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SCHOOL OF INFORMATION SCIENCE

ASSESSMENT OF ETHIO TELECOM READINESS TO DEPLOY 5G NETWORK TECHNOLOGY

A Thesis for

Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Systems

By: Amin Kemal

September 19, 2021

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented as a partial degree requirement for a degree in any other university and all sources of materials used in the thesis have been properly accredited.

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AMIN KEMAL

The thesis has been submitted for examination with my approval as university advisor.

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WORKSHEET LEMENAW (PhD)

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Abstract

Information and communication technology has taken as the significant factor for socio economic development of the world in all aspects and sectors. Today's world has undergone massive changes. The emergence of online and digital marketing, e-health, e-government and other different e-services connect people to mobile technologies. Mobile technology evolution begins with 1G in 1971 and now reaches 5G**.** Before deployment of any new technology readiness assessment should be made.

The aim of this study was to assess readiness level of Ethio telecom to deploy 5G network technology in the country. To achieve research objectives Bakry's (strategy, technology, organization, people, and environment) model was used by applying both quantitative and qualitative research approach. Data was collected through Likert scale based questionnaires and interview from 96 Ethio Telecom employees and 3 top level directors respectively. The demographic survey data was analyzed using SPSS version 25, and descriptive and analytical statistical reports for measurement model (reliability and validity of questionnaires) and structural model (significance test, R^2, path coefficient and T-statistics) were generated using Smart PLS 3.

The finding of the study from data analysis shows that readiness level of ethio telecom to deploy 5G network technology is ready in terms technology, strategy, human capital and organizational readiness but need improvements on environmental readiness.

Key Words: *Readiness, 5G ,4G,*

Chapter one

Introduction

1.1 Background of the study

Information and communication technology has taken as the significant factor for socio economic development of the world in all aspects and sectors. In recent years, the globe has drastically transformed. The emergence of online and digital marketing, e-health, e-government and other different e-services connect peoples to mobile technologies. Evolution of mobile network technologies goes back to 1971 in Finland where the first mobile network (pre-1G) begins. Early radiophones, on the other hand, were only available for military use and were not available for public or commercial usage. Afterwards first commercial 1G mobile network launched in Japan in 1979 and roll out to other countries such as USA in 1980's. Mobile network technology has advanced significantly since the 1980s.

We've seen fully analog systems with no data capability (1G), digital circuit-switched systems optimized for full-duplex communication and super voice telephony (2G), broadband and multimedia systems, and so on, decade after decade (3G). Due to rising demand, 4G technology was developed, providing us with ultra-high-speed internet connection. 5G will be able to provide us facilities that one has never experienced until date (Eluwole et al., 2018).1G designed as analog transmission that enable us to use only voice service while 2G provide a significantly improved voice quality and gave birth to the first data service offering in the evolution of the cellular networks (Eluwole et al., 2018).

In Ethiopia mobile network evolution start from 2G network as none of 1G mobile networks deployed. Globally, the first GSM call made in July 1991 in Finland and Ethiopia has launched first GSM mobile service in Addis Ababa in 1999 using Ericsson network (Haile et al., 2017). Later 3G mobile technologies developed since late 1990s by international standardization bodies. 3G supports a peak data rate of 384 kbps. Japan was the first country to launch commercial 3G mobile network in 2001 while 3G was introduced in Ethiopia six years later. With the objective to bring competitive mobile technology that address additional mobile capacity requirement and demand to have equivalent experience with wire line technologies, fourth generation (4G) Long

Term Evolution (LTE) has been developed by 3GPP in the late 2000s and its first standardization is ready in 3GPP release 8. LTE is a full IP technology that employs the multiple access techniques Orthogonal Frequency Division Multiple Access (OFDMA) in the downlink and Single Carrier FDMA in the uplink, and it is available in both FDD and TDD variants. The LTE release 8 baseline achieves a downlink peak data rate of 300 Mbps and an uplink peak data rate of 75 Mbps. The first 4G LTE data service was launched globally in Sweden in 2009, and it was introduced to the Ethiopian market in 2015(2017) (Haile et al.).

5G network technology is more advanced than previous network generations and will provide numerous benefits and advantages. 5G network technologies provide high resolution, advanced billing interfaces, and large data broadcasting in Gigabit that supports nearly 65,000 connections. According to survey conducted by GSM Intelligence in 2019, there have already been extensive 5G trials across the world; some 164 operators across 81 markets had undertaken trials as of the end of June 2019. Until the mid of 2020 many operators around the world make available commercial 5G network technology to their customers. As far as our day to day life activities are connected to mobile and internet we need extremely reliable communication and fast speed data so that we will able to use mobile technology for driverless cars, Internet of Thing(IoT), drones and others. As a result, 5G will provide extremely reliable communication, allow for even more concurrent users and units, and enable data speeds up to 100 times faster than the current 4G network. "In the near future, Ethiopia also plans to launch a 5G mobile network." (2019, Fana Broadcasting Corporation). The purpose of this study is to assess Ethio telecom readiness level to deploy 5G network technology.

1.2 Statement of the Problem

In today's world, telecommunication has important role in our daily activities. Various researcher suggested that as innovative mobile service and application is highly emerging and penetration of social media, mobile banking and multimedia, high definition video services including augmented reality, virtual reality and interactive high definition television (HD TV) is increasing from time to time huge data traffic will be issue in coming years. (J. G. Andrews, 2014). So, it is difficult to handle such huge data traffic with existing mobile technology. This suggest that we should have mobile technologies with higher capabilities that can handle huge data traffic. Ethio telecom has deployed 2G, 3G, 4G LTE and Advanced LTE mobile network generations in Ethiopia. 2G and 3G networks are everywhere in the country and 4G LTE is deployed everywhere in Addis Ababa Ethiopian's capital city but 4G LTE Advanced mobile network coverage are only restricted to selected area of country. However, there is still huge network traffic in the capital and all over the country as well(Haile et al., 2017).

"As a result mobile capacity enhancing technologies are currently being developed under 5G and trials are being undertaken by several operators. We believe similar mobile data traffic growth trend will be seen in the Ethiopian telecom market with small changes in economic factors" (Haile et al., 2017)). As presented by Haile (2017) Ethiopia should take step to strategic road on mobile capacity enhancing technology i.e. 5G as mobile data traffic usage and demand in Ethiopia is increasing. They also present empirical analysis of Ethiopian mobile usage particularly in Addis Ababa and suggest that there could be mobile capacity challenges in near future. As stated on European 5G readiness report each country's and company ability to deploy 5G mobile technology is depend on several economic, operational and social factors.

The researcher believes that there should be a clear and detail plan in place to introduce 5G network technology in Ethiopia to prevent and overcome mobile capacity challenges that will be arise in near future. 5G network technology goes beyond simply upgrading networks from one generation to the next because it believes it will change the world in a variety of ways, including making cities smart, having a smart grid, smart agriculture, remote surgery, fully connected homes, smart traffic, and so on. All of these Internet of Things applications will be fully realized once 5G network technology is in place. However, before proceeding with implementation, we should conduct a readiness assessment to determine how prepared we are in terms of technology and strategy readiness, skill requirements, organizational readiness, and environmental readiness. So, if we conduct a readiness assessment prior to implementation, we can easily identify areas for improvement and what needs to be changed before implementation.

Before deploying 5G network technologies, infrastructure and technology, regulation and policy innovation, landscape, human capital, country profile, and demand for specific technology should be evaluated appropriately and accurately to show that country or company's readiness level. The researcher looked at recent literatures on 5G readiness assessments to see what other academics have written on the topic, what knowledge gaps still exist, and what extra research is needed. The researcher identified that there is no any study done on 5G readiness assessment for

Ethiopian telecom market. Because every company's 5G readiness is unique and dependent on a country's social, economic, and technological capabilities, this study aims to address that gap.

1.3 Research Questions

This study answers the following questions.

- What is current readiness level of Ethio Telecom to introduce 5G network technology?
- What changes must be in place before introducing 5G network technology?

1.4 Objectives

The objective of the study has stated at two levels. The general objective and the specific objectives.

1.4.1 General Objective

The general objective of this study is to assess current readiness level of Ethio telecom to deploy 5G network technology.

1.4.2 Specific Objectives

Specific objectives of the study are the following:

- To identify methods that help to measure 5G network technology readiness
- To assess the Ethio telecom's general current IT status.
- To assess Ethio Telecom's current 5G network technology capabilities.
- To identify what changes must be in place before get on to 5G network technology.

1.5 Scope of the study

The scope of this study is to assess current readiness level of Ethio telecom to deploy 5G network technology in terms of technological strategies, people (skill required), organizational and environmental readiness and to identify what needs to change before deployment. Both quantitative and qualitative research approach and E-readiness assessment framework (STOPE) was used for this readiness assessment. The study is limited Ethio Telecom employees and didn't consider other stakeholders because of time and financial limitations. Data was collected using closed ended Likert scale based questionnaire item and semi structured interview. Smart PLS and SPSS version 25 are used to assess Structural and measurement model, and demographic data of respondents.

1.6 Significance of the study

Ethiopia is one of the fast growing country in Africa. Such growth can be seen from technology perspectives. Introducing new technology to the country help to attract foreign investment and tourists. However, before introducing such technology there could be readiness level assessment. The researcher believe that this study will help the country (Ethiopia) to prepare for new technology launch. In addition to the above significance conducting this research can also give the following benefits:

- It will help to identify which factors Ethiopia should take action to improve
- Help policy and regulation makers to update policies and regulations based on this research input
- Help Ethio telecom top management to put road map to 5G
- This research can be used as input for other researchers to study further
- Create awareness for stakeholders, vendors and users to make ready themselves for new technology i.e. 5G

1.7 Thesis Organization

The thesis is organized into five chapters. The first chapter presented the background to

the research, the research problem, the research objective, the research question, significance of the study and the scope of the study. The second chapter reviewed the related literature on network technology generations, 5G deployment models,5G application and challenges, and research model were presented. The third chapter presented the methodology of the study, i.e. the research approach, and the data collection and analysis procedures and techniques. In the fourth chapter data analysis and results of the study were presented. Finally, in the fifth chapter conclusions and recommendations were presented.

Chapter two

Literature review

Authors on the area of network technology explain 5G network technology in details. The future of 5G network technology is under discussion and research; however, ICT leading countries around the world such as China, USA, Japan and South Korea and some of European countries already implemented their first Commercial 5G network technology. 5G network technology stands for fifth generation mobile technology. 5G network technology enables to change of use mobile phones from low bandwidth to very high bandwidth. 5G network technology is a packet switched based wireless system with wide area coverage and high output. CDMA and BDMA, as well as millimeter wireless, are used in 5G network technologies, allowing seed speeds of more than 100Mbps at maximum mobility and more than 1Gbps at low mobility. 5G network technologies provide all kinds of innovative features that would make 5G technology more efficient and in remarkable demand in near future. It is not remarkable to integrate such a massive collection of technology into a small unit.

The new capabilities of 5G network technology will enable us to connect virtually everyone and everything together.5G is the extension of 1G, 2G, 3G and 4G networks. After emergence of 4G network experience of using broadband service with mobile devices has increased. However it is hard to provide mobile service that require high speed, rapid response, high reliability and energy efficiency (Yu et al., 2017).The primary invention of 5G network is focused on providing high speed, massive network capacity, and high reliability, increased availability, ultra-low latency, more reliability, rapid response, and energy efficiency.

2.1 Mobile Cellular Network Evolution

There has been incredible growth in the wireless industry over the last few years. User-centered networks have been promoted as a result of widespread wireless technology, a growing range of user-friendly and multimedia-enabled terminals, and increased availability of open source content development tools (Nascimento, Andrea, et al., 2013) resulting in a need for efficient network design. The gradual evolution of mobile generation starts from era of electrical telegraphy to modern internet based networks (Eluwole et al., 2018). The researchers compared and contrasted the evolution and development of different generations of mobile wireless technology based on technology, features, performance, advantages and disadvantages, and concluded that current research in mobile wireless technology is focused on advanced implementation of 4G and 5G technology (Akhilesh Kumar Pachauri, Ompal Singh, 2018).

Even though wireless telephone started with 0G or pre-1G, the first well-known and commercial era of mobile network generation is first Generation (1G) then followed by 2G, 3G, 4G and now 5G is on the way to finalize its evolution. The need of mobile network evolution comes from an advancement in technology such as invention of cloud computing, machine to machine, internet of things (IOT), increased human need, and need of more capabilities to handle increase number of mobile user and so on. Brief description of every mobile cellular networks generation with feature one over the others discussed.

2.1. 1 1G Technology

The term "1G" refers to a first-generation mobile cellular network. The first 1G network with analog system introduced in Japan, Tokyo by Nippon telegraph and telephone in 1979. The first 1G operations were approved in the United States in 1983, and Motorola's DynaTAC was one of the first mobile phones to see widespread use in the United States. Other countries such as Canada and the UK rolled out their own 1G networks a few years later.

It employs an analog radio signal with a frequency of 150 MHz, and only voice calls are modulated using a technique known as Frequency-Division Multiple Access (FDMA) (Patil, 2020). There were many drawbacks in 1G cellular network such as poor coverage, low sound quality, there was no roaming support, no compatibility between systems, and no call encryption method, frequent call drop and limited number of subscribers. Even though 1G cellular network was widely used, it is only for voice communication. 1G network can support 2kbps to 2.4kbps peak data rates. The success of 1G put concrete way for the second generation, appropriately called 2G.

2.1.2 2G Technology

In 1991, the second generation of mobile networks, or 2G introduced in Finland under the GSM standard. Ethiopia has launched its GSM mobile service in Addis Ababa in 1999 using Ericsson network and 2G is the first mobile network technology in the country (Haile et al., 2017). 2G mobile network is a wireless mobile network technology emerged after 1G network to improve the drawbacks of first generation network. Calls could have encrypted for the first time, and with less static and noise crackling, automated voice calls were considerably clearer.

Second-generation network comes up with digital radio signal that enable mobile system communication to provide secure and reliable communication channel. 2G employs multiple access schemes such as frequency division multiple access (FDMA), time division multiple access (TDMA), and code division multiple access (CDMA) to deliver services such as text messages, picture messages, and multimedia services (MMS). 2G can support data service up to 64kps.

Continuous improvement in GSM technology lead to development of new original GSM system based technologies such as 2.5G General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE). 2.5G is an extension of 2G and uses packet based services while GSM uses circuit switching. It can support data rates up to 384kbps. WAP, MMS, SMS mobile games, search directory, and internet access are all supported by 2.5G networks. Regardless of relatively slow speeds, 2G transformed the business landscape and changed the world forever.

2.1.3 3G Technology

3G refer to third generation mobile cellular networks. Japan was the first country to launch commercial 3G mobile network in 2001 with high reliability and high speed data transfer (Vunnam et al., 2019) and it is introduced in Ethiopia six years later. The 3G standard utilizes Universal Mobile Telecommunications System (UMTS) as its core network architecture. The 3G network combines aspects of the 2G network with new technologies and protocols to provide a significantly faster data rate (4 times faster than 2G). This has also resulted in the rise of new services such as video conferencing, video streaming, and voice over IP (such as Skype).

3G established the foundation for much of the wireless technology we now know and love.In the third generation, Smartphone technology such as web browsing, email, video downloading, picture sharing, and other features were introduced. HSPA+ has a theoretical maximum speed of 21.6 Mbps.

As with 2G, 3G evolved into 3.5G and 3.75G as more features were added to bring about 4G. 3G phone cannot communicate with a 4G network, but newer generations of phones are practically backward compatible, so a 4G phone can communicate with a 3G or even a 2G network.

The 3G network outperformed the 2G network in the following ways: -

- It supports greater voice and data capacity as well as high data transmission at a low cost.

- 3G mobile phones can use both 2G and 3G technologies.

- Network Access Security, Network Domain Security, User Domain Security, and Application Security are all more advanced in 3G than in 2G.

- Offers localized services for accessing traffic and weather information.

- Video calls and video conferences are supported.

"The evolution from UMTS through high speed packet access (HSPA) and evolved HSPA (HSPA+) further provided significantly enhanced end-to-end network performance and eventually led to the development of the next generation of networks i.e. 4G" (Eluwole et al., 2018).

2.1.4 4G Technology

The term 4G stands for fourth generation mobile cellular communication technology. Globally, first 4G LTE data service made available in 2009 in Sweden and it is introduced to the Ethiopian telecom market in 2015 (Haile et al., 2017) . At the beginning of 2020 GC advanced version of 4G LTE (LTE Advanced) was introduced and deployed in part of Addis Ababa city. Until the end of 2020 G.C, 4G LTE network coverage is limited to Addis Ababa and part of surrounding Oromia special zones. However, ethio telecom has strategic plan to expand 4G LTE network coverage to major regional cities in near future.

With the objective to bring competitive mobile technology that, address additional mobile capacity requirement and demand to have equivalent experience with wire line technologies. Fourth generation (4G) Long Term Evolution (LTE) has been developed by 3GPP in the late 2000s and its first standardization is ready in 3GPP release 8. It was first used as the Long Term Evolution (LTE) 4G standard in Sweden and Norway in 2009.

LTE technology was later introduced around the world, making high-quality video streaming a reality for millions of consumers. Different cellular providers use a variety of 4G mobile technology standards to meet 4G requirements, including LTE (pre- 4G), LTE-advanced, WiMAX, and ultra-mobile broadband (UMB).

LTE is a full IP technology that employs the multiple access techniques orthogonal frequency division multiple access (OFDMA) in the downlink and single carrier FDMA in the uplink, and it is available in both FDD and TDD versions. The baseline LTE release 8 achieves a peak data rate of 300 Mbps in downlink and 75 Mbps in uplink. LTE networks can provide high quality video experience to only limited number of user's simultaneously.

2.1.5 5G Technology

5G is the fifth generation mobile cellular network technologies. 5G mobile networks are the next step beyond 4G LTE networks, with faster speeds, more bandwidth, and a greater range than previous networks. According to Yu (2017), the major megatrends that drove the adoption of 5G services include the inability of existing 4G technology to handle large numbers of users concurrently, knowledge as a service enabled by big data analysis, a rapid increase in connected devices, everything on the cloud, hyper-realistic media for convergence services, an explosion in mobile data traffic, and the Internet of Things. (Yu et al., 2017). 5G is targeted to resolve those incongruous demands. Until the end of 2020 several countries have commercial 5G services but is limited to few number of operators and subscribers. USA, China, Japan and South Korea are leading countries in 5G related research, innovation and deployments.

According to de Lopper Christian (March 27, 2020), in telecommunications 5G is aimed as a successor to fourth generation networks and standard for broadband cellular networks which provide connectivity to most current cell phones. In coming four years 5G networks are predicted to have more than 1.7 billion subscribers worldwide. 5G networks are cellular networks that divide the service area into small geographical areas known as cells. To connect to the Internet and telephone networks via radio waves, all 5G-enabled wireless devices use a local antenna in the cell. The main advantage of the new networks is that they will have more bandwidth, allowing for faster download speeds of up to 10 gigabits per second. (de Looper Christian, March 27, 2020).

The fastest speed of 5G networks are likely to be at least 10 times faster than 4G,not only speed data transmission rate , efficiency, capacity, and types of multimedia support, voice streaming of 5G network is better than that of 4G networks.5G services are beyond personnel communication it covers societal level communication including robots, sensors, actuators, vehicles and different types of mobile phones(Yu et al., 2017). Because of the increased bandwidth, it is anticipated that the networks will not only serve cell phones, as current cellular networks do, but will also be used as general internet service providers for laptops and desktop computers, competing with existing internet service providers. The new networks, which require 5G enabled wireless devices, are inaccessible to 4G cell phones.

All 5G-enabled wireless devices in a cell communicate over radio waves with a local antenna array and low power automated transceiver (transmitter and receiver) in the cell, using frequency channels assigned by the transceiver from a pool of frequencies reused in other cells. The connections to local antennas is via either high-bandwidth optical fiber or microwaves that allows antennas to connect to internet and with the telephone network. The mechanism to control mobile device during crossing from one cell to another is the same as in previous cell network which is handled automatically. A single 5G network antenna is expected to support up to a million devices per square kilometer, whereas a 4G network can only support up to 100,000 connections per square kilometer (Shatrughan Singh March 16, 2018) and (Forum, C. L. X. June 13, 2019). The new 5G wireless devices also have 4G LTE capabilities, as the new networks use 4G to establish the initial connection with the cell and in areas where 5G access is not available (Segan, Sascha December 14, 2018).

Speed

Dolcourt and Jessica (2020), stated that 5G speeds will range from 50 Mbits to over gigabits. millimeter Wave(mmWave) is identified as the fastest 5G network technology. As of July 3, 2019, mmWave had a top speed of 1.8 Gbit/s on AT&T's 5G network. Dolcourt, Jessica (2020) also explained the speed of Sub-6 GHz 5G (mid-band 5G), by far the most common, will usually deliver between 100 and 400 Mbit/s, but will have a much farther reach than mmWave, especially outdoors. The use of low band helps operators to cover greater range, coverage area for site but, in terms of speed slower than the others.

Another scholar, Dave (2018), compared existing 4G radio with that of 5 NR (New Radio). His comparison revealed that 5G NR speed in sub-6 GHz bands can be slightly higher than 4G with a comparable amount of spectrum and antennas, although some 3GPP 5G networks will be slower than some advanced 4G networks, only achieving up to 500Mb/s. LAA (License Assisted Access) is also supported by the 5G specification, but it has yet to be demonstrated. Adding LAA to an existing 4G configuration can boost speed by hundreds of megabits per second, but this is a

4G extension, not a new 5G standard. In addition to the aforementioned author, Saracco, Roberto (2019), explains the speed by comparing it to a 4G network. In the current bands, the similarity in throughput between 4G and 5G is due to 4G having reached the Shannon limit for data communication speeds.5G rates in the less popular millimeter wave spectrum can be significantly higher due to its much greater bandwidth and shorter range, and thus greater frequency re-usability.

Error Rate

In 5G networks, adaptive signal coding is used to keep the bit error rate low. If the error rate is high, the transmitter will automatically switch to a less error-prone coding system. This is done at the expense of bandwidth in order to ensure a low error rate.

Range

The range of a 5G network is determined by a number of factors, the most important of which is the frequency used.

Millimeter wave signals typically have a range of only a few hundred meters, whereas low band signals can theoretically have a range of several hundred kilometers under the right conditions.

Standards

The term was initially associated with the International Telecommunication Union's (ITU) IMT-2020 standard, which required, among other specifications, at a theoretical stage 5G NR to have peak download and upload speeds of 20 gigabits per second and 10 gigabits per second, respectively. The commercial standards organization 3GPP then proposed the 5G NR (New Radio) standard, along with LTE, to the IMT-2020 standard (Flynn, Kevin 2019).

The first phase of 3GPP 5G specifications in Release-15 is expected to be completed in 2019.

The second phase of Release-16 is expected to be completed in 2020. Lower frequencies (FR1) less than 6 GHz and higher frequencies (FR2) greater than 24 GHz are possible in 5G NR.

However, in early FR1 deployments using 5G NR software on 4G hardware (non-standalone), speed and latency are only marginally better than new 4G systems, estimated to be 15 to 50% better (Teral, Stephane January 30, 2019) and (Dave 2018). IEEE covers a variety of 5G topics, with a primary emphasis on wire line sections between the Remote Radio Head (RRH) and Base Band Unit (BBU) (BBU). The 1914.1 standards are concerned with network architecture and the division of the connection between the RRU and the BBU into two major sections. The NGFI-I (Next Generation Front haul Interface) from the Radio Unit (RU) to the Distributor Unit (DU) and the DU to the Central Unit (CU) interfaces allow for a more diverse and cost-effective network. NGFI-NGFI-II and I have defined performance values that should be compiled to ensure that different ITU traffic types can be carried. Depending on the functional split used, the 1914.3 standard is developing a new Ethernet frame format capable of carrying IQ data in a much more efficient manner. This is in accordance with the 3GPP definition of functional splits. Several network synchronization standards within the IEEE groups are being revised to ensure that network timing accuracy at the RU is maintained to the level required for the traffic carried over it.

2.2 5G Network Architecture

It is clear that the network's multiple access techniques are almost at a standstill and require a drastic change to consider the 5G network on the market now. Current innovations, such as OFDMA, will be operational for at least the next 50 years. Furthermore, there is no need to change the wireless configuration from 1G to 4G. Alternatively, simply adding an application or improving the fundamental network to meet user needs could suffice. This will compel package providers to opt for a 5G network as soon as a 4G network is commercially available (C.-X. Wang et al. 2014). The architecture of a 5G wireless cellular network consists of only two logical layers: a radio network and a network cloud. The radio network is made up of various types of components that perform various functions. The network function virtualization (NFV) cloud is made up of two entities: A User plane entity (UPE) and a Control plane entity (CPE), which perform higher layer functions related to the User and Control planes, respectively. Special network functionality as a service (XaaS) will provide services as needed; one example is resource pooling. The connection between a radio network and a network cloud is known as XaaS (A. Benjebbour, P. Agyapong, M. Iwamura, D. Staehle, W. Kiess, and P. Agyapong, 2014). The physical components of a generalized 5G architecture are as follows:

1. Radio Access Network (RAN).

The wireless network component is what connects mobile devices. As the Radio Access Network for 5G networks, 5G New Radio (NR) is used. 5G NR (New Radio), according to Sacha Kavanagh (2020), is a new radio access technology (RAT) developed by 3GPP for the 5G (fifth generation) mobile network. It is intended to be the global standard for 5G network air interfaces. The 5G NR (New Radio) air interface is a new air interface developed for the 5G network. It is intended to be the global standard for 3GPP 5G network air interfaces.

2. Evolved Packet Core (EPC).

This is the core part of the mobile network and serves as the bridge between the RAN and the Internet or other IP-based services.

3. IP Multimedia Subsystem (IMS).

Most people associate this with the Voice over LTE (VoLTE) component, but it is intended to be more general. The IMS's purpose is to provide IP application services within the mobile network infrastructure, whether it's voice over IP or another IP-based communications service. According to (V. Chandrasekhar, J. G. Andrews and A. Gatherer, (2008)), to meet the demands of the user and to overcome the challenge that has put forward in the 5G system, a drastic change in the strategy of designing the 5G wireless cellular architecture needed. According to the researchers' general observations, most wireless users spend about 80% of their time indoors and 20% of their time outside. In the new wireless cellular architecture, an outside base station in the center of a cell aids in connectivity, allowing a mobile user to communicate whether inside or outside. As a result, in order for indoor users to connect to the outdoor base station, the signals must pass through the indoor walls, resulting in very high penetration losses and decreased spectral quality, data rate, and wireless communication energy efficiency. To overcome this challenge, a new idea or design technique for planning the 5G cellular architecture has emerged: distinguishing between outside and inside setups (C.-X. Wang et al. 2014). The penetration loss through the building's walls was reduced slightly by using this design technique. This concept is supported by massive MIMO technology (F. Rusek, 2013). In which a geographically dispersed array of antennas with tens or hundreds of antenna units is deployed. Since current MIMO systems use two or four antennas, the concept of massive MIMO systems has come up with the idea of utilizing the advantages of large array antenna elements in terms of huge data transmission.

2.3 5G deployment models

Although several 5G configurations have been proposed, two deployment models have been standardized to meet initial market requirements. The 5G deployment models are Non-standalone (NSA) and Standalone (SA). Different operators will have different methodologies for when and how to deploy 5G with these (GSMA, 2019). 5G NR is intended to be compatible with and interoperable with existing 4G network radio and core systems. A full 5G system deployment, involving new radio access technology and a new core network architecture, will necessitate new investment cases, and market readiness will be critical in making these decisions.

Non-standalone (NSA): - where the device is able to connect simultaneously to the 4G radio network and the NR. NR connected to 4G core network and controlled by existing core network. This configuration is most suitable for providing enhanced mobile broadband services. The 4G Radio and access networks will need upgrades to support 5G NSA.

Standalone (SA): - SA requires operators to deploy a completely new core network. SA is deployment method where the NR capable device connects to one radio access technology at any given time. During SA deployment scenario, NR connects to the 5G core only and standalone 5G system interworks at core network level with legacy 4G system. SA 5G configuration allows operators to fully exploit the features of NR as well as the capabilities of the new core network architecture

Spectrum in the 5G era

36 spectrum bands have been approved by 3GPP. These are sub-1GHz; 1GHz to 6GHz; and above 24GHz bands.it also paves the way the operators reframe their existing 2G/3G/4G spectrum for 5G use.

2.4 5G Applications

Mobile networking advancements have resulted in a plethora of diverse applications, such as smart mobility, digital banking, social networking, and health care, to improve end users' quality of life. Mobile apps are, in a broader sense, part of Internet networks, which have grown rapidly in recent decades. These new applications highlight the need for a network with ultra-low latency, high capacity, reliability, and security. Many of these applications are also context-aware, meaning that the context is sensed for triggering actions, for example, smart phones are now aware if the owner is driving and can avoid interrupting the driver (Shishkov et al. 2018).

2.5 5G challenges

According to the researchers Rampa, V.; Savazzi, S.; Malandrino, F (2019), each industry deployment must consider multiple constraints and identify a solution that will deliver an optimal solution to meet the end-user or corporate need.

The following are the primary barriers to 5G industry adoption:

1. Cost: The manufacturing industry has strict cost-cutting requirements and will only implement new applications if they have been shown to reduce costs in the long run.

2. Safety: on a factory floor, hundreds of interconnected automated devices can create a hazardous environment for humans.

3. Knowledge of deployment: Many small and medium-sized enterprises (SMEs) lack the resources to resource the learning requirements or the technical ability to capitalize on the potentials of 5G.

4. Radio Frequency Interference: Several objects on the factory floor are already communicating via radio waves.

2.6 Theoretical Frameworks

Researchers used a variety of approaches and models to assess the e-readiness of specific countries or organizations based on their scope. The most commonly used models are the "TAM" (Technology Acceptance Model), the "TOE" (Technology, Organization, and Environment) framework, the "Diffusion of Innovation (DOI) Theory," and the "STOPE" (Strategy, Technology, Organization, People, and Environment) framework.

2.6.1 Technology acceptance model (TAM)

Davis (1985) developed the TAM model, which has been used to explain individual acceptance behavior. TAM, according to Agrawal, is one of the most widely used research models for determining the level of IS/IT acceptance. In TAM models, two primary factors influence an individual's intention to use new technology: perceived ease of use and perceived usefulness. TAM has been criticized on several grounds, but it serves as a useful general framework and is consistent with a number of studies into the factors that influence older adults' willingness to use new technology (Braun, 2013).

2.6.2 Diffusion of Innovation (DOI) Theory

The Diffusion of Innovation (DOI) Theory, developed by E.M. Rogers in 1962, was one of the first social science theories. Rogers' diffusion of innovations theory, according to (Ismail, 2006), is the most appropriate for investigating the adoption of technology in higher education and educational environments. Rogers' diffusion of innovations theory includes four basic elements: innovation, communication channels, time, and social systems.

Innovation

Rogers defined innovation as "an idea, practice, or project that an individual or other unit of adoption perceives as novel." An innovation may have been invented a long time ago, but if people perceive it as new, it may still be considered an innovation. The novelty of an adoption is more closely related to the three steps of the innovation-decision process (knowledge, persuasion, and decision) (Ismail, 2006).

Communication channels

Distributing or disseminating information about an innovation viewed as a social and dynamic process within DOI theory. Different methods of communication are effective at different times in the adoption process (Scott & McGuire, 2017)

Time

Time is necessary for innovations to adopted; they are rarely adopted instantaneously. According to Rogers (2003), the time aspect ignored in most behavioral research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension.

Social System

Social system is the last elements in Diffusion of Innovation theory. Rogers (2003) defined the social system as "a set of interrelated units engaged in joint problem solving to accomplish a common goal". Diffusion of an innovation occurs within a social system comprised of members who share a common objective such as individuals, informal groups, subgroups, or professional organizations(Scott & McGuire, 2017).

2.6.3 STOPE Approach

Bakry (2004) creates the STOPE framework. According to Bakry (2001, 2003, 2004, and 2005), the STOPE (Strategy, Technology, Organization, People, and Environment) framework was developed and used to evaluate various ICT problems, such as e-business and e-government planning, information security management, and emerging enterprise resource planning tools (Al-Osaimi et al., 2006). The integration of e-readiness assessment factors includes five major domains: "strategy," "technology," "organization," "people," and "environment". Each domain contains sub-domains, which are the main issues branching from each of the main STOPE domains, and each sub-domain contains sub-subdomains, which are the issues associated with each of the main domain's sub-domains. The STOPE model can be used to evaluate the country or organizational readiness and may vary according to the type of organization being evaluated.

Strategy

The domain of "strategy" incorporates the elements concerned with "future directions, commitments, and plans toward ICT development and utilization." The strategy domain is divided into two subdomains: "leadership" and "future development plans."

Leadership sub-domain dealt with issues like vision toward ICT, government support and commitment, and ICT manager's responsibilities whereas *future development plans* includes the future ICT, organization, HR and non ICT plan.

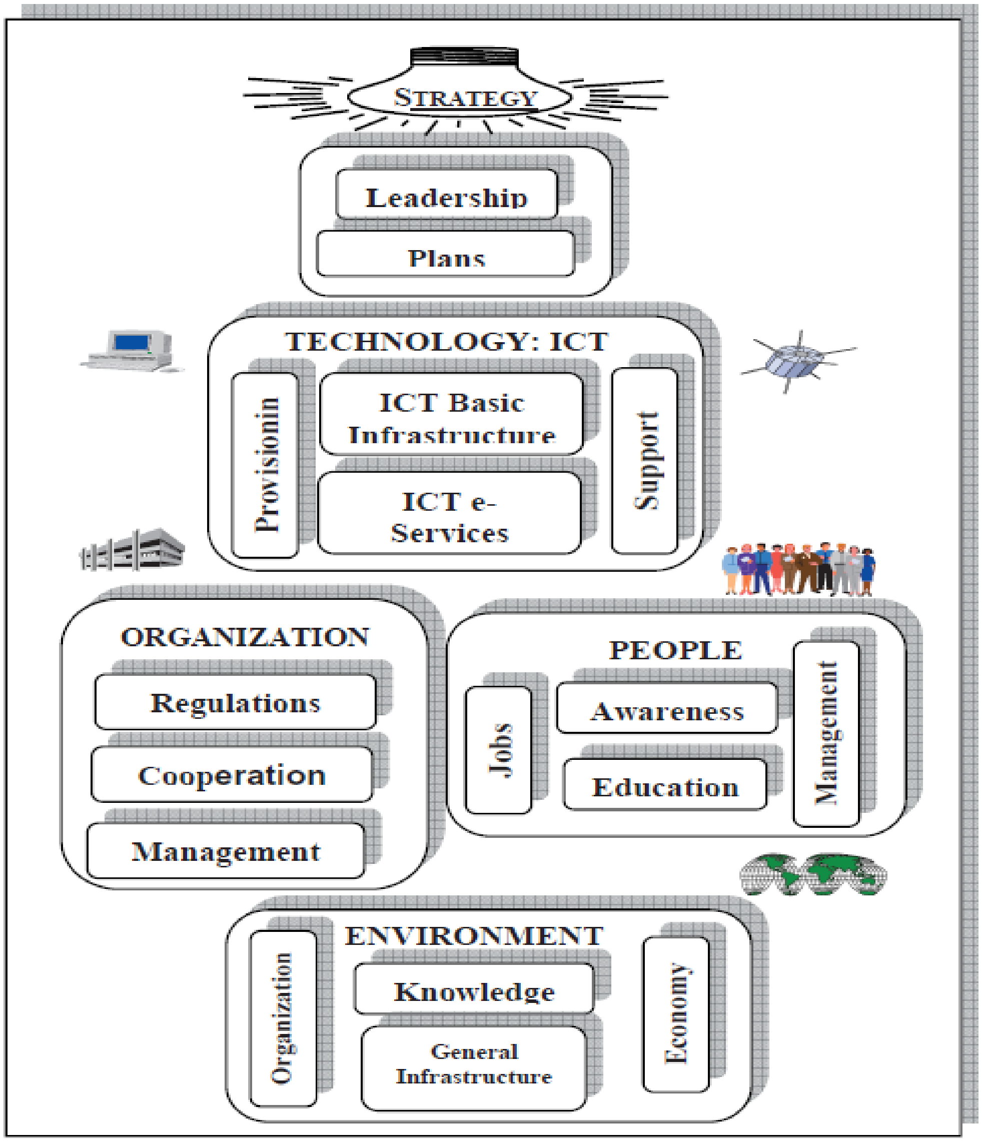


Figure 1:The STOPE framework for e-readiness assessment (source:(Al-Osaimi et al., 2006)

Technology

The “technology” domain incorporates factors pertaining to the “current state of issues pertaining to ICT facilities.” This domain is thought to be associated with four sub-domains: "ICT basic information infrastructure," "ICT e-services infrastructure," "ICT provisioning," and "ICT support."

ICT basic information infrastructure includes issues like Availability of ICT infrastructures and tools and their performance. *ICT e-services infrastructure* measures government and business organizations e-services. Another sub-sub domain associated under technology domain is ICT provisioning of products/markets and product performance. The forth sub-sub domain is *ICT support* that is availability and use of standards and availability of operation maintenance

Organization

The domain "organization" incorporates factors related to the "current state of issues concerning ICT regulations and management." This domain is thought to be associated with three subdomains: "ICT government regulations," "ICT cooperation among organizations," and "ICT management." Sub-sub domains associated with organizations includes basic ICT regulations, ICT business regulation, internet service regulation, e-business service regulations, and knowledge sharing for innovation, partnerships, ICT management quality, evaluation measures and change.

People

The "people" domain incorporates factors related to the "current state of issues concerning ICT users and skills." The domain is thought to be divided into four sub-domains: "ICT awareness," "ICT education and training," "ICT qualifications and jobs," and "management of ICT skills." Internet use, adaptability to ICT change, educational system support, and media supports are sub-sub domains associated with ICT awareness. ICT qualification and e-education/learning are two sub-sub domains of ICT education and training whereas ICT jobs and skills falls under ICT qualification and jobs domain. Management of ICT skills includes performance satisfaction ICT skills.

Environment

The "environment" domain incorporates factors related to the "current state of basic non-ICT issues surrounding and affecting the current state of ICT." The domain is divided into four subdomains: "knowledge," "resources and the economy," "organization," which includes general regulations, cooperation, and management, and the fundamental "non-ICT infrastructure." Knowledge (culture, education and training), resources and the economy, organization including general regulations, cooperation and management, Non-ICT infrastructure (basic services like electricity, transportation, postal system and health care).

2.7 Research Model

2.7.1 Readiness Assessment

E-readiness assessment goes beyond determining a country's or organization's current state because it promotes the start of long-term development in ICT. "e-readiness assessments are meant to guide development efforts by providing benchmarks for comparison and gauging progress," according to the United Nations Development Program (UNDP), as cited by Sergey (2004) Ruth 2017) also defines readiness assessment as the act of assessing how ready your organization is for a major change. The main of goal of readiness assessment is to help an organization or a country prevent themselves from challenges that may occurs after any change to their systems. This study uses STOPE model along with other methods for the assessment of ethio telecom readiness to implement 5G network technologies. As discussed earlier in chapter two TAM model is best to assess individual's acceptance behavior where DOI theory is most appropriate for investigating the adoption of technology.

However, the STOPE model is a powerful choice for assessing the readiness level of a specific country or organization because it incorporates five basic dimensions (strategy, technology, organization, people, and environment) that allow the researcher to assess the readiness level of any organization from various perspectives. Furthermore, it is flexible and allows the researcher to pool the constructs that needs empirical investigation. Furthermore, STOPE model was selected for two major reasons. The first reason is its *comprehensiveness*. STOPE model includes five different perspective domains where existing and potential issues are accommodated. The second is *modularity*, where these issues are well categorized and organized for each precise domain. The STOPE model's comprehensiveness and modularity make it easier to manage difficulties by incorporating them into a well-structured wide-scope framework, combining interrelated concerns, and allowing for flexibility in their deeper study (Kumar et al., 2018).

Al-Osaimi (2006 & 2008) employed the STOPE framework in their work for "E-readiness assessment," Saleh (2005) for "E-Business," and Bakry (2004) for "E-Government ISO 17799: 2005." (Kumar et al., 2018). For this study, the researcher identifies several factors based on STOPE model that enables the researcher to measure the readiness of ethio telecom to implement 5G network technology from strategic, technological, organizational, people and environmental dimensions based on existing literatures. Theoretical Framework of this Study developed using STOPE is present in figure 2.

2.7.2 Strategy readiness

To any business organizations, it is necessary to have corporate ICT strategy that reflects business aims and objectives. Cho (2017) stated that strategies are need to establish together with goals that aligned with the vision and objective of an organization. Strategy domain incorporates the constructs concerned with future guidelines, commitments and plans toward ICT development and utilization. Under strategy domain leadership and ICT development plans are essential construct that help to achieve study aims. Leadership and ICT development plans integrates government support, vision, commitment and government ICT regulations. So this have direct impact on implementation of new telecom technology. Based on this the following hypothesis is developed.

Hypothesis 1: Deploying 5G network technologies is affected by strategy readiness.

2.7.3 Technological readiness

Technology readiness is the most pivotal factor for 5G and maturity level of particular technology. Availability and performance of basic ICT infrastructures (hardware, high-speed lines), e-service infrastructures, availably and use of standards both national and international, ICT provision and support are factors identified to measure technology readiness. E-government ICT infrastructure possibly will include some technologies with a network infrastructure at its origin; containing servers, application servers, storage devices and other network infrastructures (IBM, 2011,Macasio,2009(Alghamdi et al., 2011)).

Hypothesis 2: Deploying 5G network technologies is affected by technological readiness.

2.7.4 Organizational readiness

Experts in the area of change management underscored the importance of preparing organizational readiness for change and new technology adoption and suggested a number of strategies for creating it. Weiner B.J.A (2009) stated that organizational readiness is multi-level, multi-faceted constructs. The more organizational readiness for change is high, the more initiation, and greater exertion, greater persistent and more cooperative of organizational members it creates and this will result in more effective implementation of change. In this study, readiness in the domain of organization is checked from government regulation related to telecom sectors, cooperation of suppliers, vendors as well as telecom management perspectives. Based on this the following hypothesis is developed.

Hypothesis 3: Deploying 5G network technologies is affected by organizational readiness level.

2.7.5 People readiness

According to Ewa&Iwona (2013) Employees of the IT Company should have experience and competence in implementing a system in general and especially in public administration(*Ruth Leulseged_2017*, n.d.). It is important to provide appropriate training for employees on how to use the technology prior to deployment and approval the new technology. Organizational cultural affect the people's readiness to adopt new technologies. Management skills, telecom related trainings and awareness are constructs used to measure people readiness for this study.

Hypothesis 4 Deploying 5G network technologies is affected by people readiness

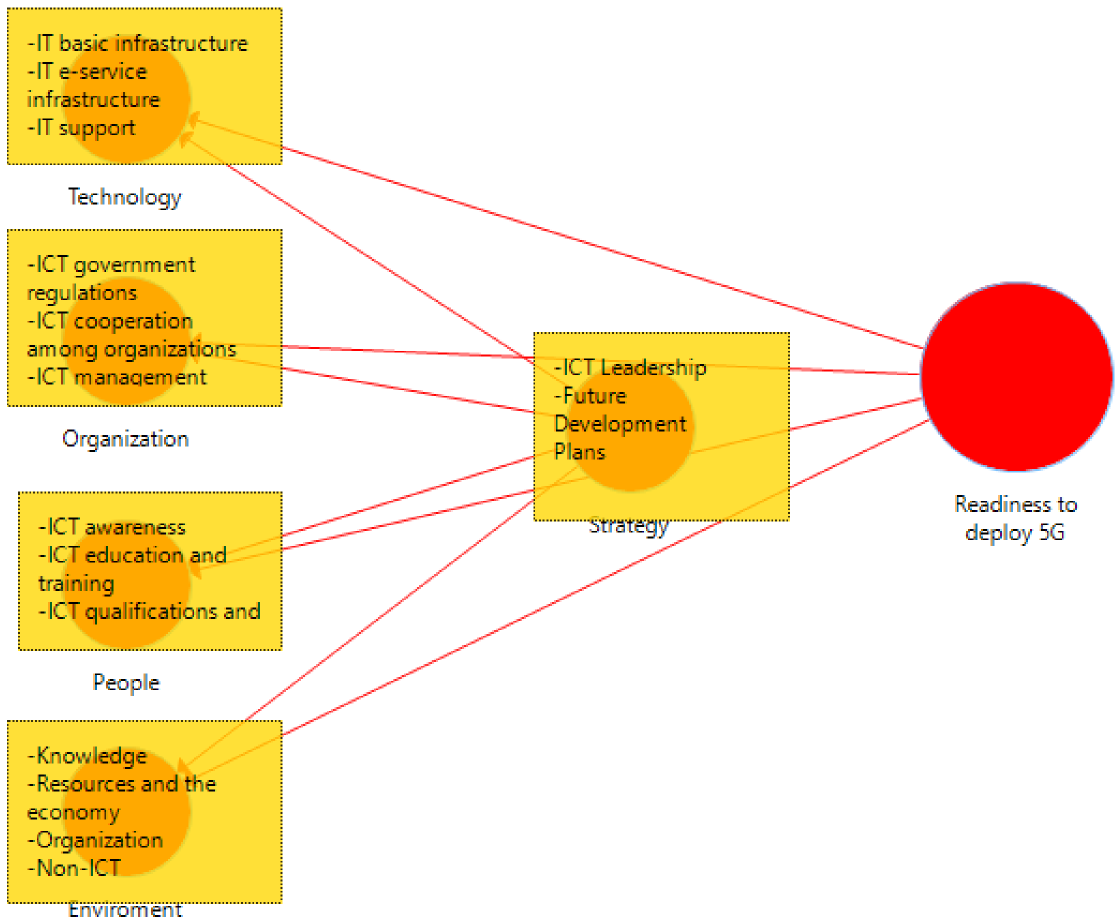


Figure 2: :Theoretical Framework of the Study using STOPE Model (Source: Ruth (2017))

2.7.6 Environmental Readiness

Environmental readiness is factors related to government support, available knowledge, available resources, and available business opportunities, national and international cooperation. For this study the environmental readiness is tested based on the following hypothesis.

Hypothesis 5: Deploying 5G network technologies is affected by environmental readiness.

Strategy affects readiness of Technology, Organization, People and Environment

Several researchers argue that strategy of one company has direct impact on all other factors i.e. (people, technology, environment and organizations). According to the researchers, strategy can influence e-government organizational ICT readiness drivers such as e-government user access, e-government programs, business processes and information systems, ICT infrastructure, and human resources. As cited by (*Ruth Leulseged_2017*, n.d.) researcher such as Azab, Kamel and Dafoulas (2009) and Amare(2011) claimed that strategy has impact on all other factors: technology, organization, people, and environment because strategy encompasses a number of aspects that can lead to change to those factors.

On the word of (Thompson, Strickland and Gamble ,2007; Ongonge J,2013) environmental uncertainties disturbs the advancement of long range strategies, scarce resource strategic planning should be aligned to use scarce resources effectively. Organization's strategic leadership involves developing ways of stimulating organizational families and stakeholders to perform in ways that attain the mission of the organization. Based on the implication of above researcher's claim the following hypotheses are developed:

Hypothesis 6: strategy affects organization readiness. Hypothesis 7: strategy affects people readiness. Hypothesis 8: strategy affects technology readiness. Hypothesis 9: strategy environmental readiness.

2.8 Related works

The future of 5G technology is under discussion and study, but several countries are deploying their first trials and commercial 5G technology. Study around 5G network technology is being competition among the researches and countries. Many studies focused on innovation of the technology itself like its architectures, implementation scenario, and 5G standards. There are few studies done on readiness to deploy 5G network technologies.

Incites Consulting S.A (2020) have studied the readiness level of European countries to deploy and adopt 5G. The study covered 39 European countries. The aim of the study was to assess the European countries readiness level and rank them based on study result. They identified six factors to measure each countries readiness rank. The factors they used to assess the readiness level were: - infrastructure and technology, regulation and policy, innovation landscape, human capital, country Profile, Demand.

They used weight allocation and aggregation and Scenario analysis techniques to measure each factors. They found Finland ranked at the top 39 Europe countries, while Switzerland, Germany, Denmark, Sweden, and UK took the next rank respectively.

Analysys Mason (2018) also investigated world countries' 5G completion rates, with a focus on the United States, in their study titled "global race to 5G in 2018 and the second report in 2019."

They concentrated not only on their readiness to deploy 5G, but also on countries' research and development practices in the field. They identified the countries that are at the forefront of the 5G race. The objectives of the study were: - To investigate actions taking place in markets worldwide, including the US, regarding the commercialization of 5G, including actions by operators, regulators and policy makers toward early 5G launch and service evolution. To compare the trends of 5G in the US to the other markets in terms of ‘readiness’ for 5G commercial launch, to produce an overall comparison of markets ranked according to a series of metrics defined for their study. They finding shows US has moved to tie with China as the leading country, while South Korea and Japan took next place.

Beneyam et al. (2017) also recommend that Ethiopians take action to adopt 5G network technology as soon as possible. The study focused on the significance of increasing network capacity for 5G technology. According to the study's empirical analysis, there could be a significant increase in data traffic in the country in the near future. To address this issue, they suggested upgrading mobile capacity to 5G technology.

Chapter Three

Methodology

Methodology of the research describes to *how* of the study and describes type of approach a researcher is going to follow, how to collect data, how to analyze collected data and explain how the results analyzed to ensure valid and reliable results that address the research aims and objectives. In this study the researcher used both qualitative and quantitative research approach to assess current state of ethio telecom readiness to deploy 5G network technology. Qualitative research approach is used to collect survey questionnaires data from respondents, whereas qualitative approach used to gather data through interview from top level management.

3.1 Target population

Target population is a group of people that the researcher conducts the study on and draw conclusions from. From preliminary investigation carried on at ethio telecom, the researcher identified five most appropriate divisions based on their association to the research objectives namely: Wireless network division, Information Systems division, Transport network division, Strategy and program management division, and Marketing division. As a result, the study's target population is ethio telecom permanent employees from the five divisions identified during the preliminary investigation. There are 2571 employees currently working under those five divisions (Wireless network division, Information Systems division, Transport network division, Strategy and program management division, and Marketing division). Wireless division is responsible for wireless network design and planning, construction, rollout, and maintenance and operation after service implemented. Information System division is in control of activities like overall system implementation, system maintenance, and support. Transport network is responsible for network line installations i.e. fiber, microwave connections and copper line etc. Strategy and program management division is in charge of overall strategy of the company and different programs. Lastly, marketing division is responsible for market research activities, product sales and promotions.

3.2 Sampling method

Sampling refers to the process of selecting a set number of study units from a larger study population (Zegeye et al., 2009). Sampling is the act of selecting a suitable representative subset of a population in order to determine the characteristics of the entire population. There are two types of sampling techniques: probability and non-probability. In the probability sampling technique, every member of the population has a chance of being chosen, whereas in the non-probability sampling technique, some members of the population have little or no chance of being chosen. The Quota sampling technique was used for this study.

For this study, each division was given a quota of participants, and individuals are selected based on their proximity to the research area. The wireless division was given 40% of the quota because it is in charge of wireless network design and planning, implementation, operation and maintenance, and other related issues. The remaining four divisions each received a quota of 15% of the total sample size.

Sample size

Sample size refers to the actual number of respondents selected for the study. Once we decide how to select the sample, we have to determine sample size. According to AAU research module accuracy and richness of data, collection is better than increasing sample size. Sample size for this study is determined from five selected divisions of ethio telecom. Ethio telecom employees under five division considered as total population of the study. Thus, total population of the study is 2571 and sample size (n) is computed using the following formula:

n= $\frac{N}{1+N(e)^2}$ whereas: −

n = no. of samples

N = total population

e = error margin

Sample size (n) = $\frac{2571}{1+N(0.1)^2}$ =96

3.3 Data Collection

The systematic collection of observations and survey data is known as data collection. Data collection allows us to gain firsthand knowledge and unique insights into our research issues. Data collection methods available include interviews, observations, questionnaires, and documents. For this study, closed ended Questionnaires and semi-structured interviews were used to collect data from respondents. Questionnaires were prepared based on STOPE (Strategy, Technology, Organization, People, and Environment) model and customized to meet with the objectives this particular study. Before collecting actual data twenty (20) pilot test questionnaires was distributed online using Google form questionnaire preparation tools to selected staff from wireless divisions in order to test the validity and reliability of the questionnaire. Then, 96 questionnaires were prepared and distributed in hard copy, and they were all collected. To gain a thorough understanding of the study, three top-level directors who can judge their company were interviewed. Eight interview questions were prepared by adopting existing e-readiness assessment literatures.

3.4 Data Presentation and Analysis

Data Analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recapitulate, and evaluate data is referred to as data analysis. For this study, descriptive analysis was made on demographic data using SPSS version 25 and evaluation of measurement model (reliability and validity test) and structural model (significance test, path analysis, R-squared and Q-squared) conducted to test using Smart PLS software package. For final readiness survey, the mean value of all five independent variables will calculated and the result will be used to show the overall readiness level of the company using e-LRS model. Data collected from interviews was also subjected to thematic analysis method.

3.5 Ethical issue

In this study the privacy of respondents kept confidential, and the researcher will respect legal and confidential matters

3.6 Pilot Study

A pilot study is a small study that is used to test data collection instruments in advance of larger research. The pilot test entails stimulating the actual data collection process on a small scale in order to obtain feedback on whether or not the instruments are likely to work as expected in a real-world situation. Pilot testing was carried out to assess the reliability and validity of the questionnaires. Online questionnaires created with Google Forms were distributed to 20 respondents, but only 12 responded.

A reliability test was performed using smart PLS software to assess the internal consistency of the questionnaire. Cronbach's alpha and composite reliability were used to assess the constructs' reliability. Most researchers agree that 0.70 is the minimum internal consistency coefficient of Cronbach's alpha (Whitley, 2002, Robinson, 2009). Each construct's Cronbach's alpha exceeded the 0.70 threshold. Convergent validity was also accepted because the extracted average variance (AVE) was greater than 0.50. Figure 3 displays the reliability and validity results.

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Enviromental	0.856	0.907	0.769
Organizational	0.766	0.843	0.527
People	0.930	0.944	0.710
Readiness	0.768	0.844	0.522
Strategy	0.848	0.885	0.504
Technology	0.863	0.895	0.546

Figure 3: Composite Reliability and Convergent Validity

Chapter Four

Data Analysis and Result

4.1 Introduction

Data analysis and results describes in detail the results of the data analysis. This chapter covers both quantitative and qualitative data presentation, data analysis, and result interpretation. First, quantitative data analysis for demographic representation of respondents is discussed, followed by statistical assessment of measurement model (reliability and validity of questionnaires) and structural model assessment (significance test, R2, path coefficient, and T-statistics). This section also discusses qualitative data analysis for data gathered from interviews.

4.2 Demographic Data of respondents

Respondents of this study were asked to fill their gender, their company experience and their position or job level in the company. Summary of respondent profile is presented in the table 1 as follows.

	Group	Frequency	Percent
Gender	Male	72	75
	Female	24	25
Job level(position)	Operational level	20	20.8
	Specialist	51	53.1
	Expert	15	15.6
	Managers	10	10.4
Company Experience	Less than 5 years	7	7.3
	5-10 years	34	35.4
	11-15 years	25	26
	Greater than 15 years	30	31.3

Table 1:Demographic data of respondents

As shown in table 5.1 profile of respondents presented from three different angles. The first one is their gender. When we look at gender of respondents among total of 96 respondent's males are 72 which yield about 75% and females took only 25%. This indicates that the higher respondent are males. Another data respondent was asked to fill was their job level. When job level(position) is concerned, 51(53.1%) are at specialist position,20(20.8%) are operational level employees,15(15.6%) are experts, and 10(10.4) are managers. This helps the researcher to predict respondent's role in company's decision making. At last distribution of respondents with respect to their company experience is presented. Accordingly, 34(35.4%) of respondents has 5-10 years' experience, 30(31.3) respondents has greater than 15 years' experience, while only 7(7.3) respondents are with less than 5 years of experience. As total 57.3% of respondents has greater than 10 years of company experience. Hence, most of respondents has good experience to company work environment and working systems.

4.3 Measurement Model

Quality of constructs in this study is assessed based on the evaluation of measurement model. The evaluation of quality criteria begins with the evaluation of factor loading, which is followed by the determination of construct reliability and construct validity.

4.3.1 Factor loading

The degree to which each item in the correlation matrix correlates with the given principal components is defined as factor loading. Factor loading can range from -1 to +1, with higher absolute values indicating greater correlations between the items and the underlying factor" (Pett, 2003). (Hair, 2016) suggested that the lowest value of factor loading be 0.5, but many other scholars (Henseler,Ringle, & Sarstedt, 2012) believe that the best minimum value of factor loading is 0.7. In this study, only two item has a value of less than 0.5 but other left items have a value of greater than 0.5. To achieve the best reliability and validity of the constructs, 10 indicators with a value of less than 0.7 have been deleted. Table 2 shows the factor loading of all indicators.

Constructs	Indicators	loadings	Status
Environment	ENV11	0.760	
	ENV21	0.7833	
	ENV31	0.752	
	ENV41	0.622	Deleted
Organization	ORG11	0.60	Deleted
	ORG21	0.564	Deleted
	ORG31	0.917	
	ORG41	0.652	
	ORG51	0.611	Deleted
People	PEO11	0.320	Deleted
	PEO21	0.639	
	PEO31	0.734	
	PEO41	0.773	
	PEO51	0.756	
	PEO61	0.726	
Strategy	STR1	0.548	Deleted
	STR2	0.659	Deleted
	STR3	0.674	Deleted
	STR4	0.717	
	STR6	0.653	
	STR7	0.811	
	Str5	0.748	
Technology	TEC01	0.808	
	TEC02	0.759	
	TEC03	0.783	
	TEC04	0.691	
	TEC05	0.757	
	TEC06	0.696	Deleted
	TEC07	0.152	Deleted

Readiness	RE01	0.691	
	RE02	0.675	
	RE03	0.605	
	RE04	0.639	
	RE05	0.569	

Table 2 :factor loadings

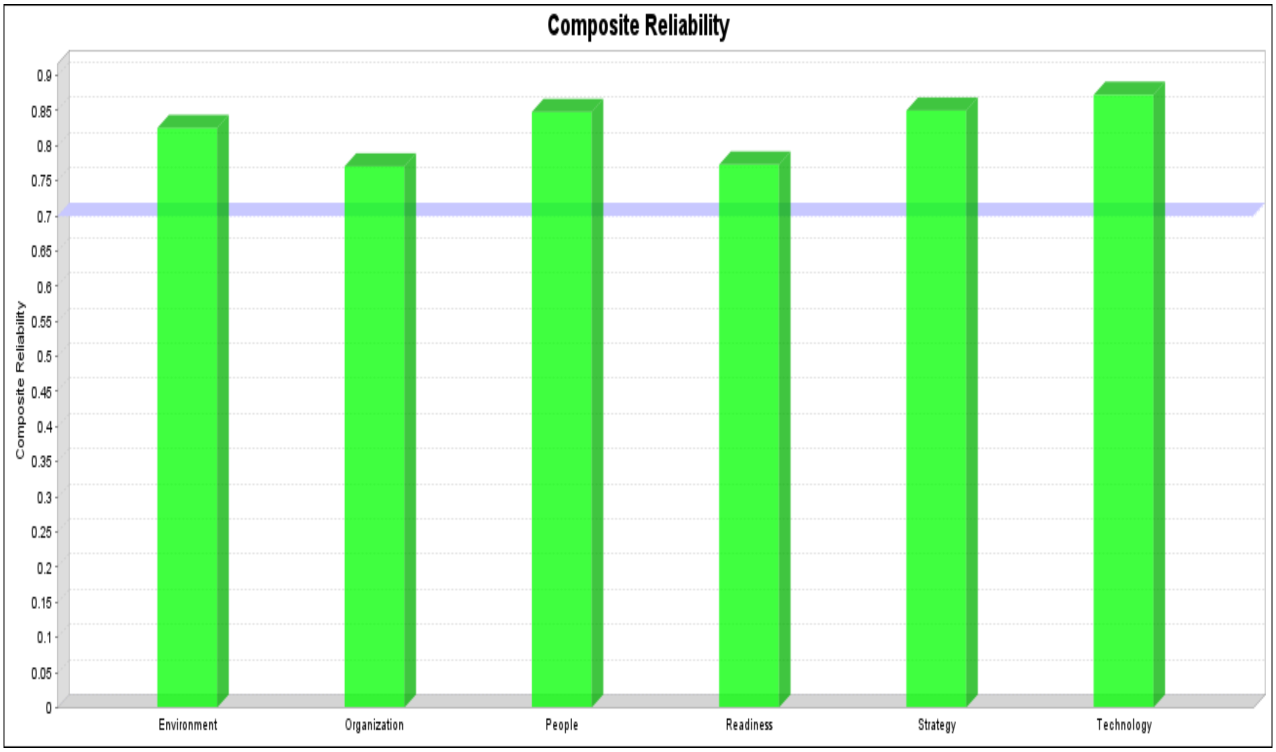
4.3. 2 Reliability of constructs

According to Mark (1996) “reliability is defined as the extent to which a measuring instrument is stable and consistent. The principle of reliability is repeatability. If the instrument is administered again and again will it yield the same results” p.285. Cronbach Alpha and Composite Reliability (CR) are the two most widely used methods for determining reliability. Because Cronbach's alpha can overestimate or underestimate scale reliability, composite reliability is a preferred alternative to Cronbach's alpha among PLS-based researchers (Hair et al., 2014).

However, the acceptable cutoff for composite reliability is the same for all reliability measures, including Cronbach's alpha. All constructs in this study have composite reliability results that exceed the required threshold of 0.7 (Hair et al., 2014). Composite reliability results are presented in table 3 and graph 1.

Construct	Composite Reliability(CR)
Environment	0.825
Organization	0.771
Technology	0.872
Strategy	0.850
People	0.848
Readiness	0.773

Table 3: Composite Reliability(CR)



Graph 1: Composite reliability

4.3.3 Validity

Validity is established by examining constructs convergent validity and discriminant validity.

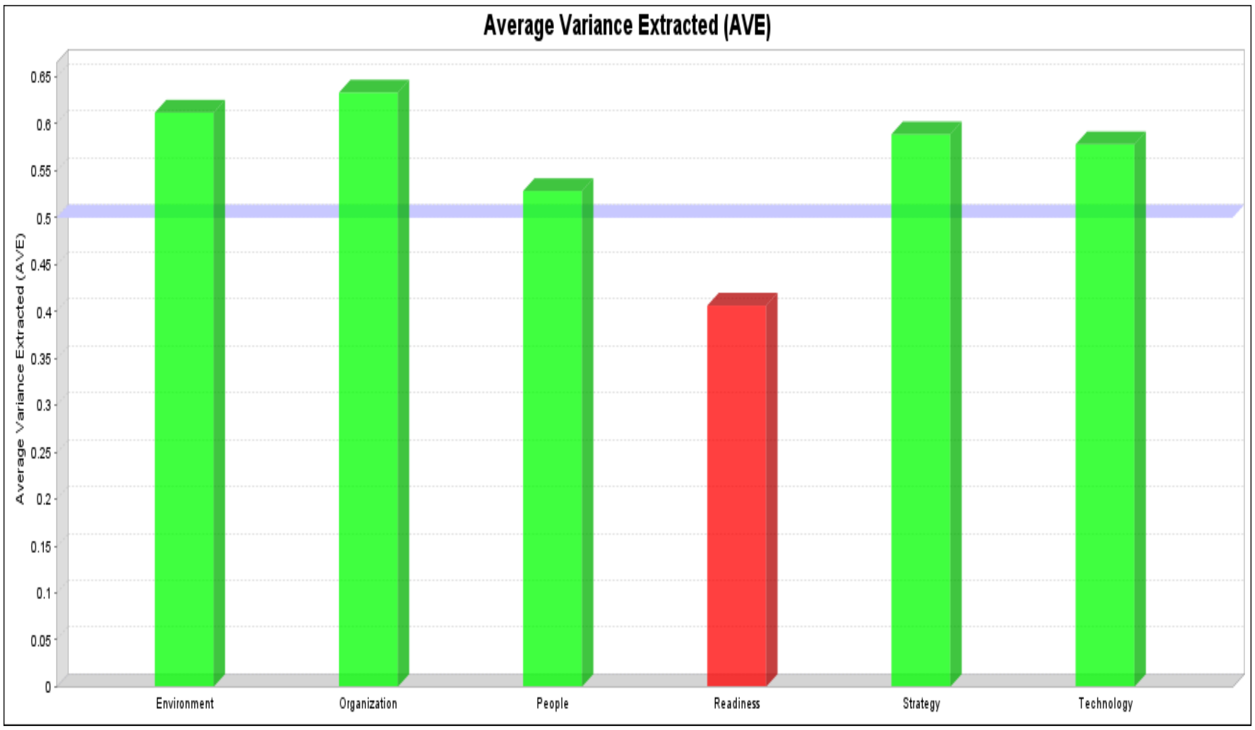
4.3.3.1 Convergent Validity

Convergent validity is defined as "the degree to which multiple attempts to measure the same concept agree."The idea is that if two or more measures of the same thing are valid measures of the concept, they should be highly correlated" (Bagozzi, 1991). Convergent validity is established when the underlying construct AVE value is greater than or equal to the recommended value of 0.5, according to Fornell and Larcker (1981).

The AVE value of all constructs in this study is greater than 0.5, with the exception of the 'Readiness' construct, which has a value of 0.406. All constructs, however, have a CR value greater than 0.7. As a result, convergent validity is not an issue. Convergent validity for this study is presented below in table 4 and graph 2.

Construct	Average Variance Extracted (AVE)
Environment	**0.612**
Organization	**0.633**
People	**0.529**
Readiness	**0.406**
Strategy	**0.589**
Technology	**0.578**

Table 4 :convergent Validity(AVE)



Graph 2 : convergent Validity(AVE)

4.3.3.2 Discriminat Validity

The degree to which measures of different concepts actually differ is referred to as discriminat validity. The general rule is that if two or more concepts are distinct, valid measures of each should not be overly correlated (Bagozzi, 1991).

"The lower-order components must be discriminantly valid among themselves and to all other constructs in the model, except for their own higher-order component, which they are a part of" (Sarstedt et al., 2019).

In this study 'Readiness' is High Order Construct(HOC) as shown on figure 4. Hence the researcher pay speacial attention to lower order constructs(Strategy ,Technology, Organization, People and Enviroment) in estabilishing discriminant validity. There are three methods for determining discriminant validity.

Fornell &Larcker criteria

Fornell and Larcker is one method for determining discriminant validity (Hair et al., 2014). According to this method, the construct shares more variance with its indicators than any other construct. To put this requirement to the test, the AVE of each construct must be greater than the highest squared correlation with any other construct (Hair et al., 2014).

In this study square root of AVE ($\sqrt{AVE}$) for a construct is greater than its correlation with all other low order constructs.Hence discriminat validity is established. Table 5 shows Fornell &Larcker assessment for this study.

	Environment	Organization	People	Strategy	Technology
Environment	$\sqrt{AVE}$ **=0.782**				
Organization	0.438	$\sqrt{AVE}$ **=0.796**			
People	0.465	0.436	$\sqrt{AVE}$ **=0.727**		
Strategy	0.562	0.501	0.545	$\sqrt{AVE}$ **=0.767**	
Technology	0.525	0.488	0.506	0.483	$\sqrt{AVE}$ **=0.760**

Table 5: Fornell &Larcker test

Cross loading

Another method to assess discriminant validity is assessing the cross loadings of the indicators. The cross loading value of each indicator variable should be higher than all loadings of other constructs and also exceed the threshold value > 0.70 (Hair et al., 2012) as citied by (*Marta_thesis* , n.d.). In this study all indicators have greater loading on their contracts. Hence discriminant validity for this study is established. Cross loading of all indicators (in **bold**) are presented in table 6.

	Environment	Organization	People	Readiness	Strategy	Technology
ENV11	**0.760**	0.308	0.316	0.569	0.470	0.357
ENV21	**0.833**	0.461	0.333	0.529	0.459	0.468
ENV31	**0.752**	0.246	0.458	0.464	0.379	0.411
ORG31	0.333	**0.917**	0.469	0.675	0.529	0.476
ORG51	0.417	**0.652**	0.152	0.414	0.194	0.264
PEO21	0.100	0.303	**0.639**	0.492	0.377	0.380
PEO31	0.285	0.362	**0.734**	0.518	0.382	0.438
PEO41	0.320	0.313	**0.773**	0.639	0.316	0.407
PEO51	0.456	0.198	**0.756**	0.527	0.403	0.271
PEO61	0.493	0.399	**0.726**	0.569	0.495	0.348
STR4	0.373	0.328	0.392	0.495	**0.693**	0.367
STR6	0.468	0.391	0.390	0.491	**0.676**	0.380
STR7	0.480	0.373	0.394	0.536	**0.859**	0.391
Str5	0.386	0.432	0.488	0.554	**0.825**	0.337
TEC01	0.449	0.562	0.422	0.635	0.473	**0.808**
TEC02	0.472	0.335	0.321	0.477	0.404	**0.759**
TEC03	0.411	0.388	0.360	0.486	0.250	**0.783**
TEC04	0.270	0.203	0.487	0.605	0.375	**0.691**
TEC05	0.398	0.337	0.294	0.479	0.280	**0.757**

Table 6:Cross loading result

4.4 Structural Model

After validity and reliability of outer model (measurement mode) is assessed the next step is measuring inner model (structural model). The inner model is evaluated by analyzing the hypothesized relationship within the inner model. According to (Wong, 2013), inner model evolution is determined by evaluating the significance test, coefficient of determination (R2), effect size (F2), and predictive relevance (Q-square).

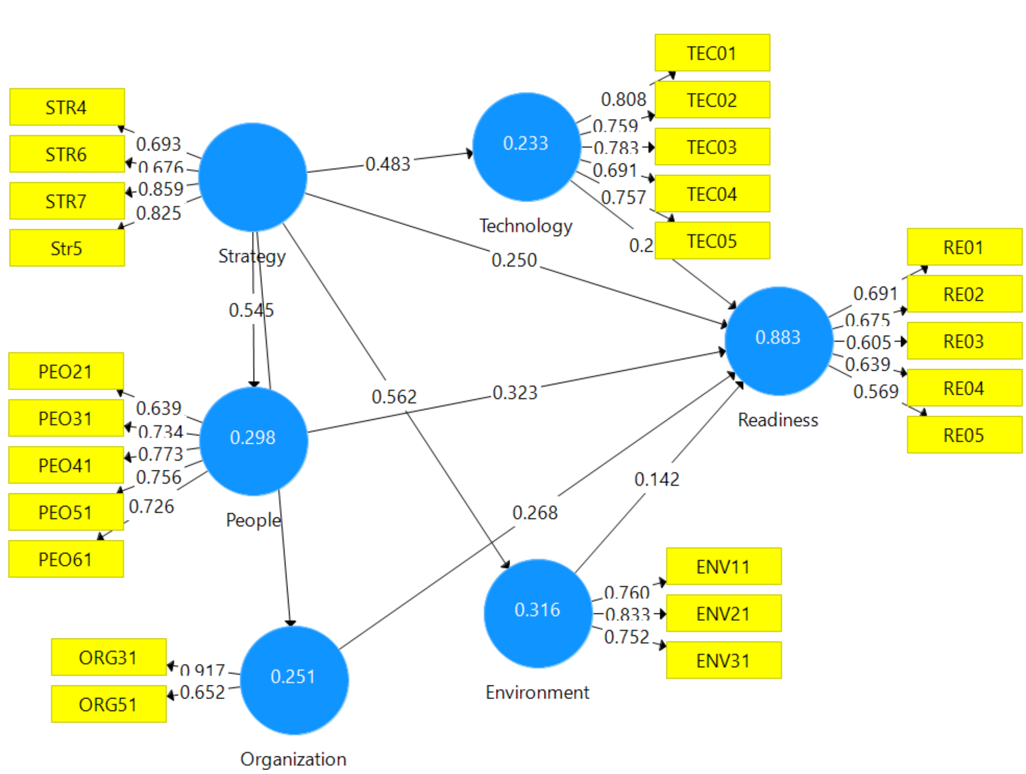


Figure 4 : Revised path model diagram of the study

4.4.1 Structural Path Significance

Structural path significance is evaluated in Smart-PLS using bootstrapping procedure. Bootstrapping procedure generate T-statistics for significance of structural path testing by taking large number of subsamples (i.e.5000) from the original sample. "Using a two-tailed t-test with a significance level of 5%, the path coefficient will be significant if the T-statistics is larger than 1.96"(Mastering Partial-Least-Square, book, n.d.) . In this study T-statistics of all variable are greater than threshold of 1.96 except for e/nvironment to readiness but their P value is significant. Hence the outer model loadings are highly significance**.** T-statistics result of this study is present in table 7.

	T Statistics	P values
Environment -> Readiness	1.860	0.063

Organization -> Readiness	3.074	0.000
People -> Readiness	4.260	0.000
Strategy -> Environment	6.740	0.000
Strategy -> Organization	4.346	0.000
Strategy -> People	5.904	0.000
Strategy -> Readiness	3.272	0.000
Strategy -> Technology	4.278	0.000
Technology -> Readiness	3.114	0.000

Table 7 : T- statics result

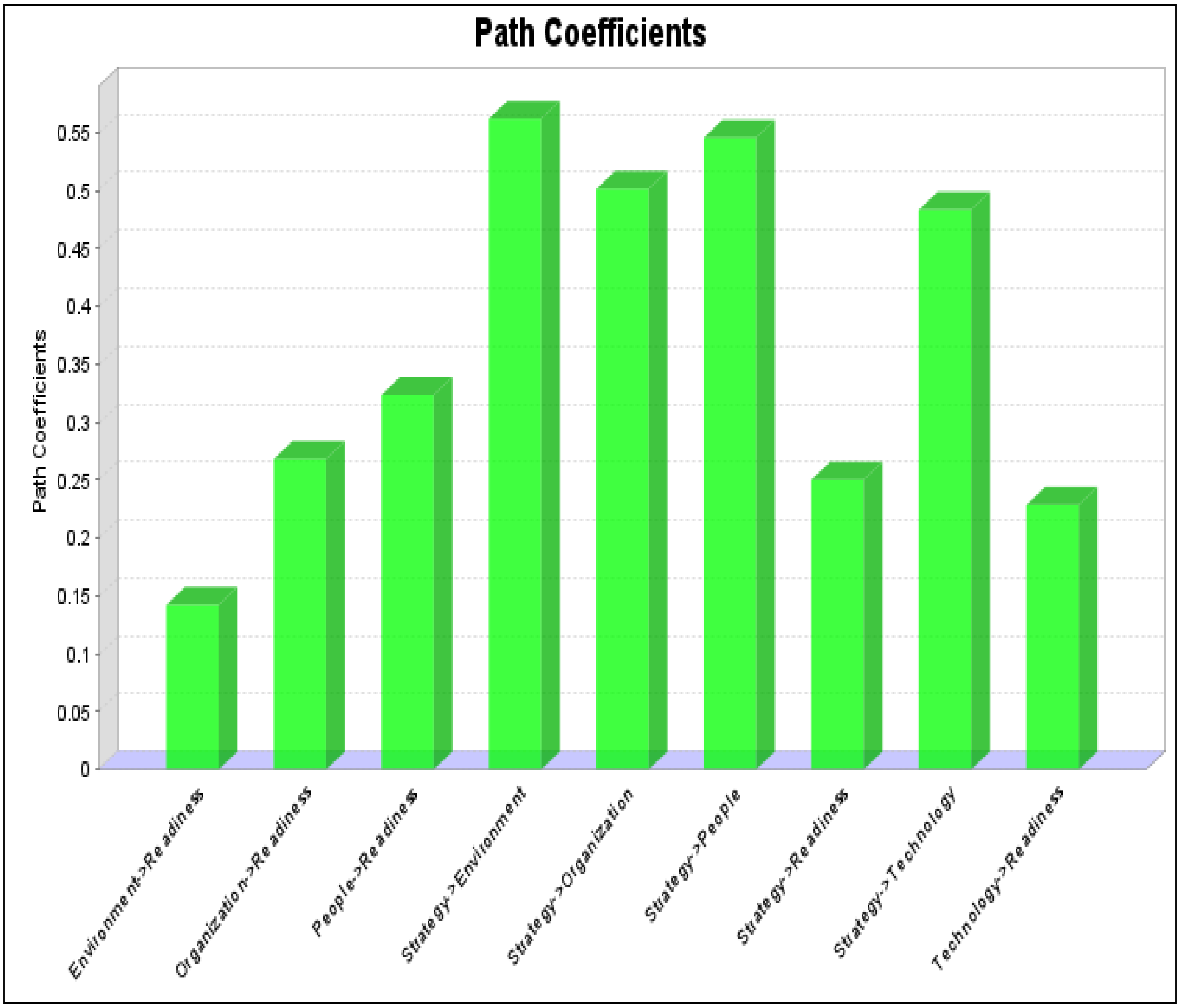
4.4.2 Path coefficient

The path coefficients represent the hypothesized relationships that exist between the constructs. “Path coefficient values are standardized on a scale of -1 to +1, with coefficients closer to +1 indicating strong positive relationships and coefficients closer to -1 indicating strong negative relationships” (Hair et al., 2014).

This study's path analysis results are shown in table 5.8 and figure 5.4 below.

	Path coefficient
Environment→Readiness	0.142
Organization→Readiness	0.268
People→Readiness	0.323
Strategy→Readiness	0.250
Technology→Readiness	0.228
Strategy →Environment	0.562
Strategy→Organization	0.501
Strategy→Technology	0.483
Strategy→People	0.545

Table 8: Path coefficient



Graph 3 :path coefficients graph

4.4.3 Multi collinearity Assessment

Multi collinearity problem exists when there are high inter correlation between two or more independent variables. Multi collinearity may be a problem when the variance inflation factor (VIF) coefficient is higher than 4.0 some use the more tolerant cutoff of 5.0 for both outer and inner model. Multi collinearity may evaluated for outer model as well as inner model. There no multi collinearity issue for this study as VIF values of outer model and structural model is below threshold 4.0. outer model and inner model multi collinearity result of the study is presented in table 9 and table 10 respectively.

	Outer VIF values
ENV11	**1.221**
ENV21	**1.555**
ENV31	**1.420**
ORG31	**1.096**
ORG51	**1.096**
PEO21	**1.448**
PEO31	**1.610**
PEO41	**1.634**
PEO51	**1.753**
PEO61	**1.592**
RE01	**1.302**
RE02	**1.190**
RE03	**1.216**
RE04	**1.295**
RE05	**1.192**
STR4	**1.473**
STR6	**1.239**
STR7	**2.270**
Str5	**1.940**
TEC01	**1.750**
TEC02	**1.929**
TEC03	**1.901**
TEC04	**1.435**
TEC05	**1.716**

Table 9: Outer VIF values

Inner VIF

Values

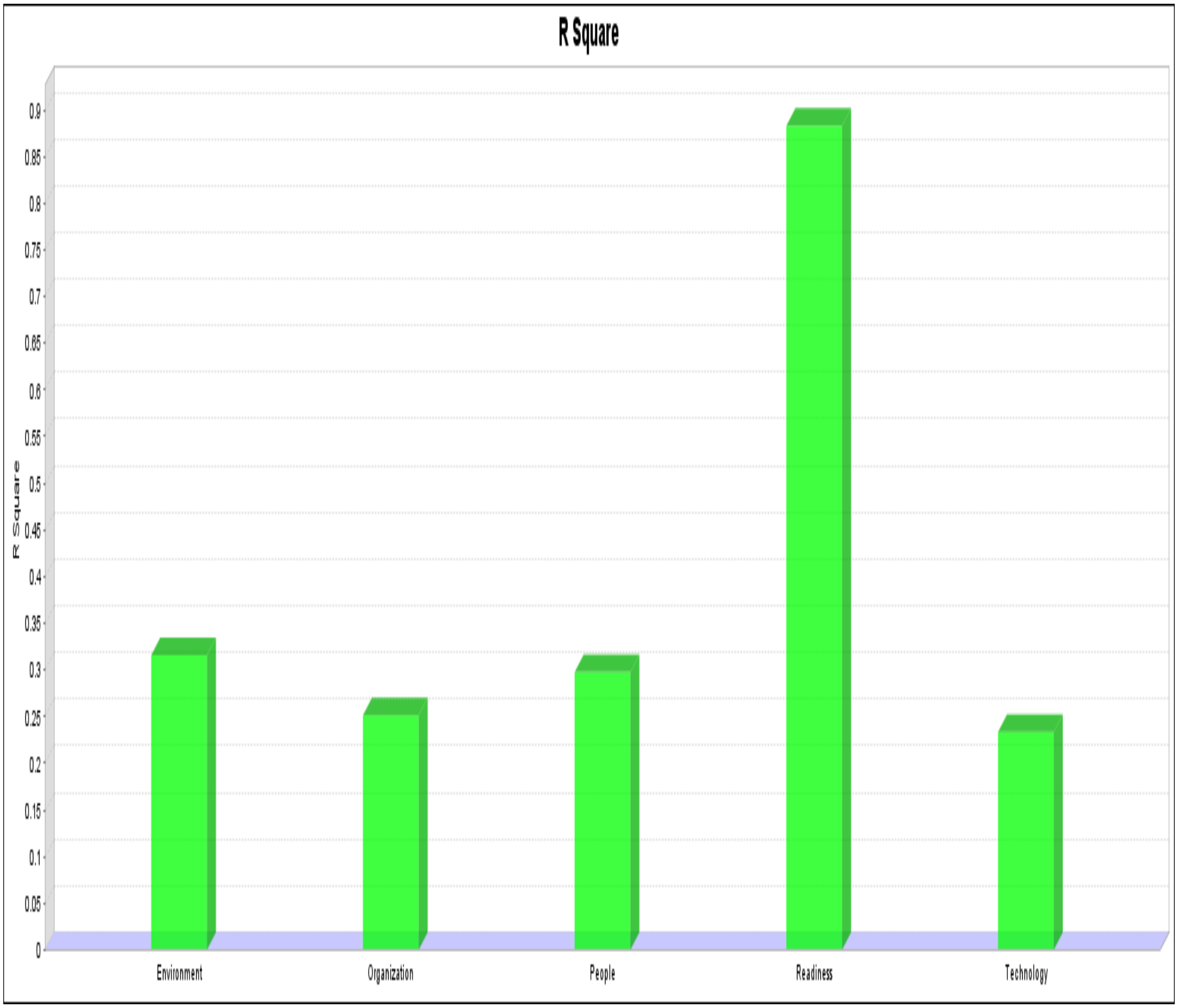
	Environment	Organization	People	Readiness	Strategy	Technology
Environment				1.771		
Organization				1.535		
People				1.647		
Readiness				0.000		
Strategy	1.000	1.000	1.000	1.861		1.000
Technology				1.701		

Table 10 : Inner VIF Values

4.4.4 Coefficient of determination (R^2)

The R^2 is a measure of the predictive accuracy of the model. R^2 is the representation of the total effect of the exogenous variables (Strategy, Technology, Organization, People, and Environment) on the endogenous variable (Readiness). This effect has a value between 0 and 1, with 1 representing complete predictive accuracy (Hair et al., 2014).

(Wong,2013) cited by (Ruth Leulseged 2017, n.d.) “if the value is closer to one, the exogenous variable explains the dependent variable well, and if it is closer to zero, it is week.” R^2 value of endogenous variable (Readiness) of this study is 0.883, which means all exogenous variables (Strategy, Technology, Organization, People and Environment) come together predict with complete accuracy. R square value of the research is present in graph 4 below.



Graph 4 :: R –square

4.4.5 Cross- validated relevance (Q^2)

Another aspect that a researcher should investigate is Q square. “The Q^2 is a method for determining the predictive relevance of the inner model. A Q^2 value greater than zero for a specific endogenous construct indicates the path model's predictive relevance for that construct” (Hair et al., 2014).

Cohen (1988) assigned Q2 values of 0.2, 0.15, and 0.35 to "small effect size," "medium effect size," and "high effect size," respectively.

This study's Q^2 is 0.309. Thus, the model has a high degree of predictive relevance with regard to the endogenous factor readiness. Table 11 shows Q^2 for endogenous factor.

Endogenous variable	**Q² (=1-SSE/SSO)**
Readiness	0.309

Table 11 : Q2

4.5 Hypothesis Testing

Hypothesis (H1): Strategy readiness is related with deploying 5G network technologies.

H1 evaluates whether strategic readiness level has a significant impact(relation) on implementation or deployment of 5G network technologies. The result shows that strategy has significant effect on implementation of 5G network technology with (β=0.25, t=3.27, p=0.000), Thus H1 is supported.

	Original Sample (O)	Standard Deviation (STDE	T Statistics	P Values
Environment -> Readiness	0.142	0.076	1.860	0.063
Organization -> Readiness	0.268	0.087	3.074	0.000
People -> Readiness	0.323	0.076	4.260	0.000
Strategy -> Environment	0.562	0.083	6.740	0.000
Strategy -> Organization	0.501	0.115	4.346	0.000
Strategy -> People	0.545	0.092	5.904	0.000
Strategy -> Readiness	0.250	0.076	3.272	0.000
Strategy -> Technology	0.483	0.113	4.278	0.000
Technology -> Readiness	0.228	0.073	3.114	0.000

Table 12: Hypothesis testing

Hypothesis 2(H2): Technological readiness is related to deployment of 5G network technologies

H2 evaluates whether technological readiness level has a significant effect on implementation or deployment of 5G network technologies. The result shows that technology has significant effect on implementation 5G network technology with (β=0.228, t=3.114, p=0.000), Thus H2 is supported.

*Hypothesis 3(H3**):** Organizational readiness level is related with deployment of 5G network technology*

H3 evaluates whether organizational readiness level has a significant effect on implementation or deployment of 5G network technologies. The result revealed that Organizational readiness has significant effect on implementation of 5G network technology with (β=0.268, t=3.074, p=0.000), Thus H3 is supported.

Hypothesis 4: People readiness is related with deployment of 5G network technology

H4 evaluates whether organizational readiness level has a significant effect on implementation or deployment of 5G network technologies. The result shows that Organizational readiness has significant effect on implementation of 5G network technology with (β=0.323, t=4.260, p=0.00), Thus H4 is supported.

*Hypothesis 5***:** *Environmental readiness is related with deployment of 5G network technology*

H5 evaluates whether environmental readiness level has a significant effect on implementation or deployment of 5G network technologies. The result revealed that environmental readiness has no significant effect on implementation of 5G network technology with (β=0.142, t=1.860, p=0.063), Thus H5 is not supported.

Hypothesis 6: strategy affects organization readiness.

H6 evaluates whether strategy has a significant effect on organizational readiness. The result revealed that strategy has significant effect on organizational readiness with (β=0.501, t=4.346, p=0.00), Thus H6 is supported.

Hypothesis 7: strategy affects people readiness.

H7 evaluates whether strategy has a significant effect on people readiness. The result revealed that strategy has significant effect on people readiness with (β=0.545, t=5.904, p=0.00), Thus H7 is supported.

Hypothesis 8(H8): strategy affects technology readiness.

H8 evaluates whether strategy has a significant effect on technological readiness. The result revealed that strategy has significant effect on technological readiness with (β=0.483, t=4.278, p=0.00), Thus H8 is supported.

Hypothesis 9(H9): strategy environmental readiness.

H9 evaluates whether strategy has a significant effect on environmental readiness. The result revealed that strategy has significant effect on environmental readiness with (β=0.562, t=6.740, p=0.00), Thus H9 is supported.

4.6 Readiness Assessment

Readiness is how ready the organization is on a number of aspects to implement e-services. According to Schreurs (2008) high priorities has to be given for readiness assessment before rushing into implementation of new technology (Chikohora et al., 2016). For this stud e-LRS model developed by Aydin and Tasci (2005) is adopted and used to rate readiness level of each category. Aydin and Tasci (2005) suggested that readiness level can be measured on a scale of 1-5 and each component level of readiness assessed on a five-point liker-type scale. They developed a e-Learning Readiness Survey (e-LRS) model that help to assess different components of readiness. The mean for all components or categories is calculated and ranked on the e-Learning Readiness Survey (e-LRS). Mean of 3.4 is the expected mean value to say institution is to ready but needs improvements.

Means	Scale
0-2.6	Not ready, needs lot of work
2.6-3.4	Not ready, needs some work
3.4-4.2	Ready but needs a few improvements
4.2-5	Ready to go ahead

Table 13 : The Scale and Indication of mean (Aydin and Tasci, 2005) {source:(Chikohora et al., 2016)

Based on Aydin and Tasci (2005) e-LRS Assessment Model mean of all five categories (Strategy, Technology, Organization, People and Environment) calculated and presented as follows in table 14.

Category	Mean	Status	Over all status
Strategy	3.7	Ready, need few improvements	Ready, need few improvements
Technology	3.6	Ready, need few improvements	
Organizational	3.5	Ready, need few improvements	
People	3.4	Ready, need few improvement	
Environment	3.1	NOT READY, need some work	

Table 14 : Readiness assessment

4.7 Qualitative data Analysis

Infrastructure and Technology Readiness

'4G network technologies has been introduced to Ethiopia in 2015, at that time 5G network technology was at concept level and initial standardization stage. 4G platforms and infrastructures deployed prior to 5G network standardization doesn't support 5G architectures. However, currently ethio telecom is on the expansion of 4G network, along with expansion ethio telecom is considering platforms, infrastructures to support future network architectures. Most of infrastructure available today are suitable to deploy Non-standalone 5G'.

Deploying technology from scratch have many challenges you may have no experience to technologies architecture and platforms, to overcome such challenges ethio telecom is considering 5G standards while deploying 4G network technology.' Furthermore, ethio telecom is undertaking network infrastructure and system enhancements to pilot 5G network in next year. To achieve this one site at Entoto park is ready for 5G deployment and testing.

'Almost all core to core connections are covered by fiber connection, this means ethio telecom doesn't face problem of change lines during deployment of 5G network technology, however most of connections between site to site are microwave based.' This may have little effect of 5G network implementation. Current ethio telecom is testing Huawei made new system called NGBSS (New generation business support system) to upgrade its business management system that aimed to allow ethio telecom to bill 5G network services. Ethio telecom planned to upgrade current system to NGBSS or shortly BSS in coming August 2021.

Demand and Environmental Readiness

Ethio telecom is providing telecom service and product to its customer since 1984. During this year ethio telecom introduce many technologies to the country based on customer demand. ‘when you provide some service and product the first you identify weather that product or service have demand on the market, when we consider 5G network technology beside few request there is no such demand which force us to introduce 5G’. Ethiopian telecom market is at low level of readiness. The simplest example is you cannot find smart phone which can support 5G network. Another problem is 5G network technology is beyond upgrading from one network generation to other. When we think of 5G the first thing we have think is Internet of things application. However, our market is not ready enough to apply Internet of Things like Smart city, Smart Home and etc.

Regulation and Policy Readiness

Ethiopian government is currently amending telecom related regulation and policies to open up telecom opportunities in the country. ‘Currently there is no any government regulation or policy that may delay 5G network implementation. Spectrum auction is simply requesting Ethiopian Communication Authority and buying the license.’ Government is supportive and focusing on market digitalization and looking forward to digital economy.

Human Capital Readiness

To provide world class telecom service human skill and knowledge around the area is very necessary. ‘Ethio Telecom is empowering its employees through different awareness and training delivery method such as on job training, external training, digital training and etc. however currently there is no training program prepared specifically for 5G network technology. we are making our staff attend 5G and related training and workshops prepared by our partners.

Chapter five

Discussion and Conclusion

5.1 Discussion

The purpose of this research was to assess whether ethio telecom is ready to deploy 5G network technology and also to assess its current status. In this chapter discussion of results based on research questions are presented. This study was aimed to address two research questions. The first question was" what *is current readiness level of Ethio Telecom to introduce 5G network technology?"* Previous studies like (*Europe 5G Readiness Index Methodology*, 2020) done on 5G readiness was focused more on technological readiness and policy readiness.

In this study the readiness level of ethio telecom to deploy 5G network technology has been assessed from five different perspectives based on STOPE (strategy, technology, organization, people and environment). The overall readiness of ethio telecom is ready to implement 5G network technology, but need some improvements. Well planned strategy improves company readiness by leading an organization to create good environment for its employees (peoples), and also help the company to deal with technological advancement.

On the premise that strategy has moderated the relationship between technology and readiness, organization and readiness, environment and readiness, and people and readiness, this study puts forward implication that overall readiness of a company would benefit from considering organizational strategy. When we look at strategical domain ethio telecom has future development plan for basic IT infrastructure, that can be used during 5G network deployment and there is also a direction and commitment toward deploying 5G. Currently in this year (2021) ethio telecom is roll outing 4G network technology to major cities of the country where there are high network traffic and will continue using 4G network as a main stream while looking at the conditions to deploy 5G network technology. In terms of human resources awareness, education, and training preparation there still big gap and need improvements.

Ethio telecom has full capacity to deploy 5G network technology financially. As result from data analysis shows ethio telecom technological readiness level is at ready state with some improvement needed on fiber installation for site to site connections and expanding 4G networks.

According to 3GPP Release 16 5G network architecture, 5G network has two deployment use cases: Non-Standalone (using 4G core and deploying 5 NR) and Standalone (deploying full 5G). So, to reuse 4G network for 5G deployment expanding 4G will benefit a company financially and boost experience.

According to GSMA 5G sites will rely both of fiber and microwave backhaul solutions, but fiber is the ideal option for 5G, to satisfy capacity demands that are significantly higher than typical microwave installations. Ericsson Microwave Outlook 2017 estimates 80% of Western Europe operators 5G sites backhaul will be provided by microwave while only 20% is with fiber(GSMA, 2019). According to researcher's observation and results from data analysis about 90% of ethio telecom sites are connected to each other via microwave installations. Another gap discovered by the researcher was communication and awareness creation among its employees. Many employees are unaware whether or not their company intends to deploy 5G. This gap should be get an emphasis another researcher((*Ruth Leulseged_2017*, n.d.) also identified communication as gap in ethio telecom. In terms of human capacity there are technical and managerial skills. Though employees of ethio telecom are attending workshops that will help them in 5G network deployment there is no 5G related trainings prepared by ethio telecom its self.

As result from data analysis shows from environmental view ethio telecom is below minimum readiness level. To assess environmental readiness external factors such as electric power supply, government policies and regulation burden and other institutions IT infrastructure that support 5G network deployment are used. Electric power supply is one factor that may challenge future generation network technology deployments. Even if results from respondent said government policies and regulations may have burden on ethio telecom, but chief officers and directors (top level managers) said in their interview that government policies are supportive and will not be an issue to the company.

The second question this study aimed to answer was "*What changes must be in place before introducing 5G network technology?* To answer this research question gaps that need improvements are identified: There should clear road map to 5G network that includes proper budgeting and resource identifications. Installation of fiber for site to site connection and at premises level is also another changes ethio telecom should give an attention before 5G deployment. Training human resource and creating awareness at company level and country level will help ethio telecom to successfully deploy 5G, help employees and customers to ready themselves, and help vendors to start ready themselves to provide 5G network technology equipment.

5.2 Conclusion

Currently, there is huge amount of network traffic and e-service demand that needs low latency. To overcome such problems different telecom operators are deploying fifth generation network technologies. Fifth generation network technology can support up to 1 million connections per square kilometer. Researchers forecasted this high traffic will be a problem in Ethiopia in near future. Ethio telecom is also looking at conditions to introduce fifth generation network technology. Before introducing new technology readiness assessment should be made to minimize a chance of failures.

This study objective was to assess the current readiness level of ethio telecom to deploy fifth generation network technology. The assessment was used STOPE model which developed by Backry's in 2004. Stope model is e-government readiness assessment model. Backry's STOPE model encompasses internal factors such as strategy, technology, organization, people and environment as external factor. This study assesses ethio telecom readiness from those five domains.

The assessment result shows that ethio telecom is ready in terms of technology, people, organization and strategy but some improvements should be made to make to boost readiness level to best level. However, environmental readiness still requires a significant amount of work; environmental readiness cannot be achieved solely by Ethio telecom, but requires the attention of all stakeholders, particularly the government, in order to prepare the Ethiopian telecom market for fifth generation network technology

As we can see from interview data of top level manager's Ethiopian telecom market is not ready to welcome 5G network technology. So ethio telecom is looking at a conditions to deploy 5G network, company will focus on 4G network expansion and will continue using 4G as main stream.

Finally, this study concludes that ethio telecom is at minimum readiness level to introduce 5G network technology

5.3 Recommendation

Based on the result of this study there are many implication and recommendations for ethio telecom, policy makers and regulators, and other stakeholders. I recommend ethio telecom to focus on boosting its 5G readiness to high readiness level before deploying 5G network. especially training employees and creating awareness at all staff level. I recommend that ethio telecom should take action in preparing the environment (Ethiopian telecom market) by working with government policymakers and regulators. It is also recommended that Ethio telecom should upgrade its main site-to-site backhaul to fiber line in order to take advantage of all of the benefits of 5G technology. My advice to future researchers is to broaden their scope to include other stakeholders such as government policymakers and to assess market readiness alongside other 5G-driven technologies such as the Internet of things.

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Appendix 1

Questionnaire items

Dear Sir/Madam**,**

I am graduate student at School of Information Science, Addis Ababa University. The purpose of this questionnaire is to gather relevant data that will be used in undertaking a study on the topic ***"Assessment of Ethio telecom readiness to deploy 5G network technology"*** as a partial fulfillment of the requirements for the **Masters of Science in Information Systems**.

I would like to express my sincere appreciation and deepest thanks in advance for your willingness, effort and cooperation in completing this questionnaire.

Amin Kemal Mama

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The questionnaires contain six parts: Demographic data, Strategy readiness, Technology readiness, Organizational readiness, People Readiness and Environmental readiness.

Instruction I: Please encircle on your choice

Part I. Demographic Data

1. **Sex:** *A, Male B, Female*
2. **Your position**: *A. operational B. Supervisor/specialist C. Expert D. Manager E. director*
3. **Your work experience in Ethio telecom**
   A, less than 5 years B, 5-10 years C, 11-15 years D, greater than 15 years

Instruction II: Please select the correct answer by putting tick sign (√) on the scale ranging strongly Disagree [1] through Strongly agree [5] or very poor [1] to Excellent [5] in the appropriate space provided.

Part II: STRATEGY READINESS		**s/disagree**	**Disagree**	**Neutral**	**Agree**	**s/agree**
STR1	Your organization has a clear articulated mission, directions and give priorities for ICT					
STR2	The government provides plan/fund or any other					

	support of network technologies in your company					
STR3	Government policies of telecom sector are in place to promote new technology to your organizations					
STR4	Your company has a future development plan for basic ICT and information infrastructure, e-service Infrastructure and ICT support to adopt 5G network technology.					
STR5	There is a plan that is needed and accessible by human resources for awareness, education, and training to prepare for readiness to adopt 5G network technology					
STR6	There is clear plan that includes proper budgeting and identification of resources for future generation network technology project implementation					
STR7	Your organization has a direction, commitment, and plan toward deploying 5G network technology					
	Part III: TECHNOLOGY READINESS	**Very Poor**	**Poor**	**Fair**	**Good**	**Excellent**
TEC01	Degree of 4G network penetration at national level					
TEC02	Percentage of fiber coverage at your company's network at individual house level and national level					
TEC03	4G mobile network maturity and reliability of your company's network					
TEC04	Availability of adequate network operation and maintenance persons of your company					
TEC05	Existing fixed and wireless network infrastructures your company possess					
TEC0	To what extent internet exchange points available					

	in your company's network					
TEC07	Your company has licensed spectrum band for low bands(**Sub-1Ghz and sun 3GHz**) , mid bands(**3GHz-6GHz**), and high bands(**Above 24GHz**) that will be used in 5G.					
Part IV: ORGANIZATIONAL READINESS		**s/disagree**	**disagree**	**neutral**	**agree**	**s/agree**
ORG 1	Do you agree that 5G network technology encourages individuals and investors to participate in demand and supply of telecom services?					
ORG 2	Your organization can afford cost of 5G network technology deployment					
ORG 3	Your organization's vision for planning of adoption 5G network technology is widely communicated throughout the company					
ORG 4	Organizational policies are in place to promote and manage mobile network technologies					
ORG 5	Your organization level of agreement with the legal vendors					
Part V PEOPLE READINESS		**s/disagree**	**disagree**	**neutral**	**agree**	**s/agree**
PEO1	Highly skilled telecom sector scientists and engineers are available at your company					
PEO2	Awareness of deployment of 5G network technology exist among senior level managers in your company					
PEO3	Your organization has proposed training initiatives that could be useful in deploying 5G network technology					
PEO4	Your organization has technical and managerial					

	skills on the use of technological innovation					
PEO5	The capacity of ICT is adequate to make business decisions in your organization					
PEO6	The level of training and education quality for ICT in your organization is adequate					
Readiness		**s/disagree**	**disagree**	**neutral**	**agree**	**s/agree**
RE01	Considering available human resource, ethio telecom is ready to implement 5G network technology.					
RE02	Ethio telecom has begun to find opportunities to implement 5G network technology					
RE03	Considering available technological capacity ethio telecom is ready to implement 5G network technology.					
RE04	Considering available market demand, ethio telecom is ready to implement 5G network technology.					
RE05	Considering your company current strategy ethio telecom is ready to implement 5G network technology.					
Part VI: ENVIRONMENTAL READINESS		**Very Poor**	**Poor**	**Fair**	**Good**	**Excellent**
ENT1	To what extent inconsistency of electric power supply affects the implementation of 5G network technology					
ENT2	To what extent government regulations have burden on adopting new technology at your company					
ENT3	To what extent technology infrastructure of other institutions is capable of supporting implementation					

	of 5G network technology					
ENT4	To what extent educational institutions can contribute telecom sector Scientists and engineers					

Appendix 2

Interview Questions

1. How many premises/network sites are covered/passed by fibers at national level? What about core network and backhauling?
2. Can we say your company's 4G network is mature enough? What about its penetration and accessibility across the country?
3. Is there any 5G network trials took place yet?
4. What current policies and regulations are in place for telecom sectors in the country? Did you think current telecom policy and regulation support and suitable to deploy small cell antennas everywhere?
5. How many internet exchange points your company are using now? Did you think they are enough if your company introduce 5G network technology?
6. What did you think about introducing 5G network technology with existing economy of the country? How can you explain government support (includes legislative, financial, regulations and procedures) of new technology?
7. Is there any customer demand and e-services that can lead the company to introduce 5G network technology?
8. What is the current state of ICT/telecom industry completions?

Abbreviations

1G-first generation

2G-second generation

3G-third generation

4G-fourth generation

5G- fifth generation

GSM-Global System for Mobile Communications

LTE-Long Term Evolution