The Impact of ICTs on Human Development in Tanzania

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Abstract

Information and communication technologies (ICTs) are believed to foster economic growth and social progress and are seen as significant drivers to achieve the Sustainable Development Goals. This dissertation investigates which components of ICT are most effective in achieving human development in Tanzania. To model the direct and indirect impacts of the Internet, mobile phones and telephone landlines on health, education, and standard of living, IBM AMOS is used to conduct path analysis. The results indicate that mobile phones exert the most substantial direct and indirect effect on human development in Tanzania, supporting the view that policymakers should invest in mobile phone infrastructure to foster health, education, and standard of living.

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1. Introduction

In 2000, the United Nations (UN) adopted the Millennium Development Goals (MDGs) to fight poverty and achieve human development. The MDGs aimed to eradicate extreme poverty, achieve primary education, and improve health (Chacko 2005, p. 98). The Millennium Declaration called upon world leaders and international organisations to implement policies targeting these goals and promoting development (UN 2000, p. 2). In 2016, the Sustainable Development Goals (SDGs) replaced the MDGs, recognising the eradication of poverty as the primary global challenge. The 2030 Sustainable Development Agenda emphasises the importance of human rights, investment in human capital, and infrastructure necessary for development. It states that "the spread of information and communications technology and global interconnectedness has great potential to accelerate human progress" (UN 2016, p. 9).

Information and communication technologies (ICTs) have developed significantly over the past three decades, and many studies investigate its economic implications of increasing productivity, promoting economic growth and reducing poverty (Toader et al. 2018, p. 1). The Organisation for Economic Cooperation and Development (OECD) finds that in OECD countries, ICT investment usually accounts for between 0.3 and 0.8 percentage points of per capita GDP growth (2003, p. 36). Similarly, the World Bank studies the impact of ICT investments on developing countries and finds that ICTs have a significant impact on economic growth, arguing that it "deserves a central role in country development" (2009, p. 35). More specifically, Qiang and Kimura find that a 10 per cent increase in penetration results in a 1.38 percentage point increase in per capita GDP growth in developing countries (2009, p. 45). Thus, these studies indicate a positive impact of ICTs on economic growth and development.

At present, Sub-Saharan Africa provides a significant development challenge to the international community. Over the past three decades, the number of the poor in Africa has doubled, HIV/AIDS continues to threaten people's lives, and many countries are affected by conflict (World Bank 2005, p. ii). Africa is the only region that did not achieve most of the MDGs and is struggling to meet the 2030 SDGs. Many African nations have invested hugely in ICT infrastructure to respond to the challenge of the SDGs. Tanzania is ranked 162nd out of 177 countries in the Human Development Index, facing significant challenges to achieve progress toward development outcomes (Farrell et al. 2007, p. 522). Therefore, policymakers aiming to implement national strategies must know how effective ICT investments are in improving human development.

Even though many scholars have established a positive relationship between ICT investment and economic growth in developed and developing countries (Litan and Rivlin 2001; Choi and Yi 2009), little attention has been paid to the impact of ICTs on specific aspects of human development in a particular East-African country. This dissertation contributes to the existing literature by addressing the following research question: What are the most compelling impacts of ICT use on human development in Tanzania? To further address the complexity of this question, secondary research questions state as follows:

(1) What are the impacts of the Internet, mobile phones and telephone landlines on health?
(2) What are the impacts of the Internet, mobile phones and telephone landlines on education?
(3) What are the impacts of the Internet, mobile phones and telephone landlines on the standard of living?

To investigate the relationship between ICTs and human development in Tanzania, Path Analysis will be conducted, a particular form of Structural Equation Modeling (SEM) that enables to estimate direct and indirect relationships between variables (Bankole et al. 2011, p. 4). It is an essential tool for empirical research in social sciences and can estimate interrelationships among different variables.

The remainder of this dissertation is structured as follows: The next section will provide a brief discussion of background knowledge on human development, ICTs, and the measurement of economic conditions in general. Section three will briefly introduce the country of Tanzania. Section four will present the theoretical background and establish hypotheses on the direct and indirect relationships between the three components of ICT and human development, based on empirical evidence. In section five, three models will be introduced, along with a detailed description of data collection and the variables used. Section six will apply the models and analyse direct and indirect effects of the three ICT components on human development based on the data given by the statistics programme AMOS. Section seven will then discuss policy implications and provide a conclusion.

2. Background

2.1. Human Development

When considering the impact of ICT on human development, it is crucial to understand the concept of human development within the debates on international development practices. Since the end of WWII, the interpretation of international development has shifted from a macroeconomic approach towards a human and social agenda. Until 1990, development projects were only directed towards increasing economic growth and raising the employment rate. However, high Gross Domestic Product (GDP) growth rates did not diminish socio-economic issues. In 1980, Amartya Sen understood that the key to

achieving human development was to expand the "basic capabilities" of people, such as health, knowledge, and skills (1980, p. 218). These acquired capabilities, in turn, can be used for productive purposes and promote economic growth.

Building on Sen's findings, Mahbub Ul Haq introduced the human development approach in 1989, demanding "people-centred development models," emphasising the expansion of people's opportunities and freedoms rather than economic growth (1995, p. 25). He realised that human development could contribute to higher productivity, control population growth, and produce social and political stability. After introducing the concept to the UN, the international community agreed that "the expansion of output and wealth is only a means to development, [whereas] the end of development is the welfare of human beings" (Nayak 2010, p. 3). Until today, the human development approach is deeply rooted in the UN's agenda and provides the basis for policy considerations.

Published by the UN in 1990, the first Human Development Report (HDR) defined human development as a "process of widening people's choices and the level of their achieved well-being" (UNDP 1990, p. 10). The report introduced the Human Development Index (HDI) to monitor human progress by computing an overall idea of economic and social well-being in a country. The HDI measures three dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living (UNDP 2015, p. 4). Even though it does not reflect on poverty, inequalities, and human security, the HDI is commonly used to monitor the performance of individual countries in achieving the SDGs. The HDI uses the following indicators:

- Life expectancy at birth (health) – This is the "number of years a new-born infant could expect to live", or similarly the average age of individuals in the country (UNDP 2010, p. 224).

- Mean years of schooling (education) – This is the average years of education for adults aged 25 years and more (UNDP 2019).
- Gross Domestic Product (GDP) per capita (standard of living) – This describes the average distribution of income among the citizens of a nation (UNDP 2003).

Recently, there has been much discussion concerning human development in Sub-Saharan Africa. The 2030 Agenda for Sustainable Development recognises that Africa faces various challenges in pursuing the SDGs and encourages the international community to assist Africa in achieving these goals (UN 2015, p. 10). As a result, Africa has received foreign aid payments, debt relief, and investments in ICT. The Tanzania Human Development Report 2017 stresses that even though Tanzania has made significant progress evidenced by the improvement in the HDI, rates of multidimensional poverty remain high (UNDP, p. xii). According to the report, the main factors leading to a decrease in multidimensional poverty between 2010 and 2015 are the increase in access to electricity and rates of ownership assets, including mobile phones, telephones, and computers.

2.2. ICT Infrastructure

On the global level, ICTs have shaped development around the world by accelerating economic growth and fostering social progress. Over the past decades, countries have increasingly invested in ICT infrastructure to achieve growth and enhance development. By reducing geographical boundaries, encouraging international trade, and spreading knowledge, ICTs provide significant benefits for economic growth (Freeman and Hasnaoui 2010, p. 439). The role of ICT as both medium and platform for cultural and economic exchange has become part of the daily life of millions of people around the world (Thompson 2007, p. 2). Though more than half of the world's population has access to ICT, most of this activity takes place in the global North. According to Doong and Ho,

the development of ICT is a critical indicator of an increase in the global digital divide, leaving the global South behind (2012, p. 530). International Organisations aim to decrease this gap by encouraging ICT investments in developing countries.

Since 1995, many African countries have started to consistently invest in ICT to respond to the demands of international development organisations. Advocates suggest that ICT will contribute significantly to social and economic development in Africa. Ponelis and Holmner argue that ICT helps to advance the African continent socially and economically by providing business practitioners and government officials with facts and ideas to increase the quality of life (2015, p. 173). Opponents argue that developing countries have little of the supporting infrastructure that is necessary to benefit from the productive capacity of ICT (Bankole et al. 2011, p. 6). As a result, the United Nations task force has advised African governments to prioritise the expansion of ICT infrastructure as a significant part of their poverty alleviation and human development strategies (Bollou 2006, p. 1). Following the literature (Bankole et al. 2011; ITU), ICT infrastructure includes three major dimensions:

- Main telephone lines – This is the number of fixed telephone subscriptions per 100 inhabitants (ITU).
- Mobile phones – This is measured by mobile-cellular telephone subscriptions per 100 inhabitants (ITU).
- Internet – This is the percentage of the population using the internet (ITU).

This dissertation will use the above-stated dimensions of ICT infrastructure to investigate the direct and indirect impact of ICT use on human development in Tanzania.

2.3. Measuring Economic Conditions

The existing economic conditions in the country influence the level of human development significantly. According to the UN, macroeconomic stability is an essential prerequisite for inclusive human development (2012, p. 3). The OECD points to poverty reduction, economic growth and increased worker productivity as the leading economic implications of ICT. By enabling individuals to use mobile banking services, making information accessible, and opening opportunities to access new markets, ICTs can decrease production costs, raise Gross National Income (GNI) per capita and reduce poverty (2004, p. 10). Thus, ICTs have the potential to change economic conditions, which, in turn, exerts a positive effect on the factors of human development.

The variables used to allow for indirect effects of ICT on human development will be the following:

- GNI per capita – This is the dollar value of the country's final income in a year, which is divided by its population (UNDP).
- Poverty – This is measured by the amount of the working poor at Purchasing Power Parity (PPP) $3.20 a day (UNDP).
- Output per worker – This measures the total labour productivity in the country (ILO).

The three distinct variables will be used to measure the economic conditions in Tanzania, to account for different levels of credibility in the data sets. Household's propensity to spend on items such as food, education, and health contributes directly to human development (Ramirez 1997, p. 2). Further, Mogotlhwane et al. point out that by opening new job opportunities and fostering higher paid jobs, ICTs help to reduce the level of poverty in the country, which positively affects human development (2011, p. 650).

Additionally, ICTs have the potential to increase output per worker by increasing skills and knowledge of the labour force. Thus, ICTs exert an indirect effect on human development in Tanzania.

3. Tanzania

In 1964, the United Republic of Tanzania formed out of the union of Tanganyika and Zanzibar. Since independence from British colonial rule in 1961, Tanzania's development process has been centred around human development. Julius Nyerere, Tanzania's first president, identified poverty and poor health as the primary development challenges facing the country. He further understood that development and freedom are intricately linked and agreed that policies should be directed towards people-centred development to improve health, education, and the standard of living (Nyerere 1973, p.1).

The choice of Tanzania as an empirical setting is motivated by the following: Despite policies targeting human development, the percentage of the population living below the poverty line of PPP $1.90 a day is higher than the average in Sub-Saharan Africa. In 2011, 49.1% of the population in Tanzania lived at PPP $1.90 a day, whereas the average in Sub-Saharan Africa was at 45.1% (World Bank, 2019). As a result, Tanzania belongs to the category of countries with low levels of human development, with an HDI of 0.528 in 2018 (UNDP 2019). Therefore, measures to foster human development have not yet succeeded. Even though Tanzania is willing to act within the human development approach, it is vital to further understand the critical drivers for human development to offer guidance to policymakers.

Today, Tanzania's current National Five-Year Development Plan 2016/17-2020/21 acknowledges linkages between economic growth and human development and focuses on industrialisation to achieve economic progress and human development. The

government aims to improve Tanzania's HDI score by 0.05 by 2025/26 (UNDP 2017, p. 1). By acknowledging the positive relationship between technology, economic growth, and human development, the government aims to increase access to electricity and ICT infrastructure, to achieve higher levels of human development. This dissertation will guide policymakers in Tanzania, by providing evidence which components of ICT are most effective in achieving human development.

4. Theoretical Background and Empirical Evidence

This section will provide a theoretical background for the discussion of the impact of ICTs on human development. It will first outline the critical economic theories that establish a link between the innovation of new technologies and development. Next, several hypotheses will be formed on the direct and indirect impacts of ICT on the factors of human development, based on empirical evidence found in the academic literature. ICTs exert a direct impact on human development by enhancing human capital, which is defined by the OECD as "productive wealth embodied in labour, skills and knowledge" (2007, p. 29). Further, there are several macroeconomic benefits of ICT that result from its use by individuals and households. This change in economic conditions leads to an indirect effect on human development.

4.1. Theories of Economic Growth

Economic theory has long established a definite link between the innovation of new technologies and development. Divided into neoclassical and new growth theory, several models highlight the relationship between new technologies, the distribution of knowledge, and economic growth (Asongu and Le Roux 2017, p. 45). According to the neoclassical model, economic growth results from a combination of labour, capital, and technology. While changes in labour and capital can influence short-run economic

growth, technological advancement is necessary to achieve long-run economic growth. Therefore, the model suggests that technology transfer is an essential driver of innovation in developing countries (Asongu et al. 2016, p. 8).

In 1956, Robert Solow and Trevor Swan first introduced the model of neoclassical growth theory. They defined the following Cobb-Douglas production function, where production at time t is given by:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$$

Output (Y) is a function of capital (K), labour (L), and technological progress (A), where α and 1-α represent the input factor shares. It states that the relationship between capital and labour determines the output of the economy and, therefore, economic growth. Technological progress can augment both capital and labour by increasing capital accumulation and output per worker (Solow 1994, p. 48). Therefore, growth occurs only as a result of factor accumulation. However, the model has received various criticisms as it assumes technological progress to be utterly exogenous to the economy and does not explain the variable of technological advancement.

In contrast, new growth theories argue that economic growth is the result of endogenous variables, including human capital, innovation, and knowledge. Further, they stress that cross-country spillover effects of knowledge enable other countries to take advantage of new innovative technologies and increase their productivity (Romer 1990, p. S89). Nevertheless, Verspagen points out that some countries benefit more from new technologies than others, leading to different growth rates by creating a disequilibrium of economic and human development (1992, p. 659). This argument is in line with Rosenberg, who finds that the rate at which countries adopt new technologies is essential for the process of economic growth and human development (1972, p. 3). Therefore,

developing countries should adopt new technologies as fast as possible to decrease the digital divide between the global North and the global South.

Several scholars (Ejemeyovwi et al. 2019, Andrés et al. 2017) use the Schumpeterian growth model to investigate the economic impact of ICTs. The model explains long-run economic growth as a function of institutions, technology, and other components of growth. Schumpeter argues that development results from spontaneous changes in the circular flow model because of technological innovations. These innovations break up the circular flow and attract investments, therefore leading to long-run economic growth (Langroodi 2017, p. 4). Thus, contrary to the neoclassical theory that argues that technological advancement augments labour and capital, Schumpeterian growth theory argues that technological innovations itself break the circular flow by attracting investments, therefore fostering long-run economic growth.

Building on both the neoclassical and new economic growth theory, the scholarly literature establishes several direct effects of ICTs on the factors of human development, as well as indirect effects by changing economic conditions in the country.

4.2. The Impact of ICT on Health

The literature establishes a positive direct and indirect relationship between ICT and health. After analysing data of 27 African countries, Bankole and Mimbi find that continuous investment in ICT infrastructure has a positive direct impact on the performance of the health system in Africa and significantly improves life expectancy at birth (2015, p. 14). Their argument is in line with Adeola and Evans, who further explain that by providing access to information, increasing the quality of health services, as well as making the health system more efficient, ICTs exert a positive effect on the level of health in Africa (2019, p. 77).

Further, several scholars find that ICTs indirectly exert a positive effect on health by increasing GNI per capita. Ho and Hendi argue that significant improvements in life expectancy are often associated with an increase in GNI per capita, as developed countries have a higher life expectancy than developing countries (2018, p. 1). Their argument is in line with Marmot, who finds that by exerting a positive impact on material conditions and social participation, increases in GNI per capita through ICT can positively affect the health state (2002, p. 32).

Hypothesis 1a: *Increases in GNI per capita exert a positive direct effect on life expectancy at birth.*

4.2.1. The Impact of the Internet on Health

Several studies explore the direct and indirect impact of the Internet on health care in Africa. Alzaid et al. investigate the direct impact of knowledge creation on the health and well-being of society. After using a quantitative research approach, they find a positive relationship between the Internet and life expectancy at birth, pointing to the availability of information that improves the quality of health care (2014, p. 7). Edoh et al. provide a more specific explanation for the positive impact of the Internet on health in West Africa. They find that people use the Internet to inform themselves about diseases and treatment methods and can thus react more appropriately to any illness (2017, p. 3).

Hypothesis 1b: *The Internet exerts a positive direct effect on life expectancy at birth.*

Additionally, several studies indicate a positive indirect effect of the Internet on life expectancy at birth by increasing GNI per capita. Alzaid et al. conduct simple linear regression analysis and find a positive correlation between the Internet, GNI per capita, and life expectancy. They explain that the Internet creates jobs, which increases GNI per capita and therefore fosters life expectancy at birth (2014, p. 8). Similarly, Salahuddin

and Gow find a significant positive relationship between Internet usage and GNI per capita in several Southern African countries over the period 1990-2012 (2015, p. 13). By expanding network coverage, the Internet can decrease the digital divide and provide new job opportunities, therefore increasing GNI per capita and life expectancy at birth.

Hypothesis 1c: *The Internet exerts a positive indirect effect on life expectancy at birth by increasing GNI per capita.*

4.2.2. The Impact of Mobile Phones on Health

Much of the academic literature focuses on the positive direct impact of mobile phones on health. By adopting a Cobb Douglas Production Function, Bankole and Mimbi find a significant positive impact of mobile communication services on the health system (2015, p. 8). Lee et al. investigate mobile health (mHealth) programs in sub-Saharan Africa between 2006 and 2016, which refers to healthcare assistance delivered via mobile devices. They find that by enabling to give treatment advice as well as reducing the health information gap by collecting data, mobile phones exert a positive effect on the level of health (2017, p. 2). Betjeman et al. find similar results, stressing the positive impact of mobile health on patient monitoring and communication between healthcare workers, especially in rural areas (2013, p. 6).

Hypothesis 1d: *Mobile phones exert a positive direct effect on life expectancy at birth.*

The literature also establishes a positive indirect effect of mobile phones on health by increasing GNI per capita. Asongu finds that mobile phone penetration does have a positive impact on income equality in Africa, as measured by the GINI index (2015, p. 712). Phone-based money transfer (mPay), combined with the ability to manage the household's budget and enable people to respond to shocks, are argued to be the main drivers for this positive relationship (2015, p. 713). Furthermore, Aker and Mbiti argue

that mobile phones create jobs, which increases the demand for labour and exerts a positive effect on the nation's income (2010, p.219).

Hypothesis 1e: *Mobile phones exert a positive indirect effect on life expectancy at birth by increasing GNI per capita.*

4.2.3. The Impact of Telephone Landlines on Health

A limited number of scholars has only explored the direct impact of telephone landlines on health in Africa. Mbarika claims that an increase in main telephone landlines improves various social aspects, including health service delivery (2002, p. 10). Further, the provision of main telephone landlines provides the opportunity for individuals to access health information (Info Dev, 2006). More specifically, Skolnik explains that telemedicine can increase access to health care and medical information (2016, p. 482). It can connect rural areas to tertiary care centres and specialists, which decreases travel time and enables patients to receive treatments faster.

Hypothesis 1f: *Telephone landlines exert a positive direct effect on life expectancy at birth.*

Several scholars establish a positive indirect effect of telephone landlines on health by increasing GNI per capita. According to Chong et al., the use of telephone landlines is positively linked with GNI per capita. By reducing the gap in access to both formal and informal information, telephone landlines significantly increase both farm and non-farm income levels (2009, p. 643). Rural areas, in particular, benefit from telephone landlines, as they decrease the distance between economic agents and thus reduce transaction costs. Therefore, telephone landlines enhance a more efficient allocation of resources.

Hypothesis 1g: *Telephone landlines exert a positive indirect effect on life expectancy at birth by increasing GNI per capita.*

4.3. The Impact of ICT on Education

The literature establishes a positive direct and indirect effect of ICTs on education. After examining the impact of the adoption of ICTs on quality and years of education in Africa, Barakabitze et al. highlight a positive relationship between ICTs and education (2019, p. 23). Similarly, Livingstone stresses the advantages of ICTs for education by pointing to its provision of information and collaborative learning resources (2012, p. 15). According to Crisita et al., ICTs have the potential to significantly improve low-quality instructional time in developing countries by making new teaching methods accessible (2005, p. 2). Thus, ICTs exert a positive effect on education.

Other studies stress the positive indirect impact of ICTs on education by reducing the level of poverty. Urquhart et al. find that by enabling access to information and knowledge as well as providing networks of contacts, ICT networks have the potential to reduce the level of poverty in a country (2008, p. 209). By fostering social capital development, including human and intellectual capital, ICTs help to reduce poverty. According to Iqbal, there is a high correlation between the level of poverty and education status. Poorer households usually hold less educated people, while well-off people can afford education more easily (2006, p. 36). Similarly, Wedgwood argues that access to education is biased towards urban areas in Tanzania, as people in rural areas are more impoverished than those in urban areas and, therefore, cannot afford secondary schooling (2005, p. 8).

Hypothesis 2a: *A reduction in poverty can positively influence mean years of schooling.*

4.3.1. The Impact of the Internet on Education

Several studies highlight the positive direct effect of Internet penetration on education. The Internet can directly affect the quality of education by making online materials

accessible and, therefore, providing valuable resources for teaching. The Internet Society outlines further benefits of Internet use, as it enables the adoption of interactive teaching methods and provides the necessary support to reduce inequalities among different skill levels (2017). Furthermore, Eluwole et al. argue that the Internet has significantly improved the number of schooling years, as it enables distance learning and online studies, which can provide people in rural areas with access to education (2014, p. 75).

Hypothesis 2b: *The Internet exerts a positive direct effect on mean years of schooling.*

Other scholars point to a positive indirect effect of the Internet on mean years of schooling through poverty reduction. For instance, Yilmaz et al. argue that the Internet plays an essential role in poverty reduction. By providing employment opportunities to the poor, as well as positively impacting business administration and the agricultural sector, the Internet can fight social problems such as poverty (2018, p. 64). Similarly, May et al. investigate the impact of the Internet on poverty reduction in East Africa and find that gaining Internet access reduces financial poverty (2014, p. 50).

Hypothesis 2c: *The Internet exerts a positive indirect effect on mean years of schooling, by reducing poverty.*

4.3.2. The Impact of Mobile Phones on Education

The UNESCO found several positive direct effects of mobile phones on education in Sub-Saharan Africa. After investigating the impact of mobile technologies on educational access, the UNESCO finds that mobile phones have the potential to expand learning opportunities by contributing to the curriculum with providing relevant information (2012, p. 8). Thus, mobile phones increase the quality of education. Further, Porter et al. argue that mobile phones enable students and teacher to be more connected, as it allows

students to discuss classwork or consult the teacher for help (2016, p. 27). Therefore, students can get better grades and achieve more years of education.

Hypothesis 2d: *Mobile phones exert a positive direct effect on mean years of schooling.*

The literature establishes a significant positive indirect effect of mobile phones on education through poverty reduction. Sife et al. investigate the contribution of mobile phones on poverty reduction in Tanzania. They find that mobile phones contribute significantly to reducing poverty, especially in rural areas. By expanding social networks and increasing the people's ability to deal with emergencies, mobile phones exert a positive effect on poverty reduction in Tanzania (2010, p. 10). Their argument is in line with Butner, who argues that mobile phones increase productivity, widen markets and simplify transactions, therefore creating new socio-economic opportunities that decrease poverty and foster development (2003).

Hypothesis 2e: *Mobile phones exert a positive indirect effect on mean years of schooling by reducing poverty.*

4.3.3. The Impact of Telephone Landlines on Education

Several scholars establish a positive direct effect of telephone landlines on education. Rohman measures the impact of telecommunications development on education in Africa and finds that the telephony sector significantly contributes to better education (2012, p. 38). Similarly, according to Van Slyke, telephone landlines foster social skills and contribute significantly to the number of mean years of schooling (2008, p. 286). By making students and teachers more connected, telephone landlines have the potential to improve the quality of education and, therefore, increase the mean years of schooling for the population.

Hypothesis 2f: *Telephone landlines exert a positive direct impact on mean years of schooling.*

Additionally, several studies find a positive indirect effect of telephone landlines on mean years of schooling by reducing poverty. According to Pigato, fixed telephone landlines have the potential to provide information and knowledge to the poor, that they can use to improve their lives (2001, p. 3). This knowledge can improve the educational standards of the poor, as it is more reliable than information coming from informal information networks. Global knowledge can reduce poverty and, therefore, enhance human development.

Hypothesis 2g: *Telephone landlines indirectly exert a positive effect on mean years of schooling by reducing poverty.*

4.4. The Impact of ICT on Standard of Living

According to the literature, ICTs can improve the standard of living directly by exerting a positive effect on GDP per capita. Several scholars find a significant positive relationship between ICTs and economic growth, suggesting that an increase in the use of ICTs boosts GDP. Das et al. investigate the impact of ICT development on economic growth and find that ICT diffusion positively affects economic growth (2016, p. 141). Similarly, Gelvanovska et al. explain that by driving international trade, foreign direct investment (FDI) decisions and agricultural productivity, the Internet can successfully contribute to GDP growth (2014, p. 2).

Further, the main factor through which ICTs can indirectly exert a positive effect on GDP per capita is by increasing labour productivity. Faha and Vaumi investigate the relationship between ICT and labour productivity in Cameroon and find that investment in ICT-capital has a positive and significant impact on labour productivity (2015, p. 13).

Basant et al. explain this positive relationship by pointing to the fact that ICTs reduce hierarchy within firms, increase skills and improve management practices (2006, p. 19). An increase in labour productivity due to an increase in skills and knowledge resulting from ICTs decreases input costs and uses factors of production more efficiently, therefore triggering economic development and growth (Korkmaz and Korkmaz 2017, p. 74).

Hypothesis 3a: *An increase in output per worker exerts a positive effect on GDP per capita.*

4.4.1. The Impact of the Internet on Standard of Living

Several studies confirm a positive direct impact of Internet usage on GDP per capita. By analysing data for 207 countries over the period 1991-2000, Choi and Yi investigate the relationship between the Internet and economic growth and find that increased access to Internet exerts a positive effect on GDP per capita (2009, p. 40). They further explain that by leading to spillover effects of knowledge across countries, the Internet increases productivity and enables GDP growth. Similarly, Czernich et al. investigate the impact of Internet access on economic growth and find that a 10% increase in Internet penetration leads to an 0.9-1.5% increase in GDP per capita growth (2011, p. 530).

Hypothesis 3b: *The Internet exerts a positive direct effect on GDP per capita.*

Furthermore, the literature establishes a positive indirect effect of the Internet on GDP per capita through an increase in output per worker. Rangkakulnuwat and Dunyo investigate the effect of the Internet on economic growth in Africa and find that Internet usage combined with physical capital has the potential to increase labour productivity and thus to raise economic output (2018, p. 31). After studying the impact of the Internet on labour productivity in 108 countries, Najarzadeh et al. find similar results, indicating that

a one per cent increase in the number of Internet users increases GDP per person employed by $14.6 (2014, p. 991).

Hypothesis 3c: *The Internet exerts a positive indirect effect on GDP per capita by increasing output per worker.*

4.4.2. The Impact of Mobile Phones on Standard of Living

According to the literature, mobile phones exert a positive direct effect on GDP per capita. Haftu finds that a 10% increase in mobile phone penetration results in a 1.2% increase in GDP per capita in Sub-Saharan Africa (2019, p. 96). Similarly, after investigating the impact of mobile phones on economic growth in Sub-Saharan Africa for 1993-2012, Donou-Adonsou et al. find that mobile phone penetration exerts a positive and significant effect on GDP per capita (2016, p. 74). Another study, completed by Gruber and Koutroumpis, finds that mobile phones have a positive impact on annual GDP growth, after investigating 192 countries between 1990 and 1997 (2011, p. 413).

Hypothesis 3d: *Mobile phones exert a positive direct effect on GDP per capita.*

A study conducted by Nsabimana and Funjika examines the impact of mobile phone ownership on the labour market and farm productivity in Tanzania. They find that an increase in mobile phone users leads to a movement in the labour force from agriculture into non-farming sectors. This movement into the manufacturing sector, then, in turn, increases GDP per capita (2019, p. 10). Adekola et al. investigate the impact of mobile phones on labour productivity growth in Sub-Saharan Africa and find that doubling the current rate of mobile-cellular subscriptions increases labour productivity growth by approximately 0.05 per cent (2016, p. 248). Financial inclusion is seen as one of the possible factors through which mobile phones affect labour productivity growth.

Hypothesis 3e: *Mobile phones exert a positive indirect effect on GDP per capita by increasing output per worker.*

4.4.3. The Impact of Telephone Landlines on Standard of Living

Ding and Hynes investigate the impact of telecommunications infrastructure on economic growth and find that the number of fixed telephone subscriptions exert a positive and significant impact on real GDP per capita (2006, p. 299). Chavula studies the impact of telecommunications and GDP growth in Africa between 1990 and 2007. The study concludes that fixed telephone subscriptions have a positive and significant impact on economic growth (2013, p. 20). By increasing economic productivity and efficiency, telephone landlines are vital in boosting economic growth and therefore exert a positive impact on GDP per capita.

Hypothesis 3f: *Telephone landlines exert a positive direct effect on GDP per capita.*

Adekola et al. investigate the effect of fixed-telephone landlines on labour productivity growth in Sub-Saharan Africa for 1975-2010. The study confirms significant increasing returns for labour productivity growth from fixed-telephone penetration. Doubling the current rate of fixed-telephone subscriptions increases labour productivity by roughly 0.12-0.15 per cent (2016, p. 248). By increasing the efficiency of companies and deepening capital per worker, telephone landlines lead to the growth of labour productivity and therefore exert a positive effect on GDP per capita (Mačiulytė-Šniukienė and Gaile-Sarkane 2014, p. 1272).

Hypothesis 3g: *Telephone landlines exert a positive indirect effect on GDP per capita by increasing output per worker.*

5. Data and Methodological Framework

5.1. Data

Several databases provide time-series data of Tanzania for this analysis. The International Telecommunication Union (ITU), the World Bank database, the International Labour Organisation (ILO) and the United Nations Development Programme (UNDP) contribute data to the variables used. The ITU database provides data on ICTs. The World Bank contributes data on the World Development Indicators. Further, the UNDP's archive consists of human development indicators, and lastly, the ILO provides data on labour statistics. The analysis uses data from the years 2000-2017. The period is chosen based on the availability of relevant data. Full data sets are available for all variables except for poverty, where data from eight of seventeen years is missing. These large amounts of data allow for accurate results in the analysis. GNI per capita, poverty, and output per worker are used to account for mediating effects, due to the incomplete dataset for poverty. It further allows the consideration of the impact of ICTs on several economic conditions. Table 1 displays the relevant variables.

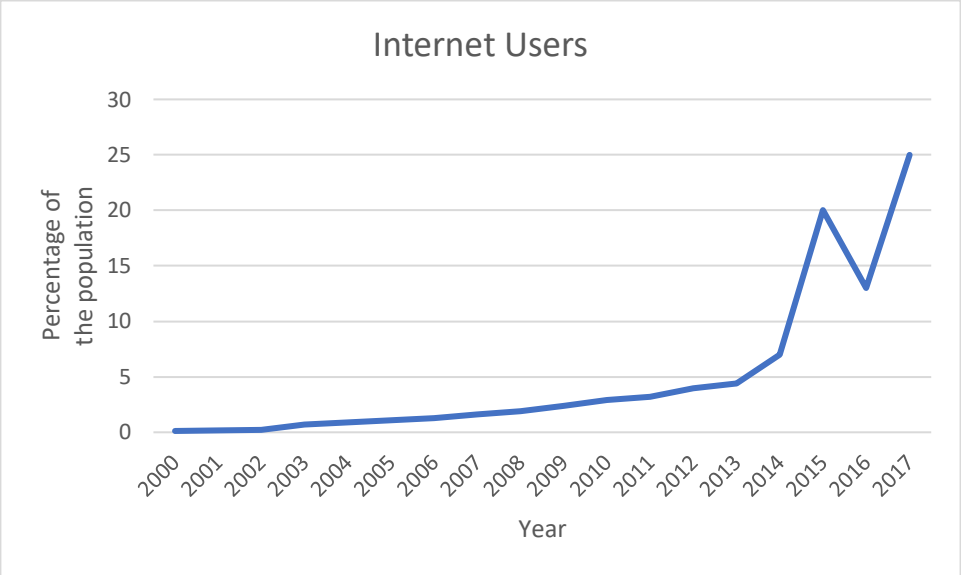
Table 1: List of Variables

Variables	Definition	Source
Exogenous variables		
Internet	Percentage of the population using the Internet	ITU
Mobile	Mobile-cellular telephone subscriptions per 100 inhabitants	ITU
Telephone	Fixed-telephone subscriptions per 100 inhabitants	ITU
Mediating variables		
GNI per capita	Gross National Income per capita (2011 PPP$)	UNDP
Poverty	Working poor at PPP $3.20 a day (% of total employment)	UNDP
Output per worker	Output per worker (GDP constant 2010 US $)	ILO
Endogenous variables		
Live expectancy at birth	The average years people are expected to live at birth as a measure of health.	UNDP
Mean years of schooling	The average years of schooling for the population as a measure of education.	UNDP
GDP per capita	Gross Domestic Product per capita, as a measure of the standard of living.	World Bank

The figures below display the values for the exogenous variables, allowing us to weigh the significance of the data used for the components of ICT. Figure 1 displays data for the percentage of the population using the Internet in Tanzania from 2000-2017. While in 2000, only 0.12% of the population used the Internet, this number increased drastically until 2017 to 25%. The most significant increase from 7% in 2014 to 20% in 2015 indicates the introduction of the National ICT Broadband Backbone as well as the deployment of two submarine cables, which reduced costs and, therefore, increased the number of Internet users (Andrés et al. 2017, p. 181). Interestingly, the percentage of Internet users decreased from 20% in 2015 to 13% in 2016, which can be explained by outdated ICT policies, which the government revised in 2016 (The United Republic of

Tanzania 2016). Thus, the data on the percentage of Internet users is significant and displays the results of national policies.

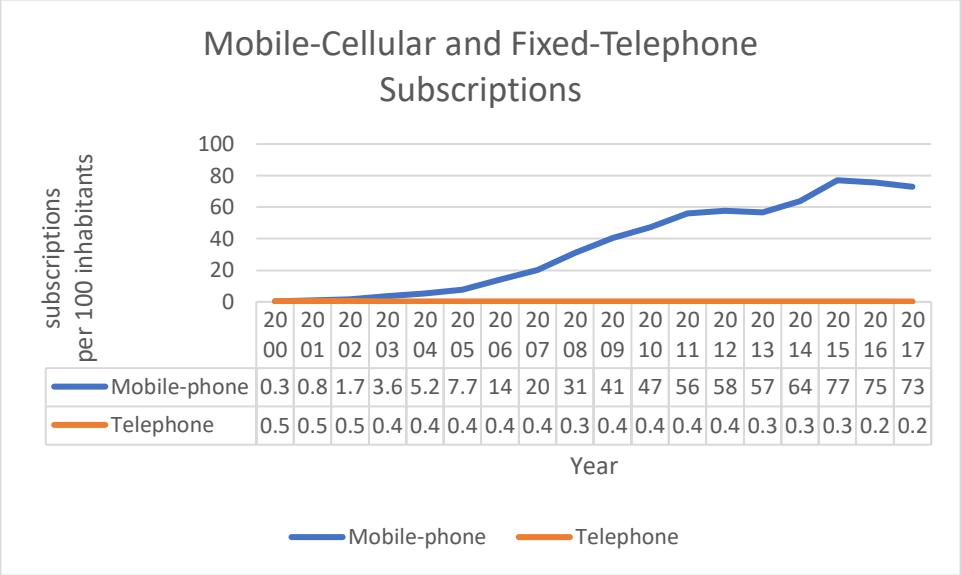
Figure 1: The Percentage of the Population Using the Internet



(Adapted from ITU Data, 2019)

Further, when plotting the numbers of mobile-cellular and fixed-telephone subscriptions per 100 inhabitants in figure 2, it is striking that the numbers of fixed-telephone subscriptions are noticeably small, compared to the high amount of mobile-cellular subscriptions. While the numbers of mobile-cellular subscriptions increased significantly from 0.33 in 2000 to 73.09 in 2017, the number of fixed telephone subscriptions remained low and even slightly decreased from 0.52 in 2000 to 0.23 in 2017. These low numbers of fixed telephone subscriptions can be explained by pointing to the fact that landline infrastructure is expensive, as every building needs to connect to the landline. In contrast, mobile phones use radio masts, which have a more extended reach and are therefore less complicated and more affordable (The Economist 2017). Thus, the numbers of fixed-telephone subscriptions may not be significant for this specific analysis, and the related results need to be reviewed critically.

Figure 2: Mobile-Cellular Telephone and Fixed-Telephone Subscriptions per 100 Inhabitants



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mobile-phone	0.3	0.8	1.7	3.6	5.2	7.7	14	20	31	41	47	56	58	57	64	77	75	73
Telephone	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2

(Adapted from ITU Data, 2019)

Based on the empirical model used by Bankole et al. (2011), this dissertation will conduct path model analysis to test the hypotheses made in section 4. The model fitting programme IBM AMOS (version 25) is used to analyse the data. For the analysis, the three dimensions of ICT infrastructure (exogenous variables), the three mediating variables, and the three components of human development (endogenous variables) are introduced into the software.

5.2. Path Analysis

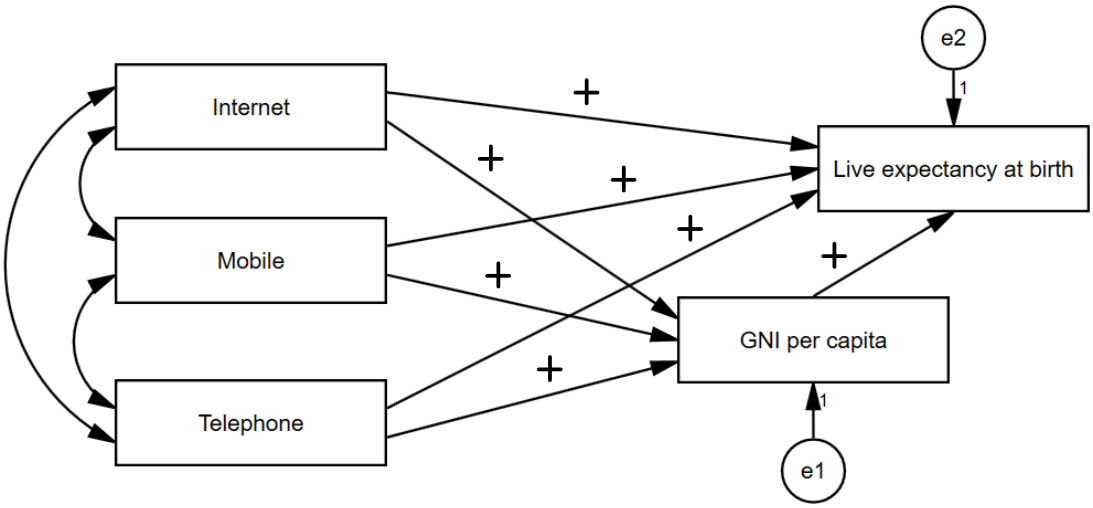
Path analysis was developed by Sewall Wright in the 1920s and is defined as "a statistical method for analysing quantitative data that yields empirical estimates of the effects of variables in a hypothesised causal system" (Bohrnstedt and Knoke 1994, p. 414). It is based on simple regression techniques but allows for a more detailed understanding of the relationship between the examined variables, by analysing not only direct relationships between exogenous and endogenous variables but also indirect effects

through mediating variables (Randolph and Myers 2014, p.2). However, path analysis only allows to compare the magnitude of the relationship between variables, but it cannot distinguish the causal direction of the correlation between the variables. The empirical evidence provided in section four is thus critical to understanding the direct and indirect effects of the three components of ICTs on the three aspects of human development.

The assumptions of path analysis are tested using IBM SPSS Statistics 25. The dependent variables are approximately normally distributed, and the relationships among the variables are assumed to be linear and causal. The residuals (indicated by the circles e1 and e2), are not correlated with the exogenous variables and include all the other causes that affect the endogenous variable. Single-headed arrows indicate the hypothesised impact of one variable (the cause) on another variable (the effect) and assume that causation only flows in one direction. Double-headed arrows illustrate a correlation between the variables, assuming multicollinearity below 0.85 (Stage et al. 2004, p. 11).

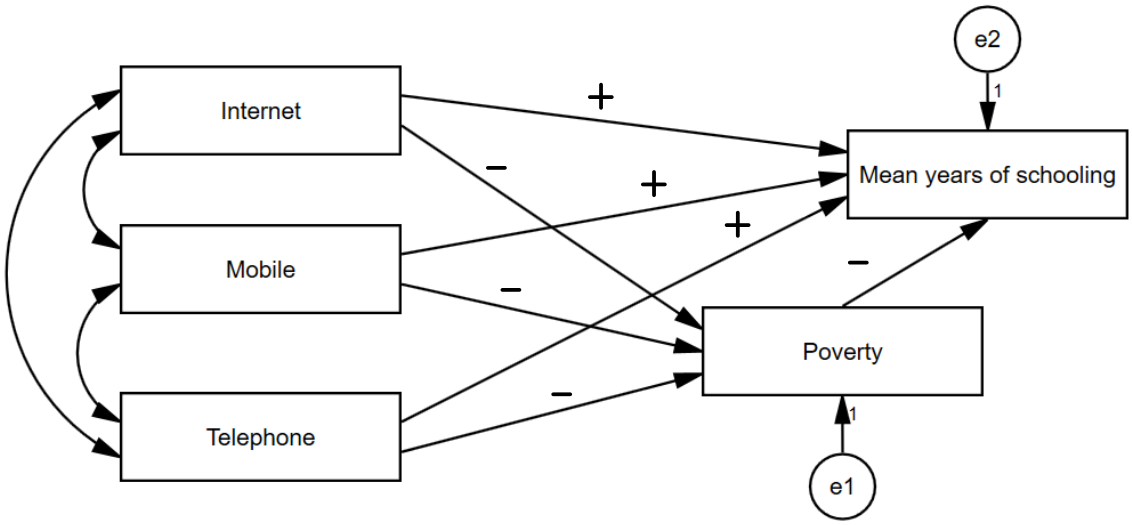
5.3. Model

Model 1: The Impact of the Internet, Mobile Phones and Telephone Landlines on Life Expectancy at Birth:



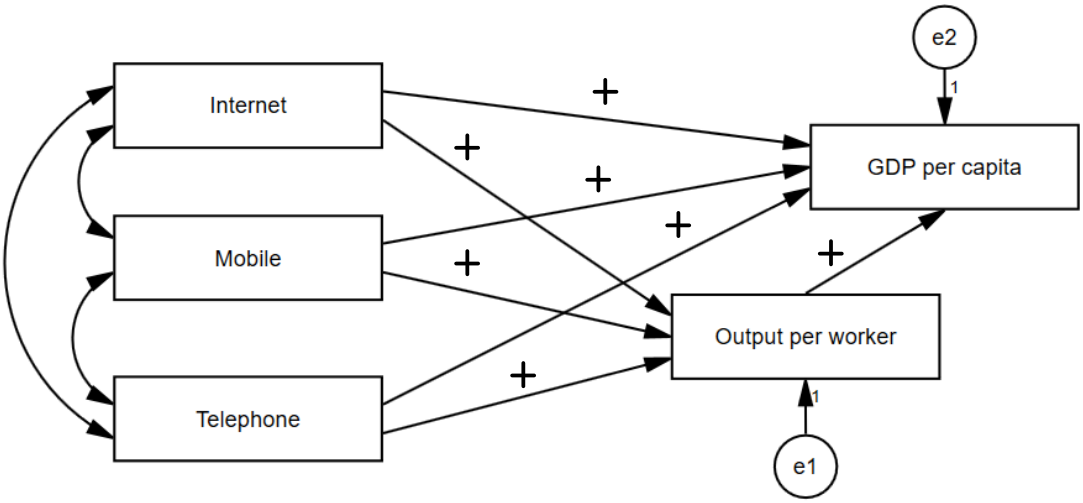
Model 1 represents the relationships among the components of ICT and life expectancy at birth, based on the hypotheses made in section four. The three exogenous variables (Internet, mobile phone, and telephone) are assumed to exert a direct positive impact on GNI per capita and life expectancy at birth. The model expects the mediating variable, GNI per capita, to have a positive direct impact on life expectancy at birth. Further, the three components of ICT are assumed to have a positive indirect effect on life expectancy at birth by increasing GNI per capita.

Model 2: The Impact of the Internet, Mobile Phones and Telephone Landlines on Mean Years of Schooling:



Model 2 shows the relationships among the components of ICT and mean years of schooling, based the hypotheses in section four. The mediating variable indicating an indirect effect is poverty. The model assumes a positive direct impact of the number of Internet users, the amount of mobile-cellular as well as fixed-telephone subscriptions on mean years of schooling. Further, poverty is expected to be negatively correlated to mean years of schooling. Similarly, the three components of ICT are expected to decrease poverty and, therefore, to exert a positive indirect effect on mean years of schooling.

Model 3: The Impact of the Internet, Mobile Phones and Telephone Landlines and GDP per capita:



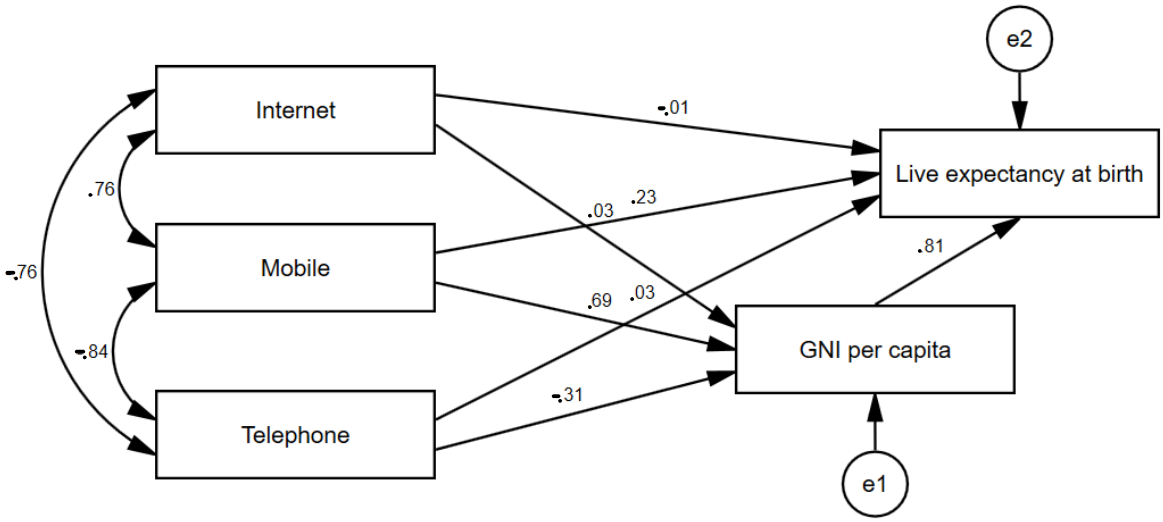
Model 3 represents the relationships between the three components of ICT and GDP per capita as the measure for standard of living. The mediating variable indicating labour productivity is output per worker. The model assumes a positive direct effect of Internet users, mobile-cellular subscriptions, and fixed-telephone subscriptions on GDP per capita. Further, a positive relationship between output per worker and GDP per capita is expected based on the hypotheses in section four. Additionally, the model assumes an indirect positive effect of the three components of ICT on GDP per capita, by increasing output per worker.

6. Application and Analysis

A Maximum Likelihood Estimation is applied to test the models, assuming multivariate normality. The following figures represent the path coefficients, which are the numerical estimates of the causal relationship between two variables. IBM AMOS (version 25) provides the numerical values of the path coefficients. They represent the amount of change expected in the effect variable due to a one-unit change in the cause variable.

6.1. Findings

Figure 3: Path Coefficients in the Path Model for Health



Direct Effects:

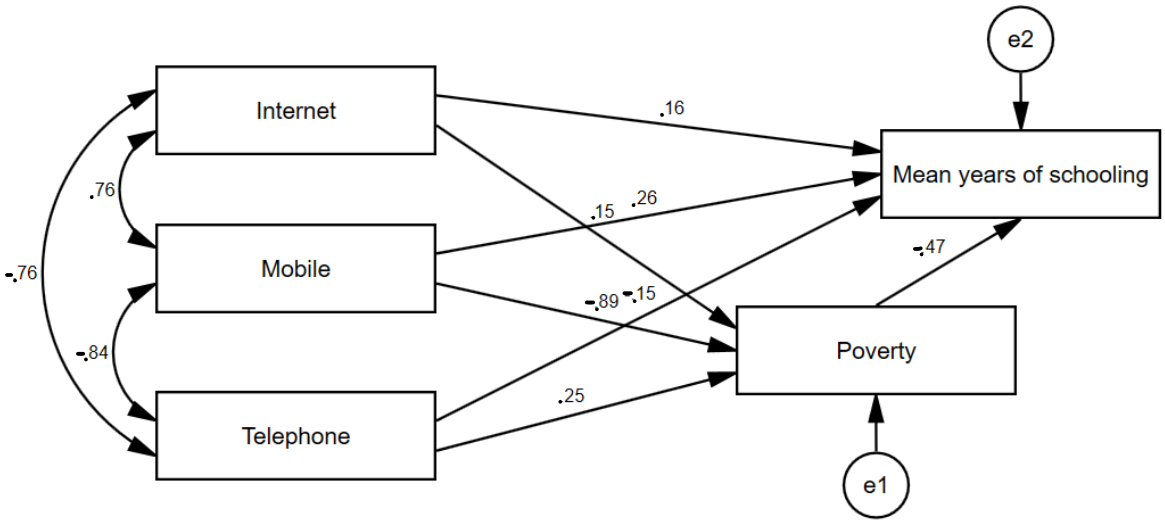
The path coefficient between the Internet and life expectancy at birth is negative, but not statistically significant, as -0.01 (in absolute number)<0.05. Next, the number of mobile-cellular subscriptions directly has a positive and significant impact on life expectancy at birth, as 0.23>0.05. It means that if more people have a mobile cellular subscription, it will increase the years of life expectancy at birth. Meanwhile, the impact of fixed-telephone subscriptions on life expectancy at birth is positive but insignificant, as 0.03<0.05. Further, GNI per capita exerts a positive direct and significant effect on life expectancy at birth, with a path coefficient of 0.81.

Similarly, the impact of the Internet on GNI per capita is positive but insignificant, with 0.03<0.05. In contrast, the impact of mobile phones on GNI per capita is positive and statistically significant, with 0.69. It means that the more people have mobile-cellular subscriptions, the higher is the amount of GNI per capita. The impact of telephone-subscriptions on GNI per capita is negative, but also statistically significant, with -0.31.

Indirect Effects:

The Internet has a positive but insignificant indirect impact on life expectancy at birth through GNI per capita (as 0.03 x 0.81 = 0.02<0.05). Further, the number of mobile-cellular subscriptions indirectly has a positive and significant impact on life expectancy at birth through GNI per capita (0.69 x 0.81 = 0.56>0.05). An increase in the number of mobile-cellular subscriptions indirectly increases life expectancy at birth through increasing GNI per capita. The number of fixed telephone subscriptions has an indirect negative significant effect on life expectancy at birth through GNI per capita (-0.31 x 0.81 = -0.25 (in absolute number)>0.05).

Figure 4: Path Coefficients in the Path Model for Education



Direct Effects:

The path coefficient between the Internet and mean years of schooling is positive and statistically significant, with 0.16. The higher the percentage of Internet users, the higher are the average years of schooling in society. Similarly, the path coefficient between mobile-cellular subscriptions and mean years of schooling is also positive and statistically significant, as 0.26>0.05. An increase in mobile-cellular subscriptions will directly

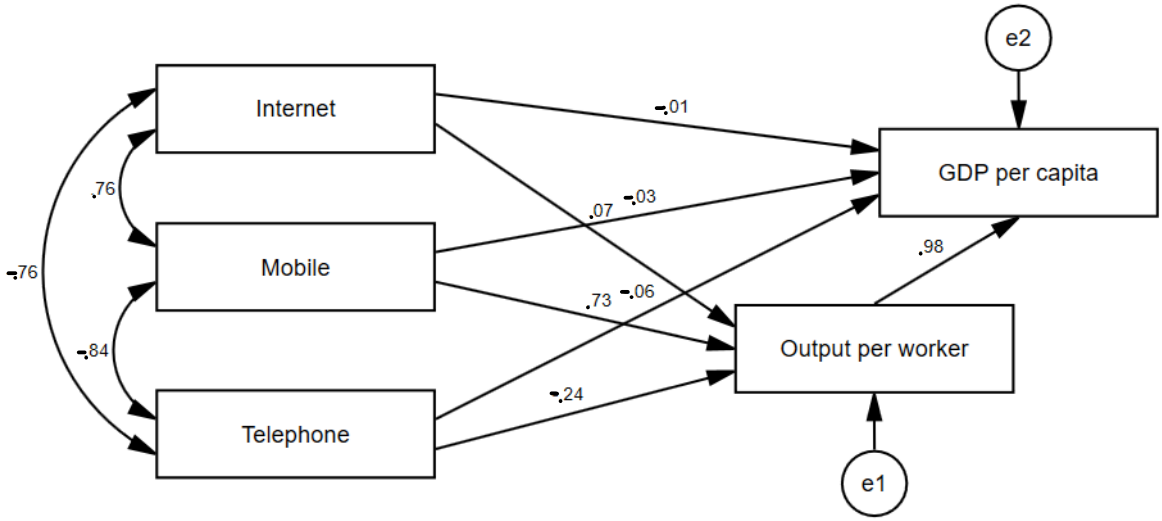
increase the mean years of schooling. The impact of fixed-telephone subscriptions on mean years of schooling is negative and statistically significant, as -0.15 (in absolute number)>0.05. Poverty exerts a negative and significant impact on mean years of schooling, with -0.47. A reduction in poverty will increase the mean years of schooling in society.

The direct impact of the Internet on poverty is positive and significant, with a path coefficient of 0.15. Further, mobile phones exert a negative and statistically significant impact on poverty, with -0.89. The higher the number of Internet users and mobile-cellular subscriptions, the lower the number of poor people. The impact of fixed-telephone subscriptions on poverty is positive and statistically significant, with 0.25>0.05.

Indirect Effects:

The Internet has a negative indirect impact on mean years of schooling, through poverty. The impact is weak but significant, with 0.15 x -0.47 = -0.07 (in absolute number)>0.05. Further, the number of mobile-cellular subscriptions indirectly has a positive and significant impact on mean years of schooling, through poverty (-0.89 x -0.47 = 0.42). An increase in the number of mobile-cellular subscriptions indirectly increases the mean years of schooling by reducing poverty. The number of fixed telephone subscriptions has a negative but significant indirect impact on the mean years of schooling (0.25 x -0.47 = -0.12).

Figure 5: Path Coefficients in the Path Model for Standard of Living



Direct Effects:

The path coefficients for both the number of Internet users and the number of mobile-cellular subscriptions indicate a negative direct impact on GDP per capita. These impacts, however, are not statistically significant. Fixed-telephone subscriptions have a weak negative impact on GDP per capita, with a path coefficient of -0.06. The path coefficient between output per worker and GDP per capita is 0.98 and indicates a significant positive impact. An increase in output per worker will significantly increase GDP per capita.

Further, the direct impact of the Internet on output per worker is positive and significant, with 0.07>0.05. The higher the number of Internet users, the higher is the output per worker. The path coefficient between the number of mobile-cellular subscriptions and output per worker indicates a strong positive impact. As 0.73>0.05, it is statistically significant. An increase in the number of mobile-cellular subscriptions increases output per worker. Lastly, the path coefficient between fixed-telephone subscriptions and output per worker is negative and significant, with -0.24>0.05.

Indirect Effects:

The Internet has a positive indirect impact on GDP per capita through output per worker. The impact is weak but significant, with 0.07 x 0.98 = 0.07>0.05. An increase in the number of Internet users indirectly increases GDP per capita. Further, the number of mobile-cellular subscriptions indirectly has a positive and significant impact on GDP per capita, through increasing output per worker (0.73 x 0.98 = 0.72). The number of fixed telephone subscriptions has a negative and significant indirect impact on GDP per capita (-0.24 x 0.98 = -0.24).

6.2. Analysis

The research questions stated in the introduction can now be answered by applying the findings to the hypotheses stated in section four.

(1) What are the impacts of the Internet, mobile phones and telephone landlines on health?

Table 2: Test of Hypotheses for Health

H1a: Increases in GNI per capita exert a positive effect on life expectancy at birth. - **Supported**
H1b: The Internet exerts a positive direct effect on life expectancy at birth. – **Not supported**
H1c: The Internet exerts a positive indirect effect on life expectancy at birth by increasing GNI per capita. – **Not Supported**
H1d: Mobile phones exert a positive direct effect on life expectancy at birth. – **Supported**
H1e: Mobile phones exert a positive indirect effect on life expectancy at birth by increasing GNI per capita. – **Supported**
H1f: Telephones exert a positive direct effect on life expectancy at birth. – **Not supported**
H1g: Telephones exert a positive indirect effect on life expectancy at birth by increasing GNI per capita. – **Not supported**

Mobile phones exert the most compelling direct and indirect impact on health. This success of mobile phones results from a variety of services offered, including mHealth and mPay. These services only require a simple cell phone and have great potential to connect rural areas to the rest of the world. By enabling people to receive treatment advice and providing phone-based money transfer, professionals can monitor the people's health state, and people can budget their household income and direct it towards health services. By increasing GNI per capita, mobile phones exert a positive indirect impact on life expectancy at birth, as wealthier people can afford the resources that protect and improve health (Woolf et al. 2015, p.4). The number of Internet users and fixed-telephone subscriptions, on the other hand, do not have a significant impact on health.

(2) What are the impacts of the Internet, mobile phones and telephone landlines on education?

Table 3: Test of Hypotheses for Education

H2a: A reduction in poverty can positively influence mean years of schooling. – **Supported**
H2b: The Internet exerts a positive direct effect on mean years of schooling. – **Supported**
H2c: The Internet exerts a positive indirect effect on mean years of schooling by reducing poverty. – **Not Supported**
H2d: Mobile phones exert a positive direct effect on mean years of schooling. – **Supported**
H2e: Mobile phones exert a positive indirect effect on mean years of schooling by reducing poverty. – **Supported**
H2f: Telephones exert a positive direct effect on mean years of schooling. – **Not supported**
H2g: Telephones exert a positive indirect effect on mean years of schooling by reducing poverty. – **Not supported**

Similarly, mobile phones also exert the most significant direct and indirect impact on education. Mobile phones have the potential to connect students and teachers, which expands the learning opportunities of students and, therefore, increases mean years of

schooling. Further, mobile-cellular telephone subscriptions are most successful in decreasing the level of poverty, as they expand social networks and create new socio-economic opportunities for society. A reduction in the level of poverty has a positive impact on mean years of schooling, as wealthier households can afford education better and provide a more comfortable learning environment for students (Hirsch 2007, p. 6). Further, the Internet exerts a weak positive direct impact on education, as it enables distance learning and online studies, therefore providing an opportunity for people in rural areas to receive an education. However, the findings indicate no significant indirect impact of the Internet on education as well as no significant impact of fixed-telephone lines on education.

(3) What are the impacts of the Internet, mobile phones and telephone landlines on the standard of living?

Table 4: Test of Hypotheses for Standard of Living

H3a: An increase in output per worker exerts a positive effect on GDP per capita. – **Supported**
H3b: The Internet exerts a positive direct effect on GDP per capita. – **Not supported**
H3c: The Internet exerts a positive indirect effect on GDP per capita by increasing output per worker. – **Supported**
H3d: Mobile phones exert a positive direct effect on GDP per capita. – **Not supported**
H3e: Mobile phones exert a positive indirect effect on GDP per capita by increasing output per worker. – **Supported**
H3f: Telephones exert a positive direct effect on GDP per capita. – **Not supported**
H3g: Telephones exert a positive indirect effect on GDP per capita by increasing output per worker. – **Not supported**

According to the findings in section 6.1., none of the three components of ICT has a significant direct impact on the standard of living. Therefore, the use of ICTs alone does not contribute to a better standard of living. Only through mediating factors, the Internet

and mobile phones can indirectly impact the standard of living. Again, mobile phones exert the most substantial indirect impact on the standard of living. By connecting people in different areas of the country, mobile phones induce a movement in the labour force from agricultural to non-farming sectors, therefore increasing output per worker and GDP per capita. Further, the Internet has a weak positive indirect impact on GDP per capita, as it enables spillover effects of knowledge and, therefore, increases output per worker. Again, the findings indicate no significant direct or indirect impact of fixed-telephone lines on the standard of living.

6.3. Discussion

What are the most compelling impacts of ICT use on human development in Tanzania?

Mobile phones exert the most compelling impact on all three components of human development. Telephone landlines, on the other hand, do not have any impact on human development in Tanzania. Figure 2 in section 5.1. explains this by showing high numbers of mobile-cellular subscriptions in Tanzania, while the numbers of fixed-telephone subscriptions are small and insignificant. Thus, the results for the impact of fixed-telephone lines are unlikely and require further detailed analysis. Further, the Internet only has some weak impacts on human development, due to the lack of electricity in many areas, which makes Internet usage difficult. Thus, people invest predominantly in mobile phones, as they do not require much electricity and are most beneficial for increasing their quality of life.

7. Conclusion and Policy Implications

The purpose of this dissertation was to analyse what components of ICT infrastructure are most effective in achieving human development in Tanzania to provide relevant

information for policymakers. Three secondary research questions were established to analyse the impacts of all three components of ICT on health, education, and the standard of living. Investment in ICT infrastructure is important for Tanzania to achieve human progress, lift the country out of poverty and increase its HDI. Therefore, the right factors of ICT infrastructure need to be expanded, for the country to achieve the National Five-Year Development Plan 2016/17-2020/21 as well as the SDGs.

Section two introduced the components of human development and ICT infrastructure, as well as the measures of economic conditions affected by ICTs. With the introduction of the human development approach in the 1990s, policies aim to increase health, education, and the standard of living. The economic theories introduced in section four stress the importance of technological advancement in achieving long-run economic growth and human development. By either augmenting capital and labour or breaking up the circular flow and encouraging investments, technological progress has the potential to increase long-run economic growth. Based on these theories, hypotheses on the direct and indirect impact of ICTs on human development were developed based on empirical evidence.

The academic literature suggested positive direct and indirect impacts of all three components of ICT on health, education, and the standard of living. Based on these hypotheses, path analysis was conducted, using IBM AMOS, to analyse the direct and indirect impact of the number of Internet users, the number of mobile-cellular telephone subscriptions, as well as fixed-telephone subscriptions on life expectancy at birth, mean years of schooling, and GDP per capita. Three mediating variables (GNI per capita, poverty, and output per worker) were used to measure the economic conditions in the country. Path coefficients provided the numerical estimates of the relationship between two variables.

Contrary to previous findings in the academic literature, this dissertation concludes that telephone landlines have no significant impact on human development. Building telephone landlines is too intricated and costly, which results in an insignificantly small amount of fixed-telephone subscriptions in Tanzania. The findings on mobile phones, on the other hand, are in line with previous literature, as they exert a very strong positive impact on all factors of human development. Mobile phones directly increase life expectancy at birth and mean years of schooling. They further indirectly increase health, education, and GDP per capita by increasing GNI per capita, output per worker, and reducing poverty. Mobile services such as mPay and mHealth enable people to receive treatment advice and conduct phone-based money transfer, which has a significant positive impact on their daily life. The Internet, on the other hand, has only a small role in achieving human development in Tanzania. Internet requires a lot of electricity and digital infrastructure, which is lacking in most areas in the country. The findings indicated a weak positive direct effect of the Internet on mean years of schooling and a positive indirect effect on the standard of living by increasing output per worker.

Overall, the first step for policymakers is to invest in simple mobile phone infrastructure in Tanzania, to increase the HDI and reduce poverty. The next step in the future will be to make the Internet available through mobile phones, which will require only small amendments in the infrastructure and open up important opportunities to access global markets.

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