2.5.5 Transmission Ring

The operator has extra capacity on the core ring network which can be leased or rented to accommodate another operator; for example, a new operator who may be lacking in resources to build their own core ring.

2.5.6 Core Network Logical Entities

"Core network logical entity sharing represents a much deeper form of sharing infrastructure and refers to permitting a partner operator access to certain or all parts of the core network" (Global System for Mobile Communications, 2014). Any operator could implement this with another operator at any level they wish to. GSMA (2014) suggests that operating and maintenance costs are reduced but the "scale and practicality of these remains uncertain."

2.5.7 Network Roaming

"Network roaming can be considered a form of infrastructure sharing although traffic from one operator's subscriber is being carried and routed on another operator's network" (Global System for Mobile Communications, 2014). An agreement is all the participating operators require for this type of sharing to occur. When the agreement comes to an end, the two can renegotiate or make a new agreement with another existing host network. Network roaming is not considered to be a form of sharing by (Ehiagwina & Offa, 2015) because there's no shared investment in infrastructure involved. Network roaming can be further divided into the following: National roaming, International roaming, and Inter-system roaming.

"*National roaming occurs between operators (that are usually direct competitors) within the same country code as they provide service within the same geographic region or within different geographic regions*" (Global System for Mobile Communications, 2014). Operators have an agreement that permits one another to roam on each other's network if the home network is not present in a location.

International roaming is like national roaming, the difference is that operators in one country have an agreement with operators in other countries. The agreement allows users to use their handsets in other countries and still get the same Value-Added Services (VAS) and basic voice services given that the host network provides these services. A complication arises because regulators in one country may have different dedicated frequency bands to the same technology in different jurisdictions. However handsets must be able to operate at different bands (Global System for Mobile Communications, 2014). Inter-system roaming "occurs between networks operating to different standards and architecture as in the case of 3G and GSM roaming" (Global System for Mobile Communications, 2014), it imposes more requirements

on subscribers' devices and network operators because they should be able to support calls on both standards and maintain calls when changing between standards. This additional complexity may add to the cost of network operations and maintenance in the short term, which may be offset by additional roaming revenue (Bhawan & Marg, 2007) and (Global System for Mobile Communications, 2014).

2.5.8 Mobile Virtual Network Operator Sharing

Mobile Virtual Network Operator (MVNO) is a mobile operator that provides mobile communication services but does not have its own radio access network (Kim & Seol, 2007), (Shin, 2010). "MVNOs typically have no network and spectrum rights of their own though some advanced MVNOs will build parts of their core network needs, they basically depend on infrastructure to get access to subscribers and offer services" (Ehiagwina & Offa, 2015).

2.6 Factors Driving Sharing

Capital Expenditure (Capex) and Operation Expenditure (Opex) reduction – "since collocation is possible for up to six (6) GSM network operators, this reduces Capex of rolling out network by new operators, and the expansion of older network into less profitable areas and a further cut-down of Opex" (Ehiagwina & Offa, 2015). Passive infrastructure sharing can potentially yield overall cost savings as much as between 15% and 30%, with clear cost savings on yearly site Capex of up to 60%, due to less investment duplications, and in addition to significant savings in operational expenditure such as costs of renting the sites, site maintenance, personnel and power, air conditioning and fuel expenses (Global System for Mobile Communications, 2014). Rationalising Capex also reduces the time to pay back on investments received, depending on the elements shared and the surrounding arrangements (Cellular News, 2015). Table 4 below shows the combined Capex to have jumped the highest between 2015 and 2016 owing to the reduction of electricity supply in the country and use of other forms of energy to power an active site.

Furthermore, the price of setting up active infrastructure is at 60% while for passive is at 40%, but prices for items required prior to setting up of passive infrastructure are ever increasing. Costs of land, cement, blocks, steel bars, insurance and other items are constantly increasing.

Table 4: Zambia MNOs Revenue Reflection for the Past Four Years

Revenue	2012	2013	2014	2015	2016
Number of active Subscribers	10,524,676	10,395,801	10,114,867	11,557,725	12,017,034
Revenue – (Kwacha' 000)	2,803,313,895	3,155,010	4,113,268	4,527,030	4,371,404
Capex – (Kwacha' 000)	424,496,837	306,171	157,018	565,217	3,057,378

Source (Zambia Information & Communications Technology Authority, 2017)

Tower companies like Helios, IHS Holding and Eaton Towers in Africa solely enter the business of tower operation to serve the mobile operators in this regard (Malungu & Moturi, 2015). New entrants looking to increase coverage follow this route and share infrastructure to penetrate the market without incurring much costs at set-up (Malungu & Moturi, 2015). MNOs achieve this by deploying ICT to achieve widespread affordable access to broadband services. Furthermore, infrastructure sharing has been used to bridge the digital divide, meet regulatory requirements and help governments to achieve ICT sector universal access goals (Habeenzu, 2010). In countries where telephony is still low, infrastructure sharing may help digital penetration to the remote areas that do not have connectivity.

Combined efforts and resources, and reducing individual infrastructure needs mean that targets are achieved speedily and with great coverage. MNOs get to deploy newer or other technologies quicker (3G being a drive in emerging markets, LTE being a key driver for sharing in more developed markets). Infrastructure sharing reduces the extent of "negative externalities, such as the environmental impact of telecommunication towers, and luckily, these negative effects can be decreased through infrastructure sharing because sharing can reduce energy consumption" (Garcia & Kelly, 2015).

Lastly, the motivation behind infrastructure sharing differs from market to market; in mature markets, infrastructure sharing is an additional source of revenue, a way to minimise operation cost, and a way of adding capacity in congested locations (Bhawan & Marg, 2007). In developing markets, however, infrastructure sharing is an opportunity for operators to expand their network coverage and their market share (Malungu & Moturi, 2015). Mobile operators who shared infrastructure when they were just rolling out their networks such as 3G and 4G could reduce capital and operational expenditure (Kimiloglu, Ozturan, & Kutlu, 2011). "Infrastructure sharing, therefore, is a trade-off between expected faster and cheaper network expansions and the potential disincentives to innovation and investment in new technologies" (Garcia & Kelly, 2015).

2.7 Challenges in Sharing

As per Malungu's study, in Kenya, the maturity of the communications sector determines the types of challenges that MNOs face when sharing infrastructure. These include: valuating assets, cost and pressure from the shareholders and board members of the MNO, types of sharing and culture alignment in the nation, as well as stakeholder management (Malungu & Moturi, 2015). Kenya has one of the top performing telecoms market in Africa (International Telecommunication Union, 2009).

Operators' unwillingness to share infrastructure with their competitors is a key barrier to infrastructure sharing. This is because MNOs would rather protect their investments to retain domination in areas they have the largest base of customers (Markendahl & Mölleryd, 2012). Incumbent MNOs have no power over customers' decision to move from the current subscription to the new entrant's network which may promise better services.

Infrastructure sharing challenges could arise in the initial stages of the project implementation and signing of sharing agreements among two operators who would like to share the infrastructure (Markendahl & Mölleryd, 2012). Interests between the parties involved could clash. Issues such as confidentiality of the deal, and leaking of sensitive information could create huge risks if ever exposed against the agreement, thereby requiring top management relations to keep these issues under control to achieve success. Use of different supplier chains and equipment, either inferior or

incompatible equipment, makes it difficult for two operators to share infrastructure (Markendahl & Mölleryd, 2012). Incumbent operator's monopolistic behaviour where only one company owns infrastructure which is to be shared, is another factor that hinders infrastructure sharing.

Lastly, absence of regulatory frameworks that oversee the operators and tower companies and ensure everyone is treated equally is considered a barrier to infrastructure sharing by (Malungu & Moturi, 2015) in Kenya. "The Kenya Information and Communications Law of 2009 CAP. 411A section 85A recognises infrastructure sharing but was not specific on the implementation guidelines as compared to Tanzania and Botswana, which had a comprehensive infrastructure sharing law" (Malungu & Moturi, 2015).

Telecommunications has historically required high fixed costs that are sunk upon execution. This exposes investors to losses over the long run, and many investors are averse to the industry as a result (Allen & Overy, 2012). By reducing the risk profile to an acceptable level, the industry will be able to attract new capital into the Zambian market. New capital, especially derived from multiple international sources, may encourage economic growth. As the new capital accesses the markets, job creation could be an inevitable result as the market expands. In short, as capital flows into the telecommunications market in Zambia, it could begin to spark the economic cycle that will also promote more business developments in other service industries, more jobs throughout the economy, and an increase in consumer spending.

Given these benefits, countries such as United Arab Emirates, Kenya, Uganda, Lebanon, Cameroon, and India have adopted the tower-sharing model as it is neither mandated nor discouraged (Bhawan & Marg, 2007). Tower sharing is encouraged through incentives in countries such as Bahrain, Jordan, Oman, and Nigeria while in China, Bangladesh, and Singapore, tower sharing is mandatory and operators cannot refuse to share (Allen & Overy, 2012).

2.8 Tower Acquisition in Zambia

There are many recent transactions that involved the buying and selling of large volumes of communications towers in Zambia. The first major recent transaction in Zambia involved the acquisition of MTN towers by IHS, which established the

largest telecommunications company in Zambia. The second major transaction occurred in December of 2014.

Airtel, a large multinational telecommunications company, sold over 1,100 telecommunications towers to IHS among two countries (IHS Towers, 2015). IHS purchased over 13,000 towers from various firms in February 2015, and has further reinforced its position as the largest private telecommunications company in Zambia (IHS Towers, 2015). The overarching goal listed by the company for this growth activity is to improve profitability for the organisation through improved customer coverage in the region, establishment of new towers, and continued investments in alternative energies (Darwish, 2015).

These developments are majorly owing to the entry of big private players in the telecom market in Zambia. Globally, there has been increased participation of private companies in the form of partnerships and alliances with Government companies, for a variety of reasons which include attaining a larger budget, improving quality and efficiency and the changing market scenario owing to globalisation. For example, in Jordan, before the entry of the private sector, telephone service had a penetration rate of about only 7%, with about 120,000 people on the waiting list; Thailand, too, had a waiting list of nearly one million people, which drastically reduced once private companies could enter (Rondinelli, 2001).

There are several instances that are linked in a cause-effect relationship surrounding this activity, some negative and others bearing good news. Amongst the recent activities, IHS Towers, which spent US $500 million on power systems since the first quarter of 2013, across Africa, declared that it had finished selling and leasing back 949 towers from Airtel Zambia. These were under long-term contracts renewable in nature (Cellular News, 2015).

In February 2014, ZICTA also confirmed that it had plans to construct 169 telecommunication towers in various rural regions to boost network coverage (Zambia Information & Communications Technology Authority, 2015). The project was completed at the end of 2015 and confirmation of the second phase of tower roll-out is expected to be given to Huawei company for construction. The existing mobile operators are expected to connect to the new towers with each set to pay ZICTA for usage.

The Government of Zambia constructed new mobile towers to boost communication in the form of mobile phone and Internet connectivity, throughout Zambia, with a focus on the rural areas. An added advantage of this was envisioned as being able to tap into mobile economies because "decreased mobile gadget and higher internet speed connectivity is fuelling more usage of mobile phone as browsing tools in the region." As per survey conducted by GeoPoll Survey Company and World Wide Worx organisation, called the Mobile Africa 2015 study, there has been an increase in mobile browsing usage in African countries, with Zambia recording 10 million subscribers, and 6 million subscribers with internet access. This initiative was made to help boost these numbers and the bid for the construction of these towers was won by Huawei Technologies, a Chinese company.

2.9 Telecommunications Industry in Zambia

Telecommunications development in Zambia began in 1913 when the initial manual phone was securely connected in Livingstone (Munyeka, 2014), and by 1964, the country depended on fixed line telephones for communication. The services were hugely demanded at that time. Houses, offices and public phones required to be manually connected to the exchange house whenever a call was placed (Habeenzu, 2010).

In 1958, a telex service, owned by 11 subscribers, was introduced to allow communication among a network of printers. Expansion of the telex service was achieved through the construction of light communication poles along the line of rail connecting to Zimbabwe, Botswana and South Africa. This paved way for cross-border communications (Zambia Telecommunications Coorporation, 2015). In 1974, the Mwembeshi Earth Station, supplied and installed by Nippon Electronic of Japan, was installed to allow national and international calls to pass via Intelsat Standard (Publications, 2006). In 1975, Post Telecommunication Corporation (PTC) was formed from the General Post Office, which existed before. PTC was then split into Zamtel and Zambia Postal Services in 1994 of which Zamtel was to concentrate solely on telecommunication services. In 1995, Zamtel introduced mobile telephone services and launched the mobile GSM service in 2003 (Zambia Telecommunications Coorporation, 2015).

"MNOs were introduced during the second half of the 1990s and by 2003 there were three entities competing in the mobile sector" (Zambia Information & Communications Technology Authority, 2015). Zamcell now Airtel, introduced in 1998, was the first private MNO in Zambia. This breakthrough leapfrogged Airtel to be the market leading mobile service provider with 3.5 million users in 2010 until MTN overtook it in 2013. MTN came into the market by acquiring shares in Telecel Zambia Limited in 2005. The third mobile service provider, Zamtel, has performed poorly as compared to the two private mobile operators as it has the smallest customer base among the network providers. Zamtel remains the only company that is providing both mobile and fixed line services. Table 5 below shows the penetration rate of the mobile telephone in Zambia. Table 6 below shows the customers base distribution for each operator in Zambia for the past 5 years.

Table 5: Mobile Telephony Statistics in Zambia

2016		
Indicator	**Number**	**Penetration Rate**
Mobile Subscription	12,017,034	74.93%
Fixed Line Subscription	101,407	0.63%
Mobile Internet Users	5,156,365	32.15%
Fixed Internet Subscription	35,919	0.22%

Source (Zambia Information & Communications Technology Authority, 2017).

Table 6: Zambia MNO Network Coverage by Percentage

Network Coverage	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Airtel Zambia	-	-	42.7%	42.7%	42.7%	42.7%
MTN Zambia	36.6%	37.5%	39.4%	31.7%	45.4%	44.1%
Zamtel	75.0%	75.0%	29.7%	27.0%	27.0%	27.0%

Source (Zambia Information & Communications Technology Authority, 2017).

2.10 Tower Access Competition

A market is a "*system with locally interacting components that achieve some overall coherent global behaviour through simple interactions of trading, i.e., buying and selling*" (Clearwater, 1996). The mobile telecommunication market is a very competitive market where the customers tend to move from one company to another easily (Keropyan & Gil-Lafuente, 2012).

General market structures have

> *"Interconnected characteristics of a market, such as the number and relative strength of buyers and sellers and degree of collusion among them, level and forms of competition, extent of product differentiation, and ease of entry into and exit from the market"*

(Izaidin et al , 2012).

There are four basic types of market structure:

> *"(i) perfect competition: where there are many operators offering the service and good amount of buyers, none being able to influence prices, (ii) oligopoly: where several large network operators exist and who have some control over the prices, (iii) monopoly: single operator with considerable control over supply and prices and (iv) monopsony: single operator with considerable control over demand and prices"*

(Day et all, 2000).

> *"A mixed oligopoly is a market where a homogeneous or differentiated good is supplied by a 'small' number of firms and the objective function of at least one of them differs from that of the other firms"*

(Fraja & Delbono, 2006).

The author refers to mixed oligopoly to mean simultaneous presence of private and public enterprises in the economic system.

The telecom market structure in Zambia can best be categorised as oligopoly because it is an industry that has few mobile network operators competing for the same customer base, and offering the same service (Soko, 2012). As outlined by (Day, Shocker, & Srivastava, 2000), in an oligopoly, there are only a few firms that make

up an industry. This select group of firms has control over the price and, like a monopoly; an oligopoly has high barriers to entry. The products that the oligopolistic firms produce are often nearly identical and, therefore, the companies, which are competing for market share, are interdependent because of market forces (Fraja & Delbono, 2006). The gap in literature is evident when determining the market structure of telecommunication tower sharing in Zambia; little research has been done to determine this. With the inclusion of IHS Holdings and Zamtel retaining their towers, it is unclear which category of the market structure infrastructure sharing falls.

Mobile telecom market has limited operators because of "constraints due to the limited amount of radio spectrum available and substantial economies of scales in building network facilities" (OECD, 2014) and (Doyle & Smith, 1998). Due to the requirement to manage spectrum as well as to ensure stable and continuous services, mobile markets are not an area typified by frequent market entry and exit (OECD, 2014). This has been seen in the Zambia telecommunication market, where only three operators have been present for over a decade and no new operators have entered the market.

(Habeenzu, 2010) suggests that problems with connectivity in the country have been due to lack of adequate telecommunication infrastructure, which has also led to a spurt in the establishment of telecommunication towers. The Zambian mobile telecom market has always had few firms. This has helped firms involved to always be aware of their competitor's actions, as well as reactions to strategies effected by one firm. For example, if one operator built a tower in a certain location, the competitor would be aware and would also build a tower in that location to provide coverage to their customers in that area. The idea of tower sharing leads to the phasing out of duplication of towers and the relocation of some to other areas which lack network connectivity.

(OECD, 2014) reports that "in countries where there are a larger number of MNOs, there is a higher likelihood of more competitive and innovative services being introduced and maintained." (Firli & Kaltum, 2014) advises that customers' growth in telecommunications is "supported by enhanced infrastructure," such as the "amount of BTS to handle the services for the customers of telecommunications

operator." With this, we can conclude that increased customer growth should be accompanied by improved infrastructure while increased number of MNOs is accompanied by an increased value-added service for the customer. Zambia has had the same number of MNOs meaning services have not changed.

Tower sharing market has similar characteristics in the Zambian market to the general telecom market described above. There are three operators that own towers, these are Zamtel, IHS Holdings and, most recently, ZICTA. Zamtel, an MNO which is government-owned, retains ownership of its towers and shares, at a cost, with both mobile operators and operators that are not necessarily into providing mobile network services such as IHS, radio stations, and police radio communications. Even though IHS Holdings is not an MNO, the company was issued a mobile operating licence by ZICTA. However, IHS has continued to operate just as a tower company where it builds, acquires, and leases telecommunication towers to mobile operators. ZICTA, regulator, builds its towers through third parties and leases to mobile operators. No research exists on competition and market structure of operators regarding towers and tower sharing in Zambia. An important and independent authority must be present to create harmonious competition in an existing market among mobile operators in a nation. The regulator must be handed the duty to be continuously vigilant on the functions of the market with a sound regulatory environment to be established. (ITU, 2009) reported that about 83% of African economies had established such an authority by the end of 2008, which aimed to regulate the telecommunications market and create competition through lower prices, better-quality services and openness to innovation.

Tower sales and acquisitions in Zambia's telecommunications industry have caused room for concern. The literature review has shown that these sales activities are tightly regulated by a government agency with a history of positive governance. However, very little is known outside of theoretical assumptions to render this activity a positive or potentially threatening circumstance. The tower acquisitions in recent months by IHS have all been reviewed and approved by ZICTA, which is acting in the common interest of all stakeholders.

Zambia has a governance framework concerning telecommunications; however, they are embarking on a new level of control never experienced. ZICTA does have active

policies and regulatory standards that govern all this activity. (Zambia Information & Communications Technology Authority, 2015) has been given authority and responsibility by the Government to enforce the following actions:

> *"Regulate the provision of electronic communication services and products in Zambia, monitor the performance of the sector including levels of investment and availability, quality, costs and standards of electronic communication services, disseminate information and promote the participation by the public in the provision of electronic communication services, promote competition in the sector and also regulate tariffs charged by operators offering electronic communication services, and protect the rights and interests of consumers, service providers, suppliers and manufacturers."*

As such, every major transaction is reviewed and approved by the ZICTA board, with a final approval coming from the Director. This includes the recent transactions involving MTN, IHS, and Airtel. First, given the scope of its regulatory authority, ZICTA approved the acquisition of MTN towers by IHS. Secondly, ZICTA approved Airtel's sale of over 1,100 towers to IHS in Zambia. Finally, the large proposed acquisition of over 13,000 towers by IHS has been reviewed and approved by the ZICTA board.

There are several noted advantages of private investment in telecommunications that include infrastructure sharing. One of ZICTA's (2015) listed responsibilities is to encourage infrastructure sharing among competing firms in Zambia. While it appears that private businesses are actively monopolising the telecommunications market in Zambia, the reality is that the businesses involved are trending towards sharing the towers in a new infrastructure model. Per (TeleGeography, 2014), Airtel's sale of 1,100 towers to IHS holdings "will accelerate infrastructure sharing amongst operators and benefit customers in form of affordable tariffs and wider network coverage." This means that many towers are owned by a single private corporation

today; however, ZICTA is actively executing initiatives to force providers to share towers.

Low market penetration and decreasing profit margins for telecom operators in the emerging markets have also contributed in making tower sharing an attractive proposition for operators in countries such as Bahrain (Cellular News, 2015). This has been seen in the Zambian market as well, where small rural towns between big towns are still experiencing network failure.

The major benefit of sharing telecommunications towers is the economies of scale that can be achieved (Allen & Overy, 2012). Many of the world's leading governments are enacting regulatory policies that require businesses in the telecommunications industry to become partners regarding the ownership and management of towers. Sharing towers will limit the tendency for competing firms to duplicate the same investment and helps to encourage telecommunication businesses to target under-served areas such as rural regions in developed nations as well as developing countries that have little to no coverage (Capgemini, 2015). The overall impact of infrastructure sharing is an improved product and service profile for customers (Smith, Infrastructure Sharing, 2014).

Other major benefits of sharing passive infrastructure for operators include reduced infrastructure expenditure (Capgemini, 2015). The cost of raising the infrastructure is reduced by 16 to 20% (Capgemini, 2015). The tower companies, on the other hand, derive regular annuity income.

Tower sharing can be instrumental in allowing several operators to enter remote regions that would normally have very high roll-out costs. Ever-increasing demand to roll-out 3G/WiMAX/LTE networks has been putting a lot of pressure on the infrastructure spending of operators. Reduced network operation cost is another advantage of sharing passive infrastructure because operational costs are rationalised due to reserves produced by sharing site rent, power and fuel expenses (Global System for Mobile Communications, 2014). There is an enhanced focus on service innovation which in turn alleviates pressure of network roll-out and cost management from operators, allowing them to focus on customer service in a highly competitive and customer-centric industry (Capgemini, 2015). This becomes especially important in a regulatory environment demanding fast roll-out of services (Allen & Overy,

2012). For new entrants, there is lower entry barrier because new entrants or small players in the market can penetrate the market without so much cost (Smith, Passive Infrastructure Sharing in Telecommunications, 2011).

While tower sharing empowers new entrants to scale up faster in an existing market, it exposes established players to the risk of market share loss (Allen & Overy, 2012). Additionally, the obstacles encountered in monitoring network performance and quality will grow as control over network roll-out and equipment maintenance decreases (Bhawan & Marg, 2007). However, the challenges are easy to deal with through appropriate contract governance structures and well-defined service level agreements which are then monitored by ZICTA. In this case, ZICTA considered the competitive advantage that tower sharing provides in the telecommunications market. However, what it has to bear in mind is the fact that new and smaller operators will be incurring lease payments as an operating expense with relative lower risk, whilst the large and incumbent operators are still recovering the capital expense incurred in erecting the towers.

CHAPTER 3: METHODOLOGY

3.1 Introduction

To answer the research questions, a quantitative research design was employed using questionnaires to collect data from staff of the three mobile operators (Airtel Zambia, MTN Zambia, and Zamtel) and one tower operator (IHS Towers). The questionnaire went through several refinements by the supervisor to ensure respondents could answer the questions on their own. This ensured that the researcher could ask more respondents to fill out the questionnaire. Quantitative research is appropriate when variables to be used and/or examined are clearly defined and numerical data is present (Chen, 2011). Quantitative data collection was employed in this research for the following reasons:

- this is a structured research design and can be naturally imposed on the research being conducted;
- the researcher chose to be objective, that is, the researcher was not part of what he or she observes, and did not bring personal interests, values, or biases to the research;
- quantitative data can be broken down and assigned some type of numerical value although the phenomena being captured may be complex (Chen, 2011).

3.2 Research Process

The major sources of data were primary. Primary data is the original research that is obtained through first-hand investigation by the researcher; it includes information collected from interviews, experiments, surveys, questionnaires, focus groups and measurements. Primary data is tailored to the needs of the researcher. When conducting a study, researchers can ask questions that best collect the data that help with their study using surveys, interviews and direct observations. Primary data can be **quantitative**, focused on numbers and measurements, or **qualitative**, as when

attitudes or opinions are collected and studied. However, conducting this research is often costly and time-consuming.

Secondary data is research that is widely available and obtained from another party through literature review (Säfsten). “Secondary data analysis is analysis of data that was collected by someone else for another primary purpose” (Johnston, 2014). It is usually immediately available to the public at little or no cost. It can also be used for extended lengths of time. For example, looking at a company's income rates over a 10-year period can provide insight into trends that may not be obtainable from primary data. The downside to secondary data is that it is generally focused on broader topics and may be out of date. The research question, the budget and the available resources determine whether researchers use primary data, secondary data or both (Säfsten).

In the simplest terms, qualitative research gathers information that is not in numerical form, for example, diary accounts, open-ended questionnaires, unstructured interviews and unstructured observations. Qualitative data is typically descriptive data and, as such, is harder to analyse than quantitative data. Qualitative research is useful for studies at the individual level, and to find out, in depth, the ways in which people think or feel. Analysis of qualitative data is difficult and requires an accurate description of participant responses, for example, sorting responses to open questions and interviews into broad themes. Quotations from diaries or interviews might be used to illustrate points of analysis. Expert knowledge of an area is necessary to try to interpret qualitative data.

Quantitative research gathers data in numerical form which can be put into categories, or in rank order, or measured in units of measurement. This type of data can be used to construct graphs and tables of raw data.

Experiments typically yield quantitative data, as they are concerned with measuring things. However, other research methods, such as observations and questionnaires can produce both quantitative and qualitative information.

For example, a rating scale or closed questions on a questionnaire would generate quantitative data as these produce either numerical data or data that can be put into

categories (e.g. “yes,” “no” answers). Whereas open-ended questions would generate qualitative information as they are a descriptive response.

3.3 Sample Size

The sample size was calculated using the guidelines illustrated by Gogtay (2010). The researcher wishes to determine the problems experienced by the operators in infrastructure sharing and the main determinants driving the sharing. To calculate the sample size based on the sample required to estimate a proportion with an approximate 95% confidence level, the formula below was used:

$$n_r = \frac{4pq}{d^2} \qquad \textit{(Gogtay, 2010)}$$

Where;

n_r = required sample size,

p = proportion of the population having the characteristic,

q = 1- p and

d = the degree of precision.

The proportion of the population (p) may be known from prior research or other sources; if it is unknown, use p = 0.5, which assumes maximum heterogeneity (i.e., a 50/50 split). The degree of precision (d) is the margin of error that is acceptable. Setting d = 0.10, for example, would give a margin of error of plus or minus 10%. Applying this formula to this research;

Since the researcher does not know p, Gogtay (2010) recommends the researcher to assume p = 0.5, and the value of q is = 1- p, d is to 90% accuracy; therefore

p = 0.5,

q = 0.5 and

d = 0.1, margin of error of $\pm$ 10%.

$$n_r = \frac{4pq}{d^2}$$

$$n_r = \frac{4 * (0.5) * (1 - 0.5)}{0.1^2}$$

$n_r = \frac{4*(0.5)*(1-0.5)}{0.1^2}$ (Gogtay, 2010)

Therefore, the sample size is calculated with confidence level of 90%, to be$n_r = 100$.

Table 7: Sample Size

Organization	**Sample Size**
MTN	25
Airtel	25
Zamtel	25
IHS Towers	25
Total	**100**

The questionnaire was grouped into two sections consisting of 40 questions in total. The first section, Section A, contained multiple-choice questions that required the respondents to answer based on what they knew. The second section, Section B, required the respondents to answer the questions using a Likert scale, on the determinants, drivers, and challenges of infrastructure sharing adoption among operators.

Four (4) organizations with a sample size of 100 were targeted for the questionnaires with 48 respondents from all 4 organisations responding. In those four organisations, at least two top management executives from IHS Towers, MTN, and Zamtel who oversee the decision-making process of infrastructure sharing were interviewed. IHS Towers interview was with their implementation manager, MTN with the operations manager, and Zamtel with the tower implementation project manager and no interviews were conducted for Airtel

A Likert scale was used to evaluate the level of agreement or disagreement with weights ranging from 1 - 5. This was used by respondents to evaluate the level of agreement or disagreement (strongly disagree 5, disagree 4, neutral 3, agree 2, and strongly agree 1). Percentages were used to find the level of agreement (sum of respondents for strongly agree and agree), disagreement (sum of respondents for strongly disagree and disagree), and neutral. The collected data was checked for completeness, and then coded, captured, and analysed using Microsoft Excel. Descriptive statistics used included tables, frequencies, weighted mean, standard deviations, and percentages.

Before a face-to-face interview could be conducted, it had to be established that respondents were 1) familiar with infrastructure sharing issues and the notion of sharing, and 2) knowledgeable of decision-making strategies used in infrastructure sharing by mobile operators or new entrants. The main reason for this was to minimise errors in data collection and derive valid information that is considered by the network operators, tower operators, and possibly the new entrants concerning infrastructure sharing so as to eventually compare them with our respective hypotheses based on literature findings.

Before contacting any potential respondent to be interviewed, the Human Resource departments in the respective organisations had confirmed thoroughly their positions and areas of involvement to be sure that they were relevant and met the sample selection criteria. All potential respondents were then contacted through a phone call and advised of the purpose of the interview. Additionally, all of them received an introductory letter indicative of the questions that would be discussed in the interview. After the interview, questionnaires were left to be filled out by the other respondents in that organisation.

Two interviews in total were recorded. During the interviews, it was clearly stated to all the interviewees that anonymity would be kept, and their names would not be mentioned. The target population was technical staff that usually work or are found in the field at a tower site; however, due to logistical challenges of reaching the respondents for interviews, questionnaires were administered. The interview questions are covered in Section B of the appendices.

One of the limitations of this study is that it is highly dependent on the technical people who have hands-on experience in the field. Less than twenty individuals at each targeted organisation in this research could provide complete and valid information, and the researcher relied heavily on interviews as a backup method of collecting data from the heads of departments to confirm that the data collected from the respondents was valid. Having an alternative method for collecting empirical knowledge could be a way to overcome this limitation. Other limitations are related to the scope of this study.

3.4 Response Rate

A hundred (100) questionnaires were sent to the staff members of each organisation. Of these questionnaires, 48% (i.e., 48 valid questionnaires of the 100 questionnaires handed out) were collected as valid from the three mobile and one tower operators. An additional 14 surveys were returned that were not considered useable. The unusable surveys were either blank with a note attached that explained why the respondents would not be able to complete the survey, or only partially complete with major portions of the survey blank, or in one case, the respondent created and revised categories such that the data could not be entered without serious interpretation and alteration. Lastly, organisations such as IHS had less staff members required to answer the questionnaire. However, the organisation had less than ten individuals that could respond to the questionnaires correctly. Each organization was given 25 questionnaires as directed by the heads of departments dealing with the towers and network implementation. Table 8 below shows the response rate of each organisation that was presented these questionnaires with MTN returning the highest number of questionnaires.

Out of 25, 17 came back from Zamtel but only 12 were fully useful because they had less staff members who could assist with answering the questions and some came back with more than half of the questionnaires blank, some questionnaires were partially filled (meaning two-thirds of questions were left blank which made it difficult for the researcher to interpret).

Table 8: Response Rate

Distribution			
Service Provider	**Target**	**Response**	**Percentage%**
MTN	25	14	56%
Airtel	25	13	52%
Zamtel	25	12	48%
IHS Towers	25	9	36%
Total	100	48	48%

Twenty surveys came back from MTN; however, only 14 were useful – MTN outsources all its tower business from Huawei, so the team responsible for these transactions was 9 and the others who answered the questionnaires were their operations managers who oversee the rest of the business. Thirteen came back from Airtel; the rest of the questionnaires were not filled out as the departmental head advised that it was a small department and not all could fill the questionnaires correctly. Airtel proved to be very unsupportive and this made it extremely difficult to obtain results from the mobile operator. Nine useful responses came from IHS Towers, as the implementation manager advised that the rest of the team could not answer the questionnaires because only technical individuals and finance departments would be able to provide answers to some of the questions. Hence, a follow-up interview was conducted with the heads of each of the departments responsible for infrastructure sharing.

CHAPTER 4: DATA COLLECTION, RESULTS AND ANALYSIS

4.1 Types of Towers

Figure 9 shows the main types of towers that are used and shared among Zambian MNOs. It was found that macrocell self-supporting towers covering a range of 6 to 15 kilometres are the major towers used and shared, and in relation with the literature, these towers are also the most used and shared worldwide.

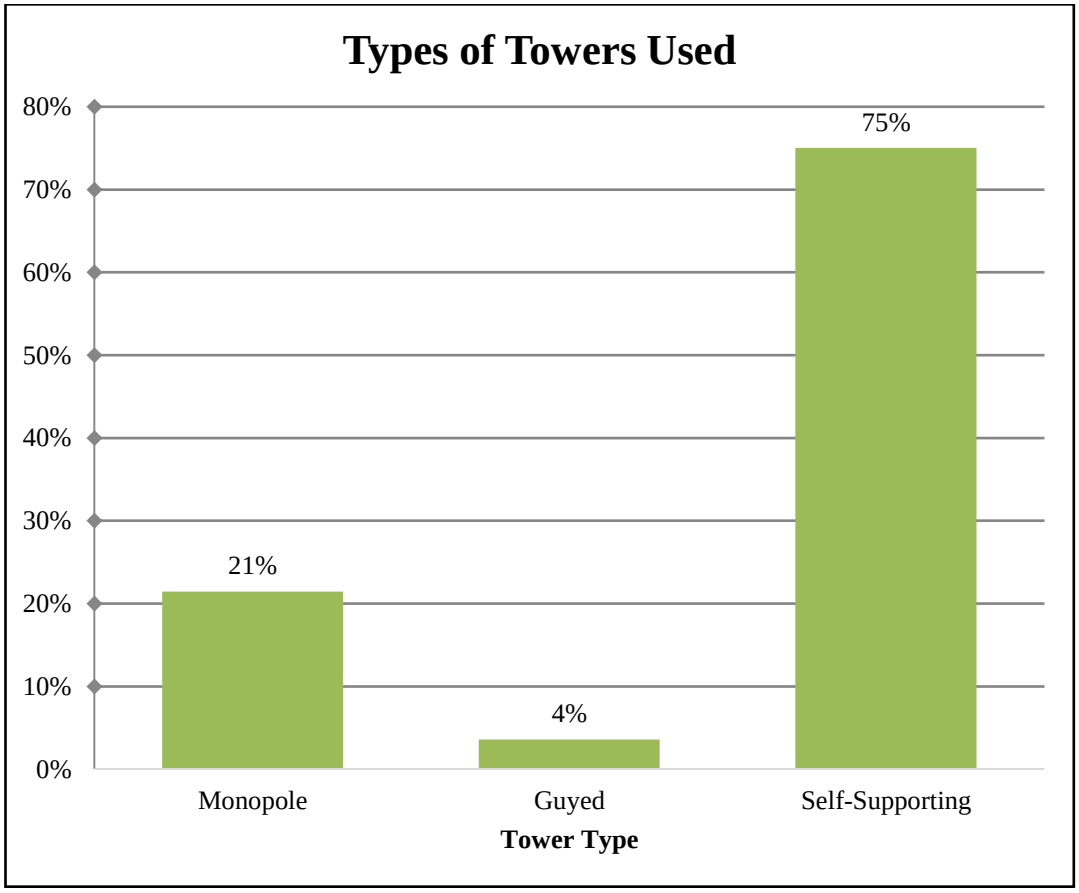

Figure 9: Types of Towers Shared among MNOs in Zambia.

The research found that infrastructure in the Zambian mobile telecommunication industry is mostly third party-controlled with 100% level of infrastructure sharing among mobile operators and tower companies. The research found that IHS Towers purchased the towers directly from the MNOs rather than building its own in each province for the following reasons: To reach the market directly, to have total control over their competition, and to be able to reduce the workload on MNOs.

However, the biggest driving force at the time of procurement came due to the fact that MNOs such as MTN and Airtel are internationally owned, and whatever decisions made at the top level are likely to trickle down and impact the subsidiaries in the developing countries where they are present. The researcher concluded that Zamtel did not sell its towers in the same vein. The analysis shows that new entrants are more likely to follow the path taken by MTN and Airtel regardless of whether they are internationally owned or not.

Both Zamtel and IHS Towers have several other types of towers such as monopoles and concealed towers. Good examples of concealed towers are found in the Southern Province, particularly Livingstone, where the towers appear as a tree to divert wild animals, such as elephants, from knocking the structures down. From the literature review, self-supporting towers were found to be one of the cheapest to build and can withstand strong winds and other disasters such as tremors and earthquakes that may occur in the country (Dehkordi et al., 2013). Constructing concealed and self-supporting towers has aided tower companies to save funds as the number of subscribers in rural areas is mostly sparse and not as prevalent as in urban areas.

Interviews and data analyses found that IHS Towers' responsibility is to acquire, build, and maintain the passive infrastructure on behalf of the mobile operators. However, its only competitor, Zamtel, is also involved in the maintenance of active infrastructure. MTN rents spaces on towers from any of the tower providers and further outsources active infrastructure maintenance from Huawei, which also gives an option of providing all the necessary equipment needed for any type of data and voice transmission. Airtel, the second largest mobile operator in the country, has a similar business model but does not outsource active infrastructure maintenance as it has an internal team fully dedicated to the maintenance.

4.1.1 Tower Usage

Figure 10 shows that the towers are used to provide subscribers with data and voice services. Figure 11 below shows the least distance each shared tower covers. The common radius of the towers and its radios was found to to be covering slightly above 10 kilometres while others mostly in urban areas only covered between 2 to 10 kilometres. The reason for the difference was because of congestion, and no high

lands are present on which to construct huge towers that can cover long distances as is the case in rural areas.

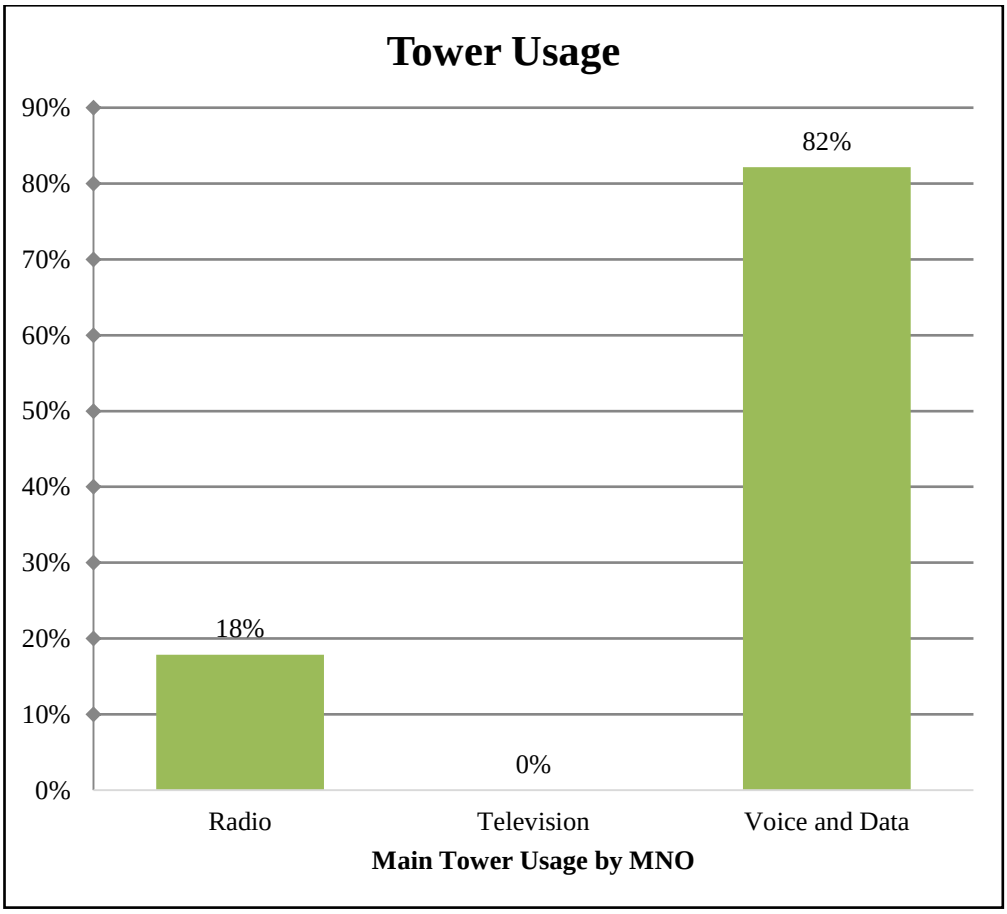

Figure 10: Main Usage for MNO Towers.

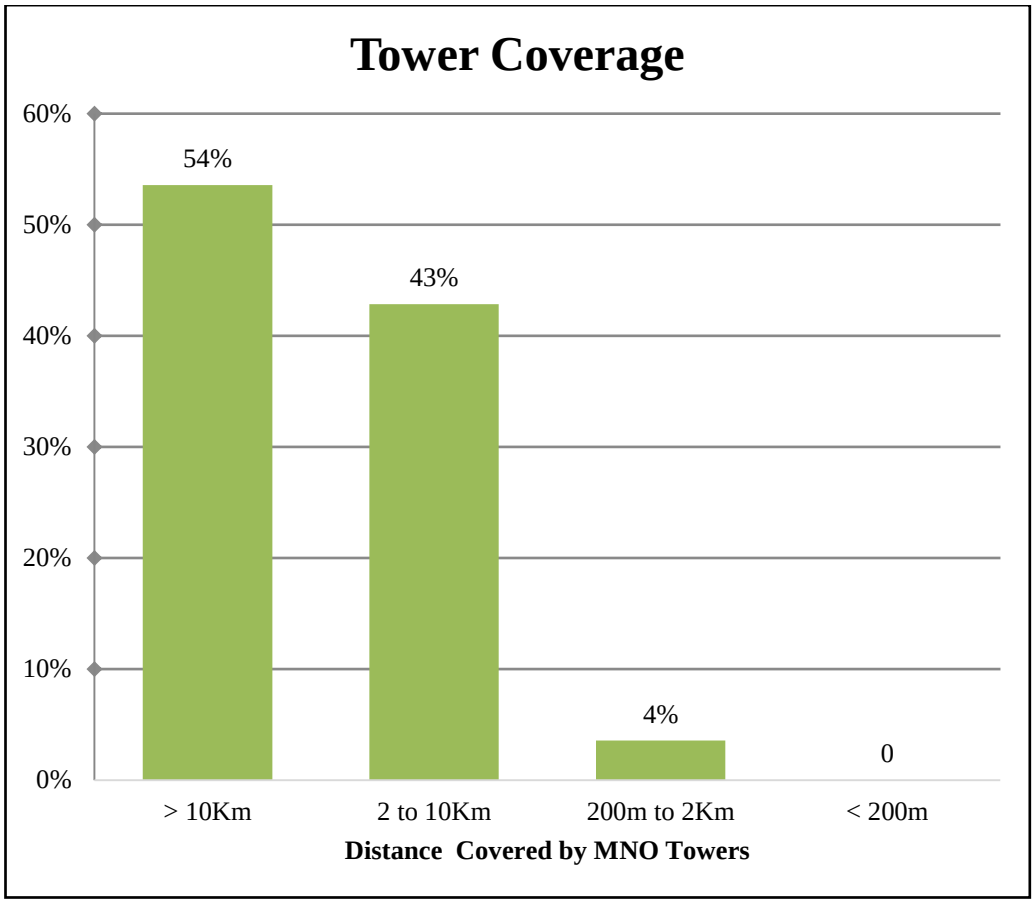

Figure 11: Tower Radius Coverage.

4.1.2 Sharing Models Used

The business models used in tower sharing for the current MNOs in Zambia are the same. The most common sharing model is the basic tower-sharing model where an agreement is signed between the two parties involved and rent charges are settled as per their agreement, that is, monthly, quarterly or yearly. The research found that both Airtel and MTN have signed similar agreements with IHS Towers. The agreement is standard. However, each player entering the agreement can negotiate the conditions of the agreement to suit their requirements.

Figure 12 shows the common sharing model used by MNOs in Zambia. The tower-sharing model allows MNOs to share the same mast, antenna frame, and/or roof-top. Figure 12 also shows that site sharing is the second most common tower-sharing model among MNOs in Zambia.

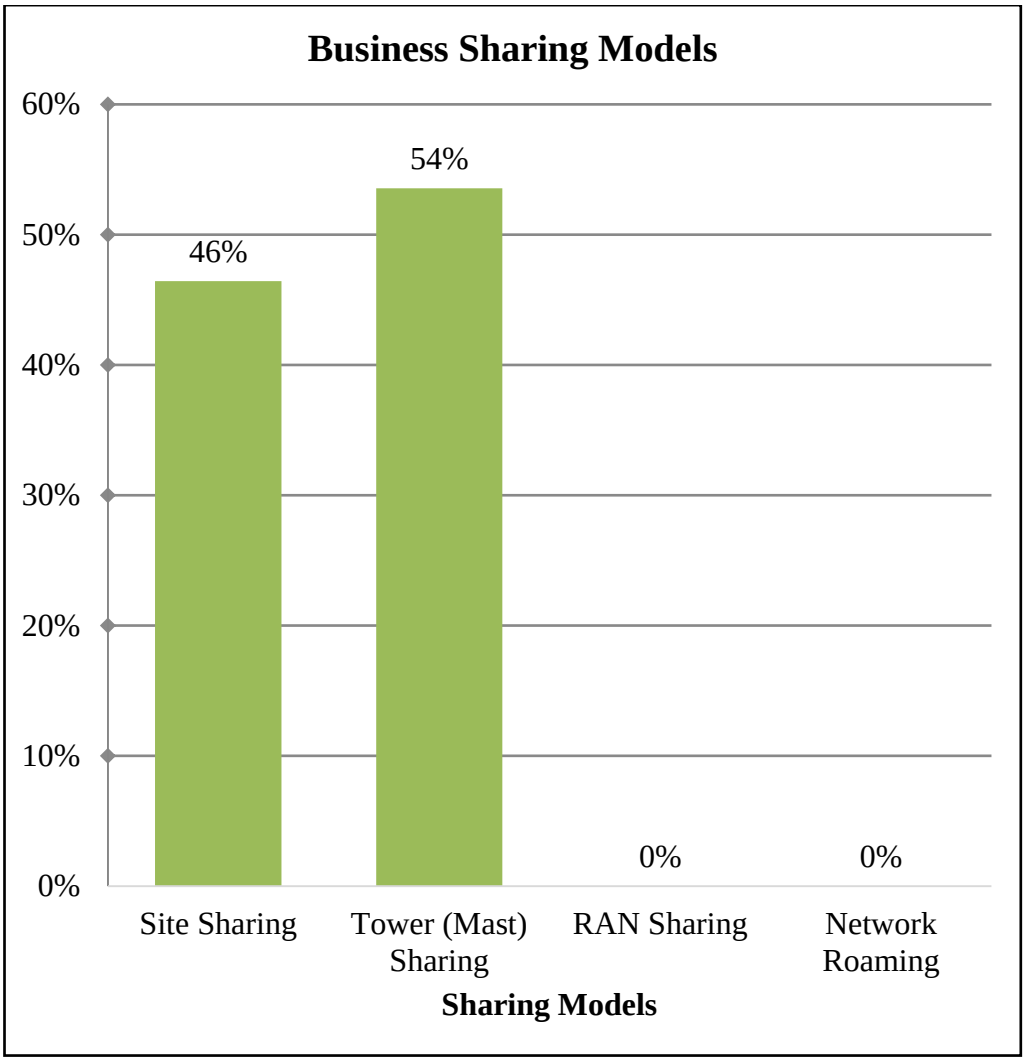

Figure 12: Sharing Models in Zambia.

The process flow of tower sharing is as follows:

The MNOs determine which tower company to use;

The tower company drafts an agreement and presents it terms and conditions to the MNOs for signage, and

If the players involved are in agreement and the agreement is signed, then payments are made to the tower companies.

At this stage, MNOs are allowed to install their active infrastructure on the towers so they can begin to conduct their business.

The interviews with Zamtel interviewees revealed that passive infrastructure sharing is not new in Zambia. Prior to MTN and Airtel selling their towers to IHS Towers, there was an active agreement between the two private telecommunication companies that allowed them to share passive infrastructure. Equally, Zamtel and Airtel shared infrastructure passively in areas that lacked network coverage. This allowed them both expansion of service. The disadvantage was observed once Airtel sold its towers to IHS, which meant that Zamtel had to enter a new agreement with IHS towers, which proved to be costly.

Figure 13 below shows that MNOs prefer to share infrastructure with the tower company than an MNO.

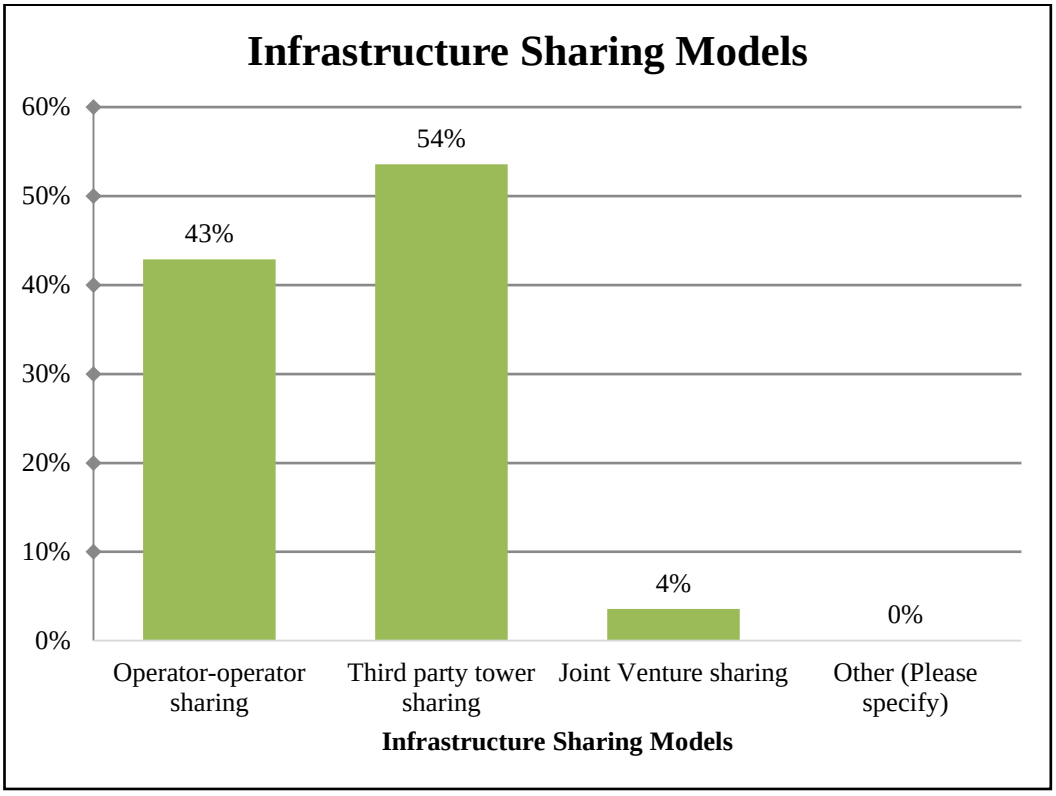

Figure 13: Preferred Infrastructure Sharing Model.

4.1.3 Reason for Sharing

Figure 14 shows the driving force of infrastructure sharing. Of the respondents, 64% thought that the following reasons are the driving factors of infrastructure sharing in Zambia: reduction in capital and operational expenditure incurred during the lifetime of the tower, maintenance fees involved, and set-up costs.

Twenty-one per cent of the respondents confirmed that their company shares infrastructure because it allows them to roll-out network services at a quicker rate, especially in rural areas. Fourteen per cent of the respondents thought that infrastructure sharing was a regulator-imposed move to encourage infrastructure sharing and reduce duplication, and to protect the environment by reducing the number of trees cut down during ground clearing just to find space to erect a tower.

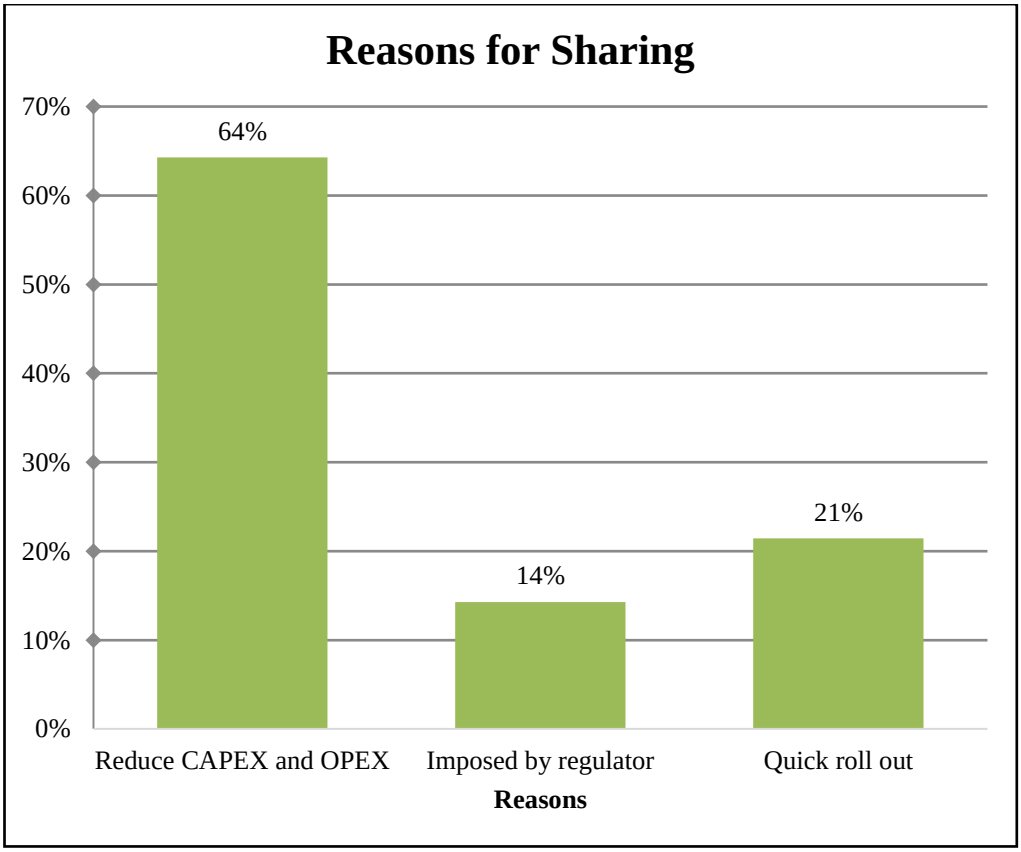

Figure 14: Reason for Infrastructure Sharing.

Table 9 below shows data analysis of what is considered as the main drivers in infrastructure sharing in Zambia. The top drivers are those with the **"Agree**" percentage range of 70 to 100%, and these include:

1. To enable MNOs to focus on their core business functions and innovations such as improving quality of service and value-added services to retain customers;
2. To improve network reliability by use of redundancy routes; and
3. To promote co-operation among competitors.

These results are similar to those found in previous researches (Malungu & Moturi, 2015; Allen & Overy, 2012; ITU, 2009).

Given that ICT infrastructure deployment requires high capital investment and the long payback periods of over 10 years, the respondents in interviews said that sharing infrastructure is not considered to be an efficient way of utilising scarce resources in the Zambian telecommunication industry. This is very contradicting as operators' decisions to share infrastructure were to reduce the cost of acquiring ICT infrastructure. The respondents explained that it is not that the resources are scarce, but they are expensive to set up and maintain with long payback periods of 10 years.

Table 9: Drivers of Telecommunication Tower Infrastructure Sharing

Drivers			
Statements	**Weighted Mean**	**Standard Deviation**	**Agree**
1. Sharing enables operators to focus on core business / innovations	1.3571	0.5	100%
2. Sharing improves network reliability by use of redundancy routes	1.8571	1.1	79%
3. Infrastructure sharing promotes cooperation among competitors	2.1786	0.7	75%
4. Sharing preserves our environment due to reduced electronic waste	2.2143	1.1	71%
5. Sharing resources lowers costs and generates revenue	2.1429	1.1	68%
6. Sharing enables new entrants' firms to launch and market their services faster	2.6071	1.2	61%
7. Sharing increases coverage and access to services	3.4286	1.2	21%
8. Sharing infrastructure is an efficient way of utilising scarce resources	3.5714	0.8	11%

Figure 15 below shows factors that determine the selection of the preferred tower operator in a location. Thirty-seven per cent of respondents first consider how many operators are in a location. If the operator is the only one, they will go with whoever

is available in that area. Twenty-seven per cent consider rent charges in that area, and choose the cheapest service provider.

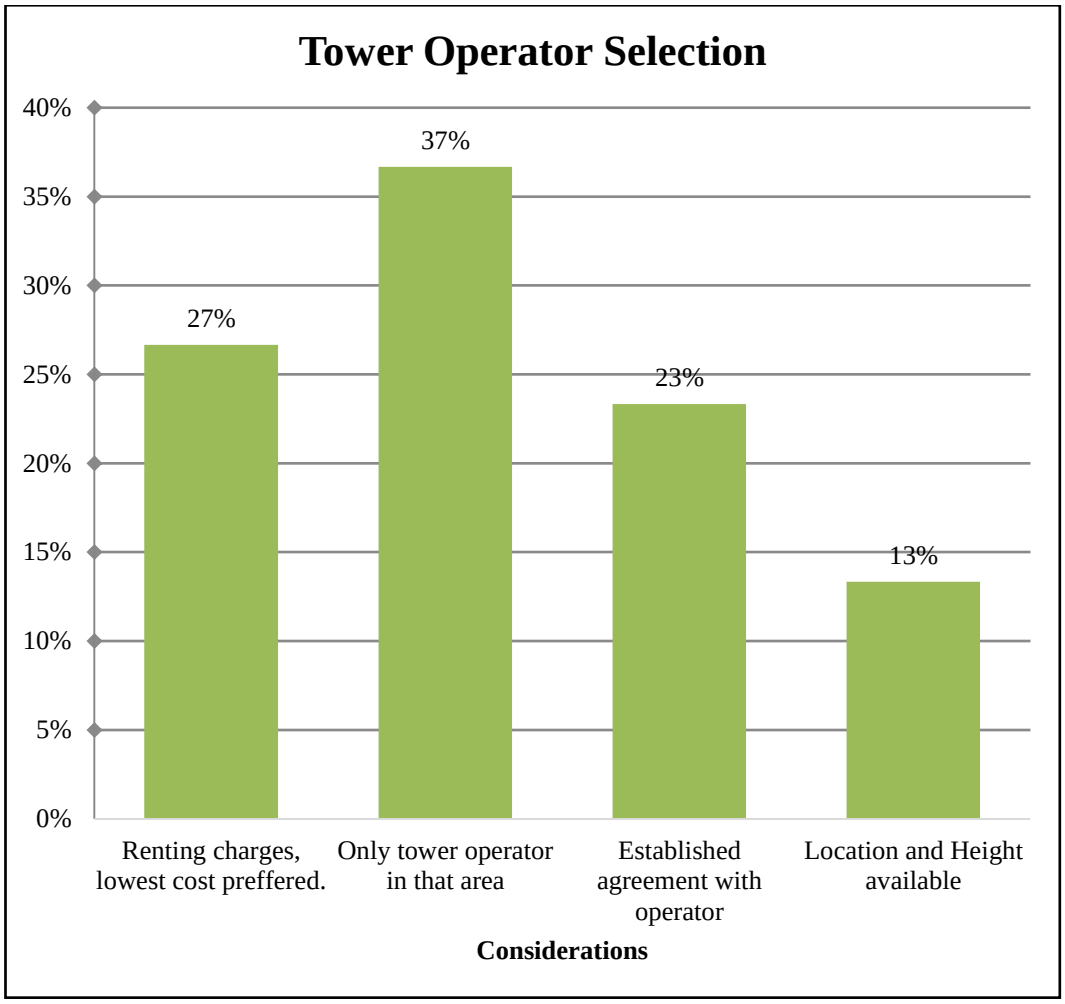

Figure 15: Factors Considered When Selecting Tower Operator.

4.1.4 Tower Market Structure

Figure 16 shows the tower market structure from the view of the respondents. The respondents view the market as a monopoly because more than 70% of the towers in the country are owned by IHS Towers. Thirty-two per cent of the respondents say that the market is an oligopoly, where only a few firms, IHS Towers and Zamtel make up an industry. This select group of firms has control over the price and, like a monopoly; an oligopoly has high barriers to entry.

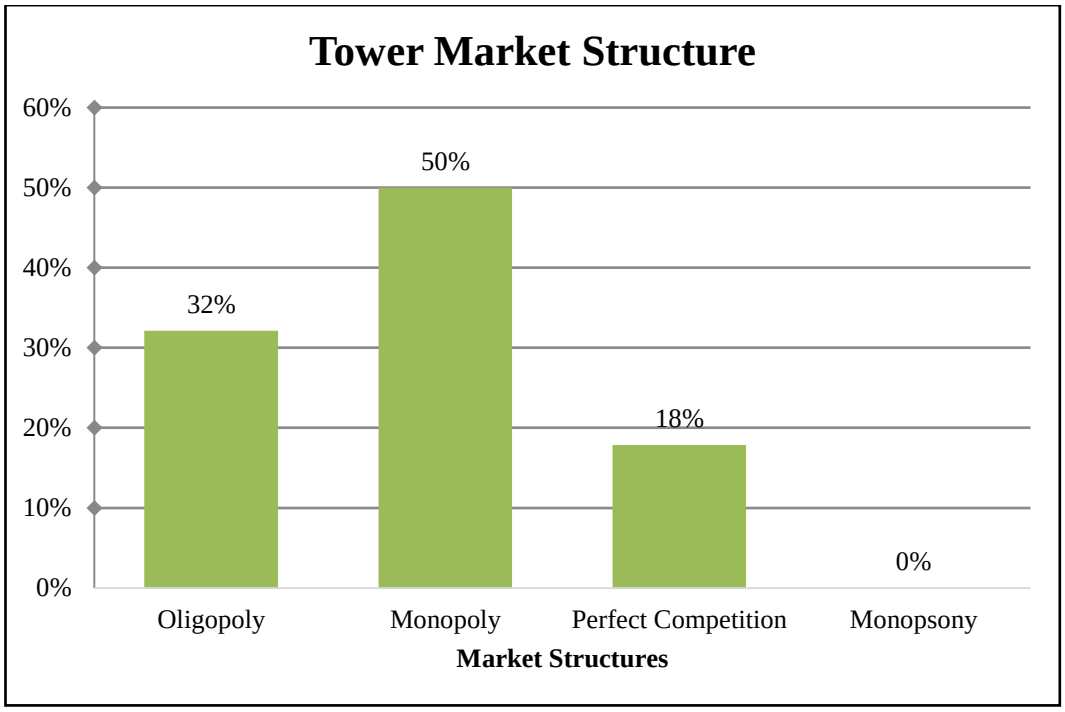

Figure 16: Current Zambia Tower Industry.

It is important to note that there are small companies, radio stations, TV stations, etc., that own towers that do not provide any services to mobile operators but to Internet Service Providers (ISPs), television and radio station broadcasters, and police stations. Even though they share standardised facilities, the prices are mainly influenced by the operator with the biggest market share. From the literature review, it has been established that any player owning more than 50% of the market is considered a monopoly. The views from the respondents are not far from this, where we have 50% saying the tower market is monopolised with one Tower Company owning most of the towers in the nation and renting them to the two biggest mobile operators in Zambia. Table 10 shows the percentage of those that agree with the statement given by the researcher. Eighty-six per cent agree with the statement that tower sharing reduces the cost of service pricing.

Table 10: Tower Market Structure

Tower Market Structure & Competition			
Statements	**Weighted Mean**	**Standard Deviation**	**Agree**
1. Tower sharing will encourage competition	2.6786	1.3	61%
2. Tower sharing reduces the cost of service pricing;	1.8571	1.1	86%
3. Tower ownership by third-party owners reduces cost	3.6429	1.3	21%

Third-party companies owning a tower does not necessarily help reduce all costs, but it has a great effect on the reduction of service prices. Table 11 below shows what was determined as the competitiveness present in the tower market in Zambia for both incumbent and new entrants. The tower-sharing business is not viewed as a business that has potential in Zambia. The major MNOs already have agreements in place with IHS and Zamtel, meaning introduction of a new tower company, no matter how low its pricing may be, will find it hard to win MNOs over. It will be costly for the MNOs to move their infrastructure from one tower to another, as this can mean cutting service for a while as they move equipment, and equipment may get damaged as it gets moved. Perhaps in areas where IHS and Zamtel are not present, the new tower companies may compete for MNOs. Tower ownership by third-parties encourages competition and is one of the goals of ZICTA in encouraging tower sharing.

Table 11: Competition in Tower Industry

Access to Towers			
Statements	**Weighted Mean**	**Standard Deviation**	**Agree**
1. Easy for new entrants to enter an agreement with tower operators.	2.6429	1	50%
2. Potential for tower ownership business in Zambia.	3.0714	0.9	21%
3. Tower ownership by third-party owners encourages competition.	2.3929	1	64%

Figure 17 below is a chart showing factors considered as barriers for new entrants on the telecom market. Cost of set-up is considered the biggest hurdle by 43% of the respondents.

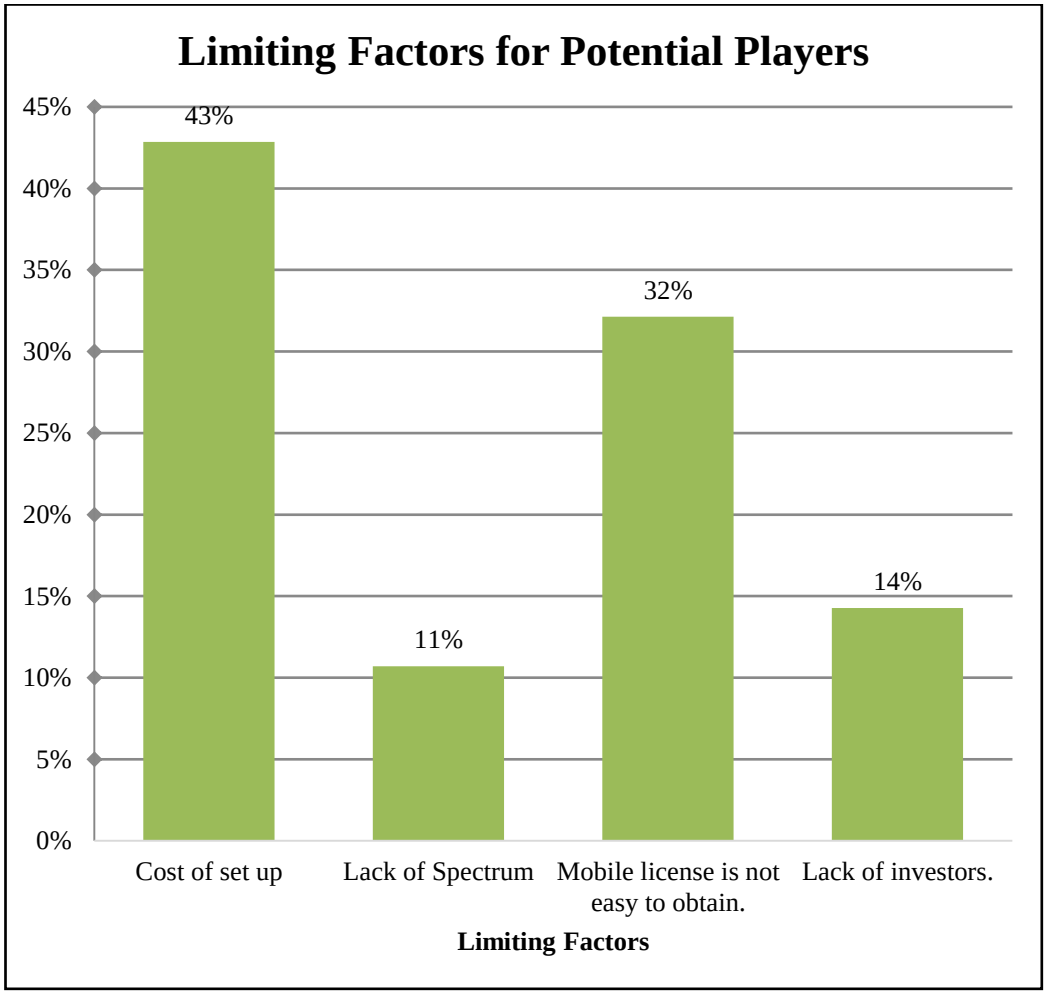

Figure 17: New Entrants' Limiting Factors in Zambia Telecom Industry.

Figure 18 below shows some of the reasons behind the limit in the number of players in the current market. As shown in Figure 17, the cost of set-up is the biggest barrier to entry for new entrants in the tower market. Set-up and maintenance of towers are very costly and limit new organisations from entering the market as the incumbent MNOs have already entered long-term agreements with the current tower companies and tower-owning MNOs.

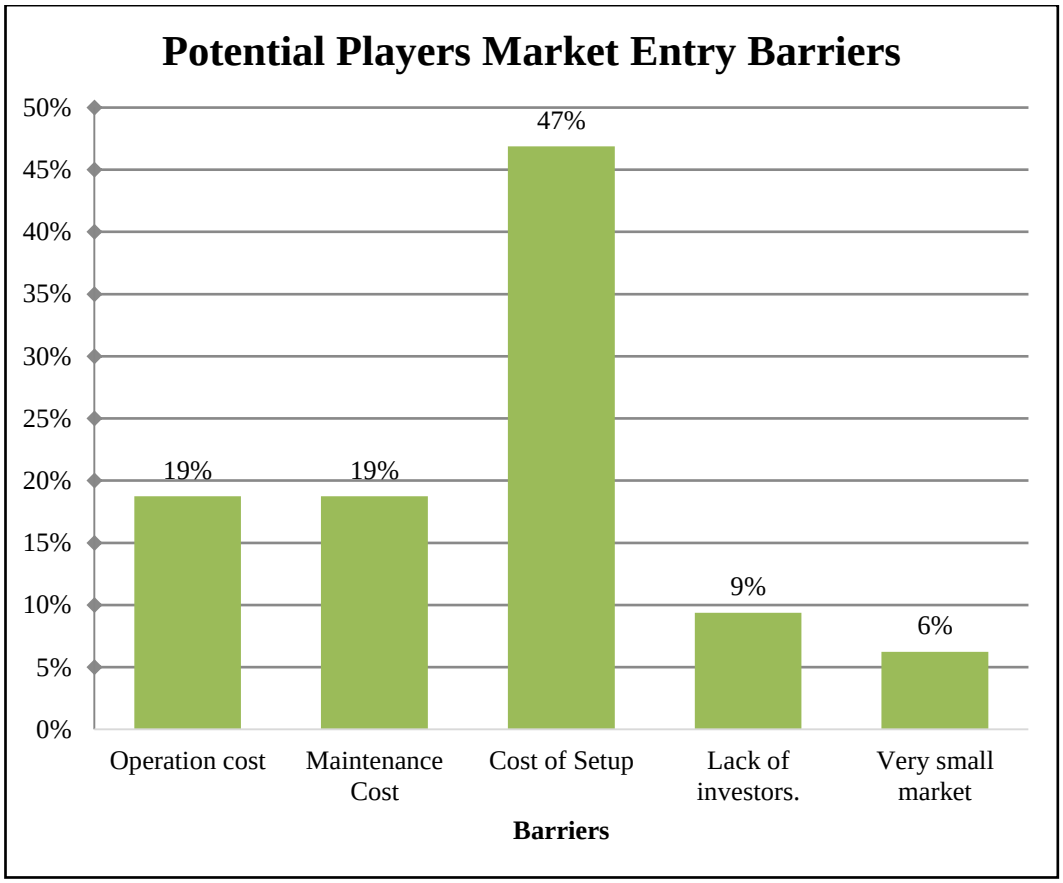

Figure 18: New Entrant Barriers in the Current Tower Market.

Furthermore, Figure 19 below shows that new entrants are more likely to adopt tower-sharing business models to achieve a quick roll-out of networks at the lowest cost possible.

In Figure 20 eighty per cent agree that it is easy for new entrants to enter tower-sharing agreements with tower companies than tower-owning MNOs because of the amount of time taken for new entrants in setting up passive infrastructure.

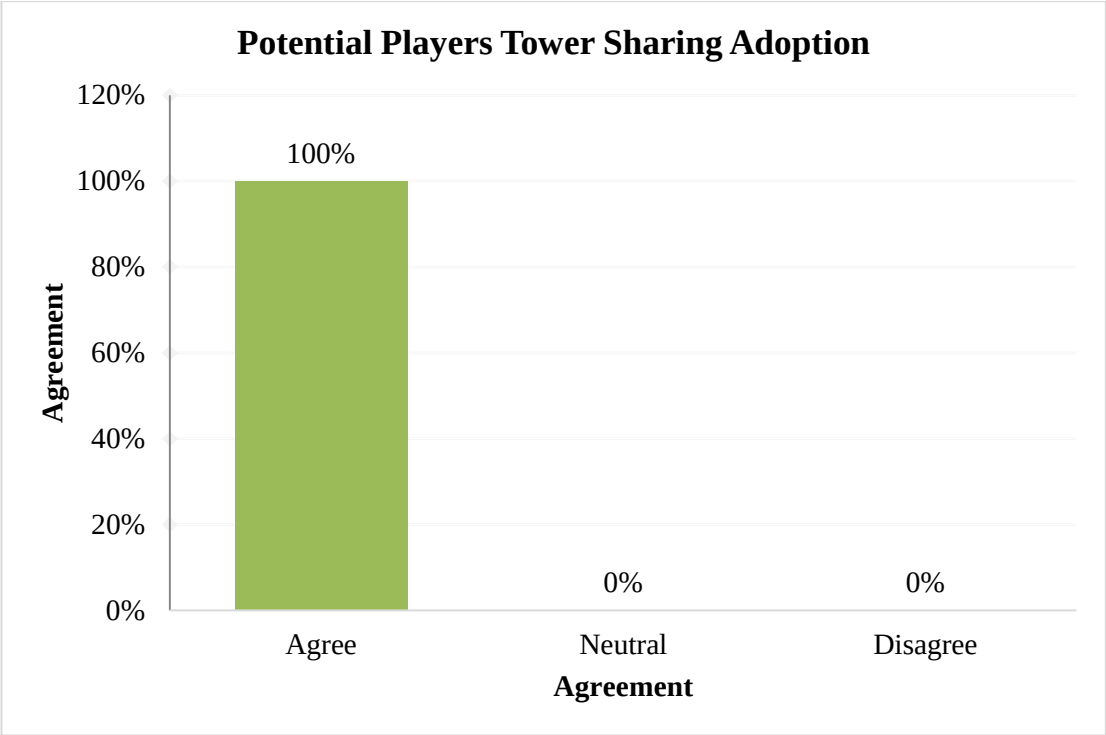

Figure 19: New Entrants' Likelihood to Adopt Tower Sharing

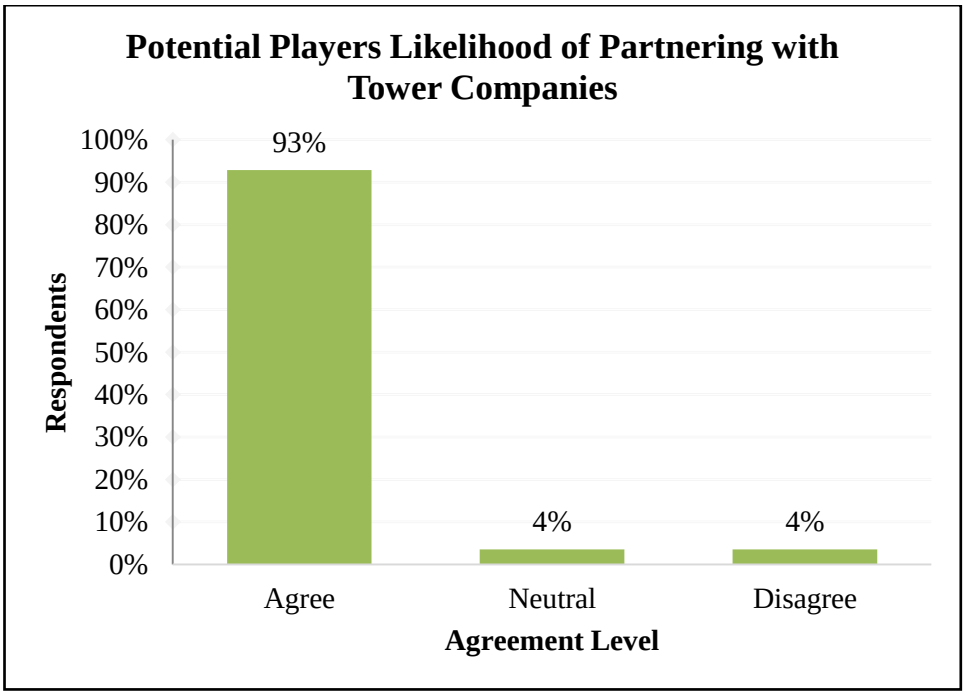

Figure 20: New Entrants' likelihood of Partnering with Tower Companies.

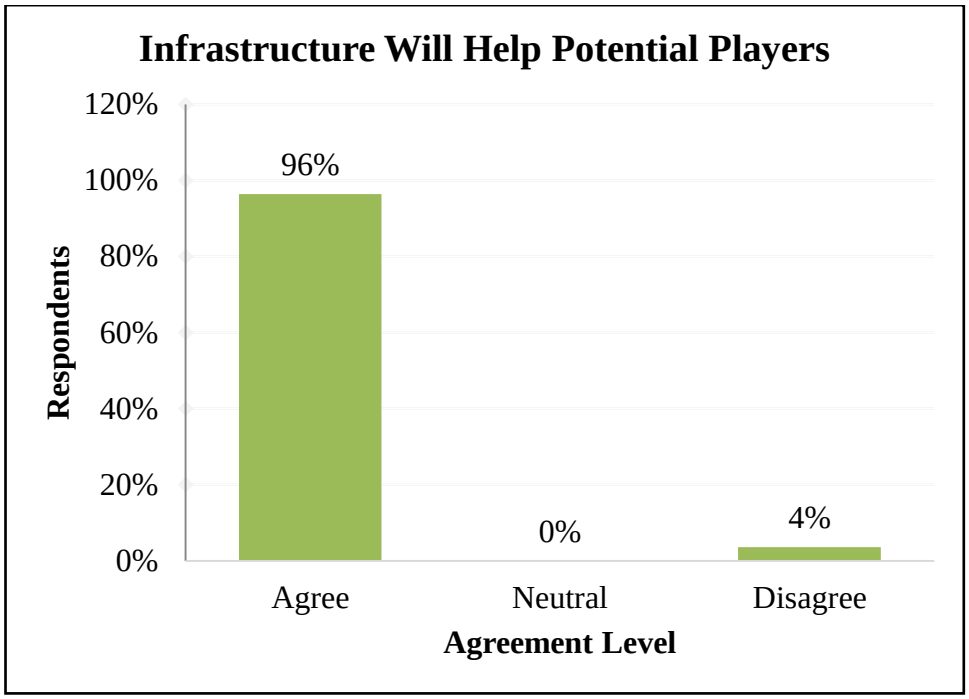

Figure 21: Infrastructure Sharing is Likely to Help Potential Players

Figure 21 shows that tower sharing is likely to help potential market players to penetrate the market more easily. Over 70% of towers are shared passively through a third-party tower company while the remaining less than 30% are shared through operator Zamtel. MTN and Airtel Zambia only share with Zamtel when IHS has no towers in the areas where the mobile operators would like to implement network coverage. In areas where Zamtel has no tower presence, they also rent spaces on towers owned by IHS. Table 12 below shows the number of towers IHS Towers and Zamtel currently have and how many are currently being shared.

Table 12: Number of Towers Owned by Zamtel and IHS Towers in Zambia

Organisation	Total Sites	Shared Sites	Shared Sites %
Zamtel	840	840	100
IHS Zambia	1,966	1966	100

4.1.5 Challenges of Sharing

The capital required of a new entrant is the biggest challenge in infrastructure sharing in Zambia. This, in connection with high contractual exit costs arising from breach of contract, is considered to be the biggest barrier to infrastructure sharing because it

increases the amount of funding required to finance other items, e.g., putting in place legal protections and mitigation risks.

Other challenges as outlined in Table 13 include:

- high charges by infrastructure owners to rent spaces on the towers;
- MNOs are exposed to several risks, e.g., market share loss – dominant operators fear market share loss and unwillingness to share due to limited or lack of capacity; and
- High capital requirements for infrastructure.

Figure 22 shows that 21% of the respondents said that operators may be unwilling to share due to the incompatibility of technologies between the MNOs. The remainder are of the view that infrastructure sharing does not depend on technology compatibility because none of the active infrastructure is ever shared.

Some agree that operators are sometimes unwilling to share due to limited or lack of capacity. This proves that unlike the findings in Kenya by Malungu & Moturi (2015), incumbent operators in Zambia are different because they are willing to share infrastructure with their competitors.

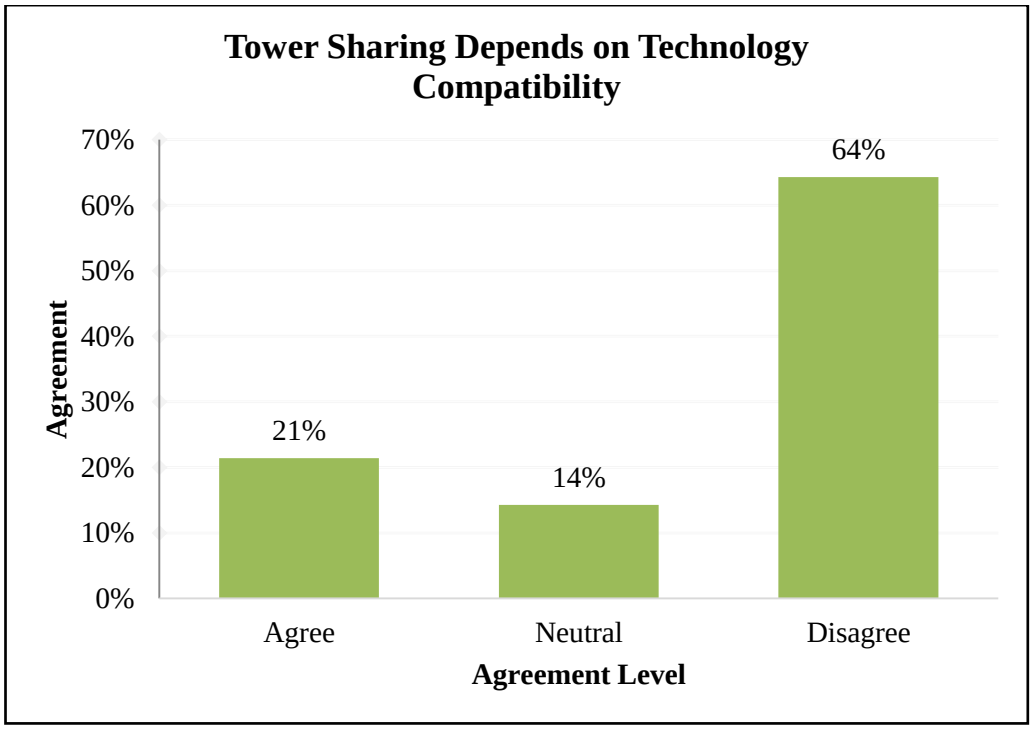

Figure 22: Infrastructure Sharing Dependence on Technology Compatibility

This is also the same regarding the lack of regulatory & policy framework being a barrier to infrastructure sharing (36% agree). The interviews found that the regulatory framework governing infrastructure sharing is an important aspect in driving the infrastructure sharing and not a barrier. The results in Table 12 show that the regulator promotes infrastructure sharing as well as encourages fair competition among mobile operators. ZICTA recognises infrastructure sharing in Zambia and encourages it in order to promote competition and improve quality of service among MNOs.

Table 13: Infrastructure Sharing Challenges in Zambia

Challenges			
Statements	**Weighted Mean**	**Standard Deviation**	**Agree**
1. Sharing may hinder competition due to reduced control and interdependence	2.3929	1	61%
2. Sharing infrastructure exposes too many risks, e.g., market share loss & security threats	2.0714	0.7	75%
3. Operators are sometimes unwilling to share due to limited or lack of capacity	2.3571	0.9	68%
4. Operators may be unwilling to share due to incompatibility of different technologies	2.8929	1	39%
5. High charges by infrastructure owners are a hindrance to infrastructure sharing	1.8214	0.8	82%
6. Lack of regulatory & policy framework are barriers to infrastructure sharing	2.9643	1.1	36%
7. High capital requirements are a big barrier to infrastructure sharing	2.4286	1	68%
8. High contractual exit costs arising from breach of contract is a barrier to infrastructure sharing	1.4643	0.6	96%
9. Dominant operators' fear of market share loss is a hindrance to infrastructure sharing	2.1071	0.8	75%

The research found that ZICTA has 204 towers countrywide mainly in chiefdoms and extreme rural places that are ordinarily left out by operators as they are deemed "uneconomical" and cannot return good investment even in the long run. However, these towers are distributed equally among MNOs, and each of these has no colocation status despite operators being at liberty to collocate without any hindrance. The distribution is as follows:

Table 14: Number of Towers Apportioned by ZICTA to MNOs

Operator	Number of Towers Apportioned
Airtel	70
MTN	67
Zamtel	67

Table 15 shows the respondents' view of the regulator's role in the tower-sharing business; 96% said that the participation of the regulator in the tower-sharing industry encourages competition, which is also the regulator's main aim for taking up an active role in the industry.

Furthermore, 32% of the respondents from tower companies and mobile network operators say that the regulator's participation is not required. However, 86% of the respondents confirm that ZICTA imposes tower-sharing tariffs on the tower-owning companies. The research found that ZICTA's imposing tariffs are a way of mitigating any risks of excessive pricing by IHS since the latter has a monopoly in the provision of passive infrastructure; the regulator determines the collocation prices which IHS uses in the provision of its services.

The results found in this research are similar to those found in this study's literature review and the results found in the research done by Malungu & Moturi (2015) regarding telecommunications regulators in Kenya. The Kenyan telecoms regulators do not play an active role in tower sharing; however, they impose tower-sharing tariffs and encourage competition between mobile operators owning towers and tower companies.

Data collection was very restrictive because there are not many countries that have regulators participating in tower sharing; however, they only regulate the telecoms industry. Even though this practice is encouraged, tower companies believe that the ZICTA is not required to participate in tower sharing.

The interviews established that the role of the regulator is in line with what was found in the literature review, that is, "regulate the provision of electronic

communication services and products in Zambia," and to "monitor the performance of the sector including levels of investment and availability" (Zambia Information & Communications Technology Authority, 2015). The ZICTA closely monitored the selling and acquisition of towers among the mobile operators and set up new rules and regulations to accommodate the new tower companies who solely operate the towers. The goal for infrastructure sharing is to achieve maximum usage and reduce costs for the mobile companies and at the same time maximise the use of scarce resources to deliver quality services to customers.

Table 15: Role of the Regulator in Infrastructure Sharing

Role of the Regulator			
Statements	**Weighted Mean**	**Standard Deviation**	**Agree**
1. Tower sharing requires the regulator's participation.	3.2857	1.3	32%
2. Regulator owning towers encourages competition;	1.5714	0.8	96%
3. Regulator imposes tower-sharing tariffs	1.6071	0.9	86%

CHAPTER 5: DISCUSSION

5.1 Introduction

The telecommunication tower industry in Zambia comprises mainly two players: Zamtel and IHS Towers. IHS Towers retains at least 70% of the country's telecom towers while Zamtel, a close second and main competitor, owns approximately 29%. The remaining towers are owned by small players in the tower industry such as ZICTA, ISP companies and radio and TV operators.

The study found that telecommunication tower infrastructure is shared passively using the tower-sharing business model that allows for equipment rooms, security, masts, air conditioners, generators, and fibre cables to be shared. The tower providers, Zamtel and IHS, provide all the necessary equipment required for the tower site to successfully run. The site-sharing business model is also used to share only the site at which the tower operator erects a tower. The effects of the adopted tower-sharing model have effects on cost, quality of service, and customer satisfaction. The reason for the adoption of infrastructure sharing was to reduce operational and capital expenditures for the operators. The reduction in the number of costs incurred means that the operators are able to invest some of the money used to service and maintain the towers into technological innovation that can improve the quality of service rendered thereby satisfying their customers.

The motives for tower sharing are dependent on the position of the player in the market. For example, the costs at the beginning of network deployment (sunk costs, and investments costs) by a new entrant or any other player are higher in comparison to costs that are incurred when a network is mature (established). Hence the MNOs opt to remove the initial cost. Airtel and MTN Zambia, who are now infrastructure receivers, say that lower costs and increased capacity in congested areas are the most important drivers for tower sharing, while for new entrants the expansion of coverage into previously unserved geographic areas and rolling out the services at a quick rate are the main drivers.

Additional revenue source is not a driver of infrastructure sharing among dominant operators such as Airtel and MTN, but it is a main driver for the non-dominant

players on the market players, Zamtel. The position of a mobile operator in the market does play a role in identifying additional revenue sources as a driver for sharing infrastructure as the market matures. Even though additional revenue is not particularly a driver for dominant operators, the research found that co-operation among network operators, through infrastructure sharing, has become a solution to overcome lack of revenue by reducing expenditures.

However, the tower/mast sharing model, used by all MNOs, only allows passive infrastructure to be shared, while active infrastructure is never shared and transmission equipment is mounted individually for each MNO. This means that there is still the issue of duplication of active infrastructure. The cost of acquiring equipment required to install at a tower site for each operator, e.g., radios, does not reduce by as significant a margin as it would if the active infrastructure were shared as well.

MNOs prefer to rent from tower companies (rather than MNOs) because they feel that renting from an MNO will increase their competitor's dominance. However, the fact that another MNO knows the challenges and risks involved in infrastructure sharing is a reason that tower operators should consider when sharing infrastructure. Furthermore, MNOs providing tower services are able to share more than just passive equipment at each site, and this might be a reason worth looking into for the long run. The active infrastructure can then be used to improve the network in other areas that do not have a good network.

5.2 Effects of Tower Sharing

The effects of tower sharing found in the research are summarised in three points: Improved quality of service offered to customers; Quick network roll-out and network expansion; Increased capacity and presence of the service provider; Development of new incentives, offered at a low price, and offered to customers to retain customers' base and gain more.

Quality of service improvement is based on the number of customer calls or complaints that come through the service provider's call centre. Since the implementation of tower sharing, there has been a decline in the number of calls coming to their respective call centres on account of errors, bad network service, low coverage, and poor quality of service.

The services are offered at very competitive prices owing to the adoption of infrastructure sharing. For example, the number of promotions on voice, text, and data bundle allocation has increased among the MNOs with each offering its services at a highly competitive price. Customer satisfaction is evident owing to the quality of service improvement coupled with new incentives made available at affordable rates, a price considered low by the customers. Basically, customers are satisfied due to the fact that: there are a variety of services being provided to them, and there are more options to choose from due to the innovative services offered by the various service providers. These include calling minutes, SMS, and bundles that an individual can choose to get as a daily, weekly or monthly package; the quality of service on phone calls, Internet, and messaging has improved. Customers can browse faster on 4G internet, talk long hours without being cut unexpectedly by their service provider, and can send short messages without delay.

Tower sharing is suitable in Zambia's telecommunications market because of the present conditions driving tower sharing. Conditions include factors such as the consistent presence of competition among the network operators to gain a bigger customer base and retaining these customers by offering better services at a lower price. Tower sharing helps achieve this because infrastructure sharing enables the quick roll-out of services in a particular area at a quicker rate and faster expansion for the network provider.

Network expansion and network roll-out are two points that have driven infrastructure sharing for the incumbent operators and new entrants, respectively. Operators take advantage of infrastructure sharing because they get to roll-out their services at a quicker rate and also improve their presence in areas that require more capacity thereby increasing their presence entirely. Passive infrastructure sharing enables independent network operators to roll-out networks at a rate they can dictate regardless of whom or where they rent towers from.

However, the operators have avoided rolling out services in remote areas. The costs of rolling out a network to rural areas are high and are perceived as a negative investment by the MNOs and Tower Company, especially in areas deemed uneconomical by the network operators themselves. The profits recognised from operating in rural areas are very low, but mobile operators have looked to tower

sharing as a way to cut down operation costs if they were going to start operating in rural areas deemed uneconomical. However, ZICTA implemented a project in which it erected towers to cater to customers in the remotest areas and chiefdoms, and it apportioned an equal number of towers to each MNO to provide services in those areas.

Two types of towers are found in Zambia's telecommunications market: self-supporting and roof-top towers. Self-supporting towers are cheaper to construct because they require less material in comparison to monopoles, guyed, and concealed towers during network deployment. Self-supporting provide a good trade-off (cheaper and constructed quicker for the long term) to meet the current growing demand on the Zambian telecom market, hence tower companies have constructed them. Rooftop towers are deployed in locations where land or space to build a tower is not easily available. The tower companies or network operators position their transmission equipment on tall buildings to provide their customers with service.

Assembling and constructing a mast base forms a major percentage of the overall tower construction costs, and therefore mast sharing has the potential to significantly reduce operators' capital expenditure, particularly during the network roll-out phase. The MNOs' target is to gain financially from every business they associate themselves with. Financial benefits refer to the reduction of operational and capital costs. Lowering cost as a driver for infrastructure sharing was more important than generating an additional revenue source for incumbent network operators. However, even though the goal was to reduce costs, the operators indirectly generated additional revenue in that they were able to gain more customers from effects, such as improved quality of services, and of infrastructure sharing.

Mobile network operators are more competitive in urban areas as the majority of the population in Zambia is usually more densely populated in the provincial headquarters than is in rural areas. For this reason, tower operators seek to increase capacity to avoid congested traffic. There are more sites located and constructed on roof-tops and other high structures in urban areas than other developed districts.

Zamtel is both an MNO and a tower operator that shares infrastructure with Airtel and MTN. There are different drivers for providing infrastructure to an existing long-time competitor and for providing infrastructure to a new entrant. Zamtel provides

infrastructure to a competitor because the level of network maturity and development is comparable. However, a new aspect emerges, which is the comparability of the network maturity and development of the infrastructure provider and receiver. Network operator Zamtel may provide infrastructure to a new entrant and not to a competitor because the new entrants' services do not compete directly with Zamtel's core market.

IHS Towers is a preferred infrastructure provider to infrastructure receivers MTN and Airtel, in comparison to Zamtel, because of the flexibility and easy adoption offered during network deployment in specific geographical areas. New entrants prefer to receive infrastructure from a tower company than an MNO because it allows for quick network roll-out and also gives them the power to dictate the pace at which they roll out.

Network operators might be less willing to receive infrastructure for sharing with a third-party because of lack of trustworthiness and their higher likelihood of going bankrupt due to high site maintenance costs.

Infrastructure sharing considers different trade-offs when both players are available in a certain geographical area. The location and availability of infrastructure in that area are analysed and strategic decisions are made at the top level. The decision is based on financial logic in line with the company's business case or the competitive strategy. Hence, each operator selects the tower provider that suits it and meets its competitive strategy in a geographical area.

Incumbent MNOs' final choices concerning infrastructure sharing involve trade-offs between the incumbent tower operator in certain geographic areas and renting charges where lowest cost is preferred, the network operators already in agreement with the tower operator, and the location and height available for the towers in that location. Zamtel, the network operator, only shares towers; the active infrastructure is never shared.

Challenges faced by the network operators also depend on the position of the player in the telecom industry. New entrants face challenges such as regulatory delays in site acquisitions or tower permissions, but sharing takes out these limitations and

difficulties and eventually assist network operators in launching their services quicker.

These challenges can be handled by the incumbent operators and the new entrants through negotiations of improved contracts. High contractual exit costs arising from breach of contract and high charges by infrastructure owners are issues that can be resolved and agreed upon among the parties involved. One way of overcoming such challenges is contract agreements that implement risk management strategies such as joint ventures for upgrades and network deployment, review sharing process to make it more efficient, and lowering the cost-leasing infrastructure while ZICTA must ensure it assists new entrants in pricing which promotes sharing and avoids unfair practices.

5.3 Conclusion

There are some possible negative outcomes to consider for Zambia regarding tower sharing. First, well-established businesses such as IHS Towers may become monopolies, and strict measures need to be put in place in order to control their pricing on the market. It is important to consider how control is diversified among the towers regarding the responsibilities of maintenance, security, quality, and performance provided as a service to the network operators.

Last, as bureaucracy and contracts rise in popularity, a natural result is an increase in filings with the legal system. The telecommunications industry in Zambia will also increase the demand for the court system to review and try conflicts via hearings. Therefore, a regulatory framework present must be strict and at the same time flexible enough to allow more presence of new entrants on the tower market.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Effects of infrastructure sharing are: improved quality of service offered to customers, quick network roll-out and network expansion for both incumbent and potential players, increased capacity and presence of the service provider in geographical areas, and development of new incentives offered at a low price, and offered to customers to retain their own customers' base and gain more.

Reduced capital and operation costs are the most important driver for both incumbent MNOs and new entrants. MNOs would not open a resource of strategic importance if they did not have high financial expectations. Reduction of costs is a more important driver at the beginning of network deployment than it is when the market matures because the level of costs is much higher at the beginning of the network deployment. Additional revenue sources become more important for the infrastructure provider as the network matures.

Quick roll-out of network expansion for new entrants and those seeking to expand their coverage base is the second most important driver of infrastructure sharing. In the early phases of network roll-out, tower sharing is the most common model of infrastructure sharing in Zambia, which allows for a quick roll-out of networks at a lower cost. As the networks mature, as is the case for MTN and Airtel Zambia, their focus shifts from deployment to service innovation. Reduction of capital expenditure and operational costs becomes a priority so that the institutions optimize profits and revenues.

The benefit of infrastructure sharing for the MNOs is that the costs saved from this involvement can be used to pursue other ventures such as relocation of their capacities and capital into the development of their core businesses such as improved innovations with services offered. This is important for mature players in the telecom industry where their core business is well established or has plans to have their core business to be established. The benefits for the tower companies come with financial rewards they derive for as long as the contract states with the receiver.

To reduce costs to a greater deal, mobile operators can adopt the radio access network-sharing model, which allows the sharing of radio equipment, masts, site compounds, and backhaul equipment. This will result in the reduction of duplication of active equipment and operating costs.

Overall, infrastructure sharing and tower acquisition in Zambia look promising. However, the success of these initiatives is also closely associated with meeting the required technical standards as specified in the contracts.

6.2 Recommendation

Future research could be focused on Zamtel and its decision to not sale towers and the effects thereof. The findings in this research can be used as a starting point to investigate the effects the non-sharing MNOs will have if they decide to retain the infrastructure. Future research could also focus on dispute handling among MNOs who share the passive infrastructure. Dispute handling is a sensitive issue and must be handled in a way that promotes competition among the MNOs.

This research found that all MNOs who share infrastructure go through a tower company, HIS Towers. Further research can be carried out to investigate the methods used to handle the conflicts that may arise, and whether the regulator, ZICTA, plays a vital role in the dispute handling. Lastly, further research can be done to examine the extent of the effects on the relations among the players in the market when one tower company shares passive infrastructure.

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APPENDICES

Appendix 1: Questionnaire.

Questionnaire – Tower Sharing

We are carrying out a research on tower sharing in Zambia and how it has effectively achieved its goal of reducing operational cost and giving access to the remote areas in the country. Thank you for taking the time to fill in this questionnaire; it should only take 10 minutes.

Your answers will be treated with complete confidentiality, and unless you choose to provide an e-mail address, will be entirely anonymous. If you have any questions about this questionnaire, please contact [lusungue@gmail.com].

Respondents organization or email: _____

Section A: Tick Appropriate answer(s)

7. Type of towers mostly used/shared.
    - ☐ Monopole: single tube tower, 30-60 m.
    - ☐ Guyed: rods supported by a lot of wires attached to the ground.
    - ☐ Self-Supporting: free-standing tower lattice towers
    - ☐ Other (Please specify)
2. Towers mainly used for? (you're free to tick more than 1.)
    - ☐ Radio
    - ☐ Television
    - ☐ Telephony
    - ☐ Mobile Data
    - ☐ Other (Please Specify)
3. Common radius covered by towers that you use/share.
    - ☐ More than 10Km
    - ☐ 2 to 10 Km
    - ☐ 200m to 2Km
    - ☐ Less than 200m
    - ☐ Other (Please specify)

      _____
4. Type of tower-sharing models used;
    - ☐ Site Sharing: operators share the same physical compound only.

- ☐ Tower (Mast) Sharing: sharing the same mast, antenna frame or rooftop only.
- ☐ Radio Access Network sharing: sharing Radio equipment, masts, site compounds, and backhaul equipment only.
- ☐ Network Roaming: sharing traffic and routing on same network.
- ☐ Core Network Sharing: sharing Core Ring and Core Network Logical Entities

5. Main reason for sharing of towers;
   - ☐ Reduction of Capital expenditure (CAPEX) and Operational Expenditure (OPEX).
   - ☐ Imposed by the regulator.
   - ☐ Quick roll-out to areas with no network coverage.
   - ☐ Other

     _____
     __
6. Market structure existing in **tower sharing** industry;
   - ☐ oligopoly: several tower operators share standardized facilities and have some control over the prices.
   - ☐ Monopoly: single tower operator controls tower facilities and has control over supply and prices.
   - ☐ Perfect Competition: no single tower operator is dominant to influence pricing of facilities.
   - ☐ Other (Please specify)

     _____
7. Limiting factor(s) for new entrants on the mobile telecom market
   - ☐ Cost of set up
   - ☐ Lack of Spectrum
   - ☐ Mobile license is not easy to obtain.
   - ☐ Lack of investors.
   - ☐ Other (Please specify)

     _____
8. Limiting factor(s) for new entrants on the **tower market**;
   - ☐ Operation cost
   - ☐ Maintenance cost
   - ☐ Cost of set up
   - ☐ Lack of investors
   - ☐ Other

     _____
9. Tower sharing with other operators is through;
   - ☐ Operator-to-operator
   - ☐ Third-party
   - ☐ Joint Venture
   - ☐ Grant of rights
   - ☐ Other (Please specify)

     _____
10. Factors leading to the selection of tower operator in a certain location;
    - ☐ Renting charges,

☐ Only tower operator in certain areas
☐ Already have an agreement
☐ Other
_____

Section B: Tick Appropriate answer.

S/N	Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
11	Tower sharing will encourage competition					
12	Tower sharing reduces cost of service pricing;					
13	Tower sharing activities require the regulators participation.					
14	Regulator owning towers encourages competition;					
15	Regulator imposes tower sharing tariffs					
16	Easy for new entrants to enter an agreement with tower operators.					
17	Potential for Tower ownership business in Zambia.					

18	Tower ownership by third-party owners encourages competition.					
19	Tower ownership by third-party owners reduces cost					
20	Sharing resources lowers costs and generates revenue					
21	Sharing enables new entrants' firms to launch and market their services faster					
22	Sharing infrastructure is an efficient way of utilizing scarce resources					
23	Sharing enables operators to focus on core business / innovations					
24	Sharing preserves our environment due to					

	reduced electronic waste					
25	Sharing increases coverage and access to services					
26	Sharing improves network reliability by use of redundancy routes					
27	Infrastructure sharing promotes cooperation among competitors					
28	Sharing may hinder competition due to reduced control and interdependence					
29	Sharing infrastructure exposes too many risks, e.g., market share loss & security threats					
31	Operators are sometimes unwilling to share due to limited or lack of capacity					
32	Operators maybe unwilling to share due to incompatibility of different technologies					
33	High charges by infrastructure owners is hindrance to infrastructure sharing					
34	Lack of regulatory & policy framework is barrier to infrastructure sharing					

35	High capital requirements are a big barrier in infrastructure sharing					
36	High contractual exit costs arising from breach of contract is a barrier to infrastructure sharing					
37	Dominant operators fear of market share loss is a hindrance to infrastructure sharing					
38	New technologies reduce capital and operational expenses					
39	Invest in new technologies as a competitive advantage					
39	New market entrants are more likely to adopt sharing					
40	Current ICT infrastructure influences sharing					
41	A decline in economic performance increases sharing adoption					
42	Stiff competition forces operators to adopt infrastructure sharing					

Interview Questions

These are the questions that were asked;

ZICTA:

1. What is the role of ZICTA in infrastructure sharing?
2. Is infrastructure sharing encouraged by the regulator?
3. Are the tasks the regulator is trying to achieve in question 1 achievable, or have they been achieved thus far?
4. Have the number of disputes increased since the beginning of infrastructure sharing?

MNOs

1. Why did you build your own towers in the beginning?
2. What was the motivate behind the selling of towers?
3. How many towers were sold?
4. What type of agreement was used for sale?
5. What business do you use to share infrastructure?
6. Has quality of service improved since the sale of towers?
7. Has variety of services given to customers improved since the sale of towers?
8. Which tower company do you use if IHS is not in an area?

IHS Towers

1. What do you consider to be the drivers of infrastructure sharing in the telecommunication industry in Zambia?
2. What are the possible infrastructure sharing barriers of entry?

3. What are the number of towers currently being used/shared with MNOs with a breakdown in each province?
4. How effective has tower sharing been in bridging the digital divide; reaching the remote areas of the country and reducing the operation cost of their companies.
5. What are your views on ZICTA erecting towers? How does it affect the MNOs in the country?
6. What are the possible areas/topics would you advise the researcher to focus on regarding tower sharing?

Appendix 2: Response Distribution.

1= Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

Question	1	2	3	4	5	n	Agree %
11. Sharing infrastructure exposes too many risks, e.g., market share loss & security threats	7	23	4	8	6	48	80%
12. Sharing enables operators to focus on core business / innovations	23	18	2	2	3	48	80%
13. Dominant operators fear of market share loss is a hindrance to infrastructure sharing	4	11	7	17	9	48	40%
14. Sharing enables new entrants' firms to launch and market their services faster	26	20	0	0	2	48	100%
15. Tower sharing will encourage competition	29	12	3	4	0	48	87%
16. High charges by infrastructure owners is hindrance to infrastructure sharing	5	18	14	9	2	48	73%
17. High contractual exit costs arising from breach of contract is a barrier to infrastructure sharing	2	8	22	14	2	48	20%

18. Stiff competition forces operators to adopt infrastructure sharing	7	23	9	9	0	48	67%
19. Operators maybe unwilling to share due to incompatibility of different technologies	2	7	8	18	13	48	27%
20. Tower sharing require the regulators participation.	18	15	8	7	0	48	73%
21. Regulator owning towers encourages competition;	7	22	7	6	6	48	73%
22. Regulator imposes tower sharing tariffs	0	5	15	23	5	48	7%
23. New market entrants are more likely to adopt sharing	32	16	0	0	0	48	100%
24. Tower sharing reduces cost of service pricing;	12	23	6	5	2	48	73%
25. High capital requirements are a big barrier in infrastructure sharing	4	5	6	28	5	48	20%
26. Sharing preserves our environment due to reduced electronic waste	25	12	4	7	0	48	80%
27. Current ICT infrastructure influences sharing	6	30	10	2	0	48	93%
28. Potential for Tower ownership business in	6	23	14	3	2	48	60%

Zambia.							
29. Infrastructure sharing promotes cooperation among competitors	10	25	13	0	0	48	73%
30. Operators are sometimes unwilling to share due to limited or lack of capacity	5	28	9	6	0	48	73%
31. Lack of regulatory & policy framework is barrier to infrastructure sharing	2	16	16	12	2	48	53%
32. New technologies reduce capital and operational expenses	19	21	7	1	0	48	80%
33. Sharing may hinder competition due to reduced control and interdependence	4	14	15	11	4	48	47%
34. Sharing improves network reliability by use of redundancy routes	6	27	4	11	0	48	60%
35. Operators invest in new technologies as a competitive advantage	26	20	2	0	0	48	100%
36. Tower ownership by third-party owners reduces cost	10	26	9	3	0	48	80%
37. Easy for new entrants to enter into an agreement with tower operators.	19	26	2	1	0	48	87%

38. A decline in economic performance increases sharing adoption	13	29	6	0	0	48	80%
39. Sharing infrastructure is an efficient way of utilizing scarce resources	19	27	2	0	0	48	100%
40. Sharing increases coverage and access to services	19	14	13	2	0	48	60%
41. Tower ownership by third-party owners encourages competition.	12	18	15	3	0	48	80%
42. Sharing resources lowers costs and generates revenue	16	22	10	0	0	48	93%