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# Can the Fourth Industrial Revolution - Industry 4.0 - Hold the Future for Africa´s Industrialisation?

Case Study of Kenya

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# Abstract

The world has seen three industrial revolutions and now it embraces the fourth. The fourth industrial revolution, (globalisation 4.0) or as this study uses industry 4.0, follows onto the third industrial revolution by connecting digital, material and living spheres. The narrative of Africa rising, and the related expansion of mobile phone motivated the thesis interest. As past development policies showed to be ineffective for Africa´s industrialisation, the thesis explores how so-called industry 4.0 characterised with technologies of speed, scope and systems can accelerate industrialisation in emerging economies such as Kenya and repeat the East Asian miracle. Review of past and recent models of industrialisation provided a theoretical proposition to build a theoretical framework. The study uses qualitative exploratory research methods to the instrumental case study of Kenya. Data collection combined findings from semi-structured interviews and results from previous studies. The case was analysed using themes from findings in relation to the theoretical framework. The analysis shows that industry 4.0 characterised by ICT innovation stimulates Africa´s share in the global economy.

Findings reveal that industry 4.0 innovations drive services, business and consumption by providing access to financial services. The use of digital platforms increases market share and potential for Africa to develop a comparative advantage. Digital platforms provide the opportunity to reduce the informal sector and formalise it via mobile payments.



**Keywords:** the fourth industrial revolution, industry 4.0, global value chain, Kenya, digital economy, Sub-Saharan Africa, industrialisation, digital platforms, green growth


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# 1 Introduction

The world is in the early stage of the fourth industrial revolution that connects humans´ biological bodies with high-tech artificial systems. This ubiquitous revolution, also called globalisation 4.0, is driven by advanced information and communication technologies (ICT). It permeates every economic sector, transforms global politics and outmodes existing economic models. It also induces the creation of the new arcane industry 4.0 that is formed by technologies such as artificial intelligence, machine learning and internet of things (*World Economic Forum, 2018*). The acceleration of ICT innovations is opening a way for Africa to integrate into the global economy. Around the year 2010 African narrative - "Africa rising" described the sharp economic growth with increased access to the internet and mobile phones. However, while the poverty rate across Africa dropped, the absolute number of people living in extreme poverty continued to increase (*World Bank, 2016).*

The African continent was the experiment of the colonial model motivated by the exploitation of Africa´s natural resources which, along with labour, were important for Europe´s industrialisation. Since decolonisation Africa continued with imposed development models aimed to promote economic growth and industrialisation. More than half a century after independence Africa, however, remains a continent with high levels of extreme poverty plagued with conflict, climate change, illiteracy and rising inequality.

Nevertheless, the new narrative of "Africa leapfrogging" metonym for a fast move in traditional industrial development due to technological innovations unlock potential to escape poverty, increase the wealth with access to social services, banking, education and apply more sustainable energy solutions. Digital innovations are transforming manufacturing with internet connectivity and data integration with opportunities for new forms of employment. The industry 4.0 sector may especially contribute to transparency and convert the informal sector, Africa ´ largest source of employment, into the formal sector. Africa´s population

is rapidly growing and accounts for the world´s largest amount of youth population below the age of 25 (*United Nations Development Programme, 2017*). A young workforce offers either an advantage to capitalise on African talent or a risk of massive unemployment as a result of lacking technological and specialised skills. Kenya, the country selected for a case study, is acclaimed a dazzle of Africa's technological innovations, entrepreneurship and mobile revolution. Remarkably, the landing of fibre optic cable, innovations of mobile money - M-Pesa, coupled with monitoring disaster platform - Ushahidi denoted Kenya as a Silicon Savannah after a global technological centre Silicon Valley. Besides Kenya, other African countries such as Rwanda, Tanzania and Nigeria are advancing on technological innovations. Kenya´s capital Nairobi is growing rapidly with a population of more than three million and the city has become the second largest for investment behind South Africa (Constable, 2018). Given significant economic growth, Kenya reaches extreme inequality level, 0.1% of people possess a wealth of 99 % population (Oxfam, 2017).

## 1.1 Problem Statement and Contribution to Research

Research on Africa´s economic development has focused among numerous on natural resources and conflict traps (Collier, 2007), weak political leaders and institutions (Acemoglu and Robinson, 2012) failures of foreign aid (Moyo, 2009). However, the literature investigating Africa´s economic transformation has not yet addressed the impact of digital services and technological innovations within Africa´s industrialisation process. Given recent debates on the fourth industrial revolution and digitalisation, academic research has mainly underlined the theoretical debate on the fourth industrial revolution, industry 4.0 and globalisation 4.0 with positive and negative implications on society and economy in developed countries. Little has been researched about industry 4.0 and the empirical analysis, the role of geography and economic clusters in Africa (Li et al., 2017). Until now, most research has examined globalisation and ICT for development with the main exploration of mobile phones in Africa and internet

expansion (Gosavi, 2018; Foster et al., 2018; Graham and Mann, 2013; Murphy et al., 2014). Current studies have illuminated increasing technological disruption in production, the threat of job replacement due to automation in developed countries but little is known about these factors in developing countries (Baldwin, 2019). Recent research also suggests limited knowledge of new technological advances and its consequences on inequality and economic development (Baek, 2018). Whilst much research on Kenya have scrutinised the development of mobile money – M-Pesa and ICT, no research has been found on industry 4.0 innovations in the context of the industrialisation process. The most released research on the fourth industrial revolution examines characteristics of new technological advances but lacks a detailed empirical study. This indicates a need to understand the theoretical dynamic of industry 4.0 and its capabilities in a real case. This thesis attempts to address such gaps and bring new knowledge to the growing research area of the fourth industrial revolution and Africa´s economic development. The thesis makes an original contribution to the development studies field by questioning if industry 4.0 can provide a new model that enables Africa´s industrialisation as this problem remains unexplored.

## 1.2 Purpose of the Study

The purpose of this study was inspired by my internship in an organisation, Copenhagen Capacity in Denmark. This experience introduced me to accelerating technological innovations and their ramifications of fierce competition for Science, Technology, Engineering, Mathematics (STEM) skills that drive society into a knowledge economy. My personal interest in Africa´s economic development and global power-structures motivated me to explore the unprecedented speed of industry 4.0 innovations in developing countries. I chose the topic because globalisation 4.0 characterised by augmentation of ICT advances changes the nature of human work and the global economy. The global phenomenon challenges the role of human beings in the society and economic growth, thereby I believe it is critical to examine its interconnection with

development studies. The thesis conceptualises the industry 4.0 sector that encompasses one of the most pressing issues such as climate change and poverty. The study highlights the essence of intersection between disciplines of development studies and global studies and the value of combining the knowledge of several academic disciplines. My wish is to offer new insight into Africa´s socio-economic development by understanding industry 4.0 framework within the development of the industrialisation process and overall contribution to the development policies and future research. Overall, I endeavour to produce new knowledge that enriches the traditions of Africa´s development model.

## 1.3 The Aim and Research Questions

The overarching aim of the thesis is to understand the opportunities and challenges of so- called industry 4.0, and whether this industry sector offers a new model for emerging countries like Kenya to accelerate development of industrialisation process. Given this aim, two following research questions have been set out;

1. What are the opportunities and challenges related to industry 4.0 in terms of enabling emerging economies like Kenya to accelerate the industrialisation process?
2. How does the development of industry 4.0 in some African countries unlock conditions for the movement of production processes from more industrialised economies to less industrialised economies?

## 1.4 Thesis Structure

The thesis consists of 6 chapters that are organised in the following way; the thesis begins by introducing the topic, outline of the research gaps, the reason for the study, purpose and research questions. Followingly, the literature review summarises the previous research and gives insights into development and industrialisation policies. Chapter three arranges theoretical dimensions of industry 4.0, premised on the literature review and used for the analysis. Chapter four outlines the epistemological approach and research design of the case study method. Chapter five provides a general background about Kenya and analyses the findings of interviews and other literature sources. The chapter six focuses on the summary of the findings and policy implications. The remaining passage concludes and suggests avenues for further research.

# 2 Literature Review

This chapter provides a brief overview and introduction to the concept of industry 4.0'and its use in past and recent development. This is to situate the concept of industry 4.0 within previous development policies aiming to promote industrialisation with particular focus on Africa´s industrialisation. The section continues discussing the effects of globalisation, its processes and the intertwining emergence of the fourth industrial revolution characterised by acceleration of ICT innovations. The passage concludes with a debate on structural transformation to understand the underlying factors of economic development and their relations in the global economies structure.

## 2.1 Development Insights and Industrialisation Policies

The demise of imperial powers led to the independence of former colonies. The genesis of development started when Africa and Asia achieved independence, after Second World War (Levitt, 2017). Development thinkers met at the leading institutions of Cambridge and Oxford and the discipline of development studies was later established at US universities with a central subject of development economics (ibid:33). Since then, the development quest has been to find an appropriate model of industrialization to encourage economic development. Accordingly, the chapter uncovers major events and responsive policies which sought to advance industrialization in countries classified in development debates as "Third World", or "Global South" (Desai and Potter, 2014).

### 2.1.1 Policy of Import Substitution Industrialisation

The following section aims to review past models of development and approaches that tried to explain economic growth and development. Lewis (1954) introduced the economic development model, a period marked as structural transformation. Lewis "dual-sector model" argues that when labour surplus from "subsistence sector"[1] is shifted to "capitalistic sector"[2], the rise of labour productivity

[1] Subsistence sector is used for "small-scale family agriculture" Lewis (1954) in (Binns, 2014: 101)

contributes to countries' productivity growth. Later, Rostow (1960) Stages of Economic Growth, introduced additional ideas of how the transformation could take place and what was necessary. Rostow's model of economic growth explains that any country may modernize if it undergoes five phases of development from, "traditional society to mass consumption" (Rostow, 1960). Developing countries, supported by development theories, decided to adopt policy knowns as import substitution industrialisation (ISI) from the 1950s until 1980s. The policy objectives were to increase domestic production and reduce dependency on foreign import from developed countries (Ahmad, 1978). Furthermore, neoliberal thought became the leading ideology with emphasis on aid reforms and structural adjustment policies known as "Washington Consensus" (Williamson, 2009). The neoliberal project of a free market economy has been widely criticised as an imperialistic construction of the Western world (Harvey, 2007).

### 2.1.2 Washington Consensus and East-Asian Economic Growth

Neoliberal policy with main ideas of free trade, privatisation and deregulation came into place under the development strategy of Washington Consensus. The Washington Consensus was proposed as an economic recommendation to help developing countries stabilise the economic growth from the economic crisis in the 1980s (Northover, 2014: 33–34). The main policy areas included market openness and macroeconomic policies. The Washington Consensus was adopted by the International Monetary Fund (IMF), World Bank and the US Treasury in the form of loans provided to developing countries to stimulate their development and growth of the market economy (loans were one of the multipronged approaches advocated by the IMF) (Williamson, 2004).

The structural adjustment policies were forced upon the countries of Latin America as a result of the Latin America countries financial crises and the inability to pay their debts from loans taken during the 1970s and 1980s. In many

[2] Capitalist sector includes manufacturing and agriculture that is private or owned by state Lewis (1954) in (Binns, 2014: 101)

African countries, deregulation had a negative impact on food export. African farmers were stripped of subsidies and commodities such as cotton for example could not compete with the US market (Levitt, 2017:35). In comparison, some of the East-Asian countries such as Japan and four tigers, Hong Kong, the Republic of Korea, Singapore and Taiwan were able to industrialize (International Bank for Reconstruction and Development, 1993). Government and business organization formulated active policies with emphasis on import substitution and export support to stimulate industrialisation. For example, a successful model of Japan represented by cooperation between large businesses and local development banks was adopted by Korea. Taiwan concentrated on technological development.

Wade (1992) argued that East-Asian countries were able to achieve economic growth and industrialise not because of IMF and World Bank policies but instead US geopolitical activities such as US inflow of economic aid in the region, which provided needed capital for industrial infrastructure (Wade, 1992:312) and disregarded neoliberal policies such as low taxes and promotion of export. Similarly, the role of state and the regulatory system against the foreign import of goods referred to "protectionism" and the import of capital and knowledge was crucial to advance industries (ibid.). In addition, already developed agriculture had enabled to allocate resource in manufacturing (ibid:312). Admittedly, strengthening of manufacturing for export, a collaboration of private and state-owned companies and incentives of foreign direct investment (FDI) succeeded in other East-Asian economies including Malaysia, Thailand, Indonesia and afterwards Vietnam. Strategies such as private and state business ownership was important for a Chinese economic model. China and to a lesser extend India became newly industrialized economies at the beginning of the 1990s. Overall, the strong state control over enterprises, protective governmental policies and methods to manage regional and equity of land were determinative factors for industrialization and economic development (Wade, 1992: 270-320).

### 2.1.3 Post-Washington Consensus

The policies of the Washington Consensus recommended and supported by the powerful financial institution including IMG and World Bank received extensive criticism for failing to increase economic growth in developing countries (Stiglitz, 2008). Therefore, a new policy framework known as the Post-Washington Consensus was designed to enhance the former neoliberal structure and formulate new objectives of "good governance and ownership" The Post-Washington Consensus particularly focused on the role the state politics, public sector and building cooperation between the government of developing countries - receivers and donors – developed countries (Öniş and Şenses, 2005; Waeyeberge, 2017). Nevertheless, these instrumental policies resulted in dependence on donor´s aid and accumulation of liabilities that promoted the donor´s agenda (Waeyeberge, 2017:209). Programmes disregarded countries social and historical condition and their "specific" needs. (ibid:211). Studies argue that donors provide more aid to countries based on economic, political and geographical interest (Younsi et al., 2019: 3-14), which results in the unequal distribution conditioned by private capital flow to developing countries (Waeyeberge, 2017:212). In summary, the Post-Washington Consensus encompassed a re-formulation of the neoliberal scheme with an emphasis on the state function and funding of development. The results of the Post-Washington Consensus failed to address the poverty, inequality and lasting economic problems. Therefore, new development policy of poverty reduction was prescribed referred to as Millennium Development Goals.

### 2.1.4 Sustainable Development Goals and African Economic Growth

Africa has significantly moved forward and improved socio-economic characteristics including an increase in children school enrolment, a decrease of child and maternal deaths and, to a lesser degree, a reduction in extreme poverty (Armah and Baek, 2015). The Millenium Development Goals ended in 2015 and official development assistance supported the progress. Africa is one the largest receivers of ODA (Armah and Baek, 2015: 473–474) and despite its significant

growth, sustainability has become an important question, especially how to accomplish and maintain sustainable economic growth?

Africa faces socioeconomic and environmental challenges and questions of sustainable economic growth are critical for development because increased growth does not automatically lead to a decrease in poverty. Specifically, the pressing problem of high unemployment keeps people trapped in poverty. Armah and Baek, (2015) underline that Africa experiences the highest extreme poverty rate globally (Armah and Baek, 2015:2). To illustrate, in Sub-Saharan Africa about 70 % of jobs are at risk of shortages with estimated youth unemployment of 21.1 %. (ibid:4). Unemployment and income inequality make difficult for people to access public services. Furthermore, large differences between rural and urban areas and formal and informal sectors weaken access to health and education service. Thieme, (2018) argues that in rapidly urbanizing cities such as Nairobi, young people live in a "hustle economy", under conditions of precarious labour markets and uncertainty about their future (Thieme, 2018). Consequently, the inability to access social services impairs development.

Furthermore, McMillan and Rodrik, (2011) explain that Africa´s dependence on primary commodities generates low productivity and block advancement into a higher industrial sector (McMillan and Rodrik, 2011). Armah and Baek, (2018) explain that low productivity occurs because of a lack of inclusive growth (Armah and Baek, 2018: 4–5). Therefore, questions have been raised about the appropriate model of industrialization to reduce inequality and meet sustainable inclusive targets. The section continues with a programme of sustainable development.

### 2.1.5 The Agenda 2030 and the Agenda 2063

Africa has adopted the 2030 Agenda for Sustainable Development, which is a global framework for Sustainable Development. It emphasizes the significance of sustainable development and aims to "end all forms of poverty", combat inequality and climate change (United Nations, 2018). Furthermore, Africa signed the continental agreement, Agenda 2063 for Sustainable Development, which

rests on past transformative initiatives to enhance growth along with sustainable development (*United Nations, OSAA, 2018*). In contrast to past global development agreements, Agenda 2030 promotes "added value and industrialization". Agenda 2063 also supports industrialisation with value added to the African nation and community *(The African Union, 2019*; Armah and Baek, 2018:6). Differences from previous policies are that both agendas pursue an inclusive approach with the importance of environmental sustainability and social inclusion. The following section discusses the globalisation and its role in the international division of labour. It focuses on the development of global economy and patterns of uneven development.

This section moves from the global development agreements to the effects of globalisation.

## 2.2 Perspective on the Global Economy and International Division of Labour

A large volume of literature has been published on globalisation; Giddens (1991) described globalisation as "time-space distanciation" of social relations interactions over space and time; Friedman (2005) labelled globalisation being a "flat" world, or Castells (1996) introduced a term of a "network society in which" information communication technologies influences the globalising society.

Dicken (2017) shows a broad debate between scholar's so-called "pro-globalist" who embrace advantages of open market and more equal opportunities, "hyper-globalists"[3] those rejecting asserting that globalisation causes uneven development and contribute to socio-economic and environmental problems. Finally, "sceptical internationalists" arguing that the world economy is internationalised but not completely globalised (Dicken, 2017: 4–5).

[3] Hyperglobalist, term firstly used by Held and McGrew (2007)

The concept of globalisation has been broadly debated and its different meanings have often been misinterpreted or refused (Scholte, 2008). The origins can be traced to the work of Marx and Engels in The Communist Manifesto. Marx and Engels (1848) write *"the need of a constantly expanding market for its products chases the bourgeoisie over the entire surface of the globe"* (Marx and Engels, 2002:16).

Dicken (2017) notes that it is important to perceive past events and historical structures, their relationships along with geographical mapping to understand contemporary global economy (Dicken, 2017:14). The foundations of the current arrangement of the global economy can be realized by examining the World-System Theory, firstly introduced by Wallerstein (1974)[4] Recently, growing research has focused on the World-System Analysis (e. g. Chase-Dunn and Babones, 2006; Hall, 2018). Wallerstein (2005) defines the world as the world-system, "world-economy" seeded in Europe and the Americas in the sixteenth century and further embraced the entire globe. "World-economy is a large geographic zone" with several political constituents where the exchange of goods, capital and labour occurs based on the division of labour (Wallerstein, 2005:23).

Wallerstein (2015) argues that the world-economy incorporates many markets that together form the capitalist system. This is a system of unlimited accumulation of capital that operates on the principles of compliances and constraints. Within global market is a system "quasi-monopolies" in other words political instruments including, "patent, protective measurements, tax, subsidies, state regulation". The use of these instruments stimulates a large concentration of capital. Thus, "quasi-monopolies" hold a large share on the market and dominates the market because of advanced products. Once the advanced product is displaced by other advanced products capital relocates to new advanced products or entire industries. (Wallerstein, 2015: 23–29). Firms are the ones who operate the markets, they are competing with other firms depending on the level of "monopolisation" and profit from the production process. Accordingly, the "capitalist system" of many

[4] Wallerstein (1974) The Modern World-System

markets, operated by firms divides labour into the structure of high-value-added manufacturing, service sector with "high-wages" and "high-technology" – "cores" and "peripheries" reliant on agriculture and raw materials with "low-wages" and "low-technologies" (Wallerstein, 1979: 38–97). In this context, "cores" have a dominant position through "quasi-monopolies" and peripheries are disadvantaged as they compete with the core producers. Therefore, core production processes are better off because of the added value flow from production of peripheries, proprietary technology, better economics of scale or network effect known as the "unequal exchange" (Wallerstein, 2005: 26-38). To illustrate, core production is represented by a few well-built states and periphery production by many states which may form a combination of both, so-called states of semi-peripheral production processes. Semi-peripheral states face a constant struggle for advancing. They compete with peripheries to escape from their position and simultaneously approach the core states (ibid:29). Wallerstein, (2005) notes that semi-peripheries face many problems and often use strong "protectionist" measures (Wallerstein, 2005:29). Babones (2017) argues that the world-system is changeable, and a new modern world-system of global cities is on the rise. Within global cities, new regimes of urban slums appear, so called "embedded peripheries" (Lindsey, 2012).

The global economy has experienced pronounced changes of increased rates of "interconnectedness" and "speed", resulting in expanding economic activities that constantly dislocate former geographies and form new "geographical space" (Dicken, 2017:6). Especially, the ways in which economic exchange interacts "across geographical space" over the quantity of goods and services that are traded. As a result, globalising systems are determined by "multiple geographies" and the degree to which economic activities integrate and move in different directions. Dicken (2017) distinguishes the following "processes" of global economic change;

1. *"Localising processes*" encompass economic activities which are geographically centred with changing the level of unification

2. "*Internationalising processes*" geographical shift occurs, and economic activities move across national borders at a low level of unification.

3. "*Globalising processes"* economic activities are increasingly shifted across geographies with high-level of unification.

4. "*Regionalizing processes*" increasing intensification of global economic activities at the supranational level with a decrease of "geographical spread". States create geographical regions with objectives of economic cooperation such as the European Union (Dicken, 2017: 7–8).

Moreover, the thesis draws especially on the work of Baldwin, (2016) who studies globalisation as a process in which production and consumption splits geographically based on three costs of remoteness. These are costs of moving goods, costs of moving ideas and costs of moving people that represent trading costs, communication costs and person-to-person costs, respectively (Baldwin, 2016:4).

These costs of remoteness gradually change as a globalisation undergoes four different phases; "*Phase one: Humanizing the globe (200 000 BCE to about 10 000 BCE), Phase two Localizing the global economy (10 000 BCE to 1820 CE), Phase three Globalizing local economies (1820 to about 1990), Phase four Globalizing factories (1990 to present*)" (Baldwin, 2016: 18-19).

The thesis focuses on *Phase three and Phase four* to understand the contemporary process of globalisation 4.0.

### 2.2.1 Globalisation 1.0 and Globalisation 2.0

According to Xu et al. (2018), the world has gone through three industrial revolutions and has since experienced a fourth industrial revolution, a term introduced by Karl Schwab (Schwab, 2017). Xu et al. (2018), describe the beginning of the first industrial revolution in 1760, signified by the discovery of steam that changed the economy from agriculture to manufacturing and had major effects on distance compression (Xu et al., 2018:90). The changes included the

use of coal in energy and trains for transport. The new technological invention in transportation reduced trade costs because steam power enabled industrialisation and shipping of goods on a larger scale than before the 15th and 16th centuries (Baldwin, 2016). The second industrial revolution started in 1900 when the internal combustion engine was invented. Importantly, oil and electricity accelerated production. (Xu et al., 2018:90). The third industrial revolution began in 1960 with an increase of electronics and communication technologies and computers (ibid:90).

Baldwin (2016), marks the period from 1820 – 1990 as "Phase Three of globalisation" also referred to as "First Unbundling"[5] that dislocated consumption from production, for example the Chinese goods were available at British market (Baldwin, 2016: 5-76). Innovation was clustered in the North, which facilitated industrialisation and a fast-economic growth opposed to the South. Accordingly, trade costs were unequally distributed and induced North-South income disparity (ibid: 40–76) that describe a current structure of the global economy. While trade experienced a low cost of shipping, the costs of communication stayed large.

### 2.2.2 Globalisation 3.0

The fast proliferation of ICT narrates a Phase Four of globalisation that started in 1990 – present. It is defined by Baldwin, (2016) as "Second Unbundling", also known as the Great Convergence or Globalisation 3.0. The period is a turning point of reduced costs of information across the world. The freer information flow has opened new opportunities and decreased information barriers between North and South. Developed countries started with "offshoring", shifting the industry to low-income countries (Baldwin, 2006: Baldwin, 2016). Production, previously centred in the North had been relocated including processes of manufacturing, management, marketing and technical knowledge (Baldwin, 2016:6). The transfers of production processes is the lowering of the overall costs of production with lower labour cost as one component, improved global competiveness and

[5] Phase three of globalisation, firstly introduced as Great Unbundling Baldwin (2006)

created a global supply chain (Baldwin, 2016: 6-7). Although, developed countries maintained technical expertise within the supply chain, the increase of ICT minimized knowledge barriers and enabled fast growth in several developing countries such as India, Indonesia and Thailand (Baldwin, 2019). Table 1summarises main industrial events with technological development and changes in costs of the remoteness of production processes.

Table 1 The Overview of Globalising Processes

| **Global processes** | | **Revolution** | **Technological innovation** | **Cost of remoteness** | **Changes in costs of remoteness** |
|---|---|---|---|---|---|
| **Phase 1** | 200 000 to about 10 000 BCE | | | | |
| **Phase 2** | 10 000 BCE to 1820 CE | The First Industrial Revolution in 1760 | Steam engine | Trade costs, Communication costs, Face-to-face costs | Large |
| **Phase 3** | Globalisation 1.0 / 1820 - 1945 | The Second Industrial Revolution in 1900 | Internal Combustion Engine | Trade costs, Communication costs, Face-to-face costs | Decrease in trade costs |
| | Globalisation 2.0 / 1945 - 1990 | The Third Industrial Revolution in 1960 | Electronics | | |
| **Phase 4** | Globalisation 3.0 / 1990 | | Information Communication Technology (ICT) | Trade costs, Communication costs, Face-to-face costs | Decrease in trade costs and decrease in communication costs |
| | 2000 - 2010 | | Internet, 3D Printers | | |
| | Globalisation 4.0 (termed in 2016) | The Fourth Industrial Revolution in 2016 | Aritifical Intelligence, Machine learning, Internet of Things | Trade costs, Communication costs, Face-to-face costs | Decrease in all three costs |

Source: Developed by author based on Baldwin, (2006); (2011); (2012); (2013); (2016); (2019); (Xu et al., 2018)

The table illuminates the rapid growth of ICT innovations and underlines the decreasing changes in face-to-face interactions ("the costs of moving people"). The new ICT innovations have significantly accelerated the flow of information and lowered the costs of real-time meeting in person (Baldwin, 2016; Baldwin,

2019). Baldwin (2019) argues that globalisation undertakes the "Third Unbounding" characterized by the remoteness of services that are being offshore across geographies. To illustrate, companies in developed countries have started to contract service work in developing countries. One of the examples of contracting services occurs in web development. The reasoning of contracting of service from developed to developing countries is due to moving higher up the value chain and outsourcing to places with lower costs. The new direction of remote service work across the globe is defined as "telemigration" (Baldwin, 2019). Accordingly, service moves into global digital regimes in which high-income countries hire workers from low-income countries to perform professional assignments without any physical interactions (ibid:2019).

## 2.3 Structural Transformation Debate

Given the overview of past and recent policies implemented to promote economic growth and development, and the perspective on globalisation, this passage introduces debates on structural transformation to understand the relation between sectoral change and economic development. Sectoral change denotes the allocation of economic activities from primary to secondary and subsequently tertiary sector. It however suggests a transformation similar to that of Europe and the North America. In recent years, there has been a growing interest in structural transformation in relation to "deindustrialisation" and "premature deindustrialisation" (Rodrik, 2016). Deindustrialisation is defined as a reduction of "the share in manufacturing" with a decrease in total employment in that sector (Tregenna, 2008:433). "Premature deindustrialisation" denotes countries loss of employment in the manufacturing sector due to the underdeveloped industrial sector. Developing countries have not advanced industrial sector but instead are moving to the service sector (Rodrik, 2016). In this context, many studies have heightened the interest to explore the question on deindustrialisation and its future consequences on economic growth. Similarly, Africa´s "leapfrogging", in other words skipping the steps in industrial development exemplified by rapid use of mobile phone instead of the fixed telephone line (e.g. Kollmeyer, 2013; Rodrik,

2016; Meglio, 2018). While structural transformation has been successful in East Asian development, Africa and Latin America have not experienced industrialisation in this way.

The early studies argue that structural change leads to economic growth and productivity increases (e.g. Lewis, 1954; Kuznets 1955; Kaldor 1966). Countries that quickly transform their low valued sector such as agriculture into higher valued sectors experience economic growth. For example, Kaldor (1966) wrote that manufacturing is "the engine of economic growth". The contemporary growth of ICT innovations has advanced service sector and altered the labour force. Growing research point to the quality of the service sector to be a driver of economic development. This leads to the question of whether the service sector is likely to replace or complement manufacturing. (e.g. Ghani & Kharas, 2010; Kucera and Jiang, 2019).

Kucera and Jiang (2019) discuss whether redistribution of production resources across economic sectors – inter-sectoral changes or rather diversification of production within the sector (intra-sectoral changes) increases labour productivity growth that stimulates economic development. Their findings show that change driven by the service sector increases overall labour productivity growth in comparison to inter-sectoral effects (Kucera and Jiang, 2019: 2-14). Furthermore, Di Meglio et al. (2018) find that manufacturing sector has played an important role for productivity growth during the past thirty years in Asia, Africa and Latin America. Notably, in Asia, business services complemented manufacturing led to intra-sectoral growth due to capabilities of high technological innovations and human capital (ibid: 10–20).

Di Meglio et al. (2018) argue that deindustrialization may not necessarily impair developing countries. Instead positive outcomes of development can be achieved by supporting business and IT services with technological innovations (ibid.). Nevertheless, there is lack of research on the area of technological changes and globalisation effects due to unreliable data (ibid.). Furthermore, research shows that allocation of labour from a low productivity sector to a high productivity

sector is critical for the economic growth (McMillan et al., 2014). This pattern of structural change was reversed in Africa and Latin America from 1990 with decrease of economic growth (ibid.). Studies suggest that Africa and Latin America have failed to diversify their economies, and focus on endowments of natural resources is insufficient to access of global trade. The incapability to expand the range of sectors impedes opportunities of stronger trade profit from sales known as "comparative advantage" and hinders the creation of additional employment. Nevertheless, Africa has seen positive changes in the new millennium as structural transformation has supported Africa´s overall productivity growth (McMillan et al., 2014).

In summary, the evidence presented in this section points to the lack of research on Africa´s structural transformation in connection to advanced services, technological change and the effects of globalisation. Africa has recently attracted investment in agriculture and generates a potential for manufacturing labour. These factors are influenced by the global economy and rising wages in China. Therefore, structural transformation needs to be understood through the lenses of the global economy and countries spatial allocation of production processes so-called international division of labour.

## 2.4 Summary of chapter 2

To summarise, firstly, the chapter outlined previous development models to understand them in the context of Africa´s industrialisation. Secondly, the chapter discussed globalisation and international division of labour formed by core, semi-peripheral and peripheral countries. The objective was to understand the uneven structure of the global economy that hinders Africa´s development of comparative advantage. Furthermore, the chapter illuminated global movement of the economic activities across geographies. Notably, the chapter provided the timeline of global processes, technological change and changes in the costs of remoteness to understand the growth of ICT and situate the concept of industry 4.0. Lastly, the chapter introduced a debate on structural transformation to understand the development of the industrialisation process.

# 3 Theoretical framework

Chapter three presents a theoretical framework of the industry 4.0 that draws on the results of the literature review and will be used to analyse the instrumental case of Kenya. The chapter begins by defining industry 4.0. Following this, the chapter explains the theoretical model and continues with defining each concept that reasons assumption of the industry 4.0 development.

## 3.1 Industry 4.0

The discourse of the 4th industrial revolution interchangeably uses the concept of globalisation 4.0 and industry 4.0. The fast growth of ICT and its impact on the global economy and society increase the amount of research with the ambiguous use of different concepts. This study applies concepts of industry 4.0 and aims to identify its narrative and conceptualise main criteria connected with the industrialisation process.

The fourth industrial revolution advances the forms of production in which human bodies and the living organism are interconnected with high technologies that make it difficult to recognise between the natural and artificial entities (Schwab, 2017: 14-25). In comparison to previous industrial revolutions, the fourth is growing exponentially at an unprecedented speed that society has never seen before. With the characteristics of "velocity, scope, and systems impact", it transforms the economic sector, industries as well as the processes of production and governance (Schwab 2017: 2-3).

One of the main opportunities of the fourth industrial revolution is reduced costs between producers and markets, possibilities of artificial intelligence, integration of systems in different spheres, robotics and internet connectivity (Xu et al., 2018:91). The fourth industrial revolution are connected also with "disruption" of the labour market. Automation leads to the replacement of the workers with demand for new competencies. As labour is being replaced by machines, the need

to upskill workers will be paramount. At this point, the most decisive factor of production is the human capital with innovative skills. The upskilling of labour will be necessary due to the growing gap between lower and higher-skilled labour, if not main threats are unemployment, the polarisation of workers and inequality (Means, 2018). The labour insecurities can spur the populist movement due to discourse on the upper class, those who are privileged against the lower class. People who lose jobs due to automation appeal voting for populist parties that promote protective migration policies (Levy, 2018).

The term industry 4.0 was firstly presented at the German Hannover fair in 2011 and since has become the starting point of the 4th industrial revolution (Qin et al., 2016). Industry 4.0 has been defined as manufacturing that includes intelligent computer systems, production units and automatic machines that use and exchange information among each other.

Industry 4.0 can be examined as manufacturing that includes four segments; "factory, business, products and customers" (Qin et al., 2016: 173–174). 1) The factory is a self-automated production of sensors, machines, robots that are interconnected and communicate based on receive and exchange of information through decentralised systems. 2) The business includes "suppliers, logistics, resources and customers" that are connected via a one communication system that operates in real time. 4) Products have software and sensors that track information and can predict customer's behaviour. Businesses can analyse the user's data and customise the production at much lower costs. 5) Customers have easier access to services at lower costs and information customised to their purchases (ibid: 173 – 174). To summarise, industry 4.0 is an automatic intelligent production of interconnected machines that produce smart products. Industry 4.0 is characterised by different technologies and the examples are presented below.

### 3.1.1 Internet of Things

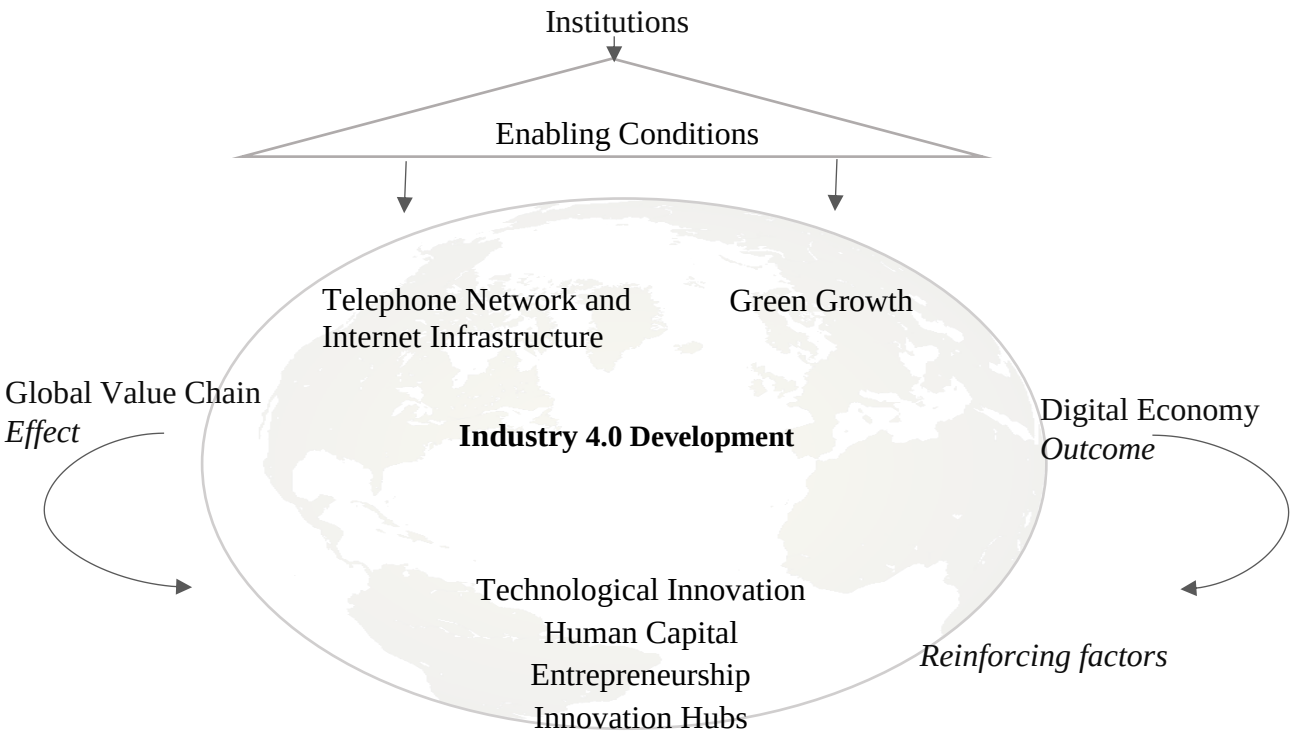
The Internet of Things (IoT) also termed as "Internet of Everything" can be defined as "global infrastructure" including physical devices, virtual objects,

forms of hardware that communicate one another via internet connection. The IoT technology operates on the basis of three functions of sensing, data transfer, data storage and control. It can be used in supply chain connecting “physical devices, human factors, intelligence machines, smart sensors and production process”. Notably, IoT has recently become used in agriculture where it has a large potential. For example, the system is able to monitor climate, irrigation and assess crops and increase harvest (Tzounis et al., 2017: 31 – 39; Lee, 2018: 4; Vaidya et. al., 2018: 235 - 236).

### 3.1.2 Artificial Intelligence and Machine Learning

Artificial intelligence defines the ability of computers to perform tasks that involve “cognitive functions such as problem-solving and learning”, traditionally associated with human thinking (Syam and Sharma, 2018: 136). Machine learning is an approach of artificial intelligence that requires a large amount of data so called “big data”. The machine capability is to learn from data, analyse and make predictions. Therefore, the machine is not “explicitly programme” but rather it learns from test data that are put into the system (ibid:36). The following figure 1 introduces the theoretical framework.

Figure 1 Theoretical Framework




Source: Developed by author

The framework depicts the process for a country to develop the industry 4.0 sector. The structure of the industry 4.0 process is underpinned by five assumptions which allow a country to develop industry 4.0 sector. The circle represents industry 4.0. development on a global level. From the top, country institutions pull the enabling conditions of the telephone network and internet infrastructure and green growth. These conditions construct necessary infrastructure and trigger technological innovation, human capital, entrepreneurship and innovation hubs. From the side, the effect of the global value chain with features of the fragmentation of the production process across countries intertwine with industry 4.0 sector and derives the outcome of the digital

economy. Lastly the bottom, illustrates the impact of industry 4.0 on a country´s socio-economic development. The section continues in the explained order and defines five assumptions that allow industry 4.0 development.

## 3.2 Institutions

Firstly, I consider the sectorial shift and ask questions how a country can develop industrialisation process and what the role of market and government is to make the structural change possible. I chose the approach of traditional institutional economics because it argues that economic activities are shaped by a country´s institutions such as norms, laws and cultural values (see Scott, 1995, Vatn, 2005). Past models of industrialisation from import substitution industrialisation to aid model (see chapter 2) fail because these approaches have disregarded social, historical and country-specific needs (Waeyeberge, 2017:209). The institutional economists offer a relevant analysis because they view the economic structure from a social and cultural perspective. Institutions are defined as forms of behaviour, laws, rules and norms that construct the society and regulate "economic activities" (Vatn, 2005).

There are two main approaches; new institutional economics that supports neoclassical theory and traditional institutional economics that criticises mainstream economics. One of the main new institutionalists was Douglas North who analysed the role of firms, organisation and institutions and their interactions in the market economy. North defined an institution as external rules according to which individuals act to maximise their own utility (North, 1993:3). On the contrary, traditional institutional economists view collective benefits, associated with work of Thorstein Veblen. Veblen criticised the mainstream economics of capitalism and power and argued that institutions change because individuals have different preferences influenced by culture, history and geography. Veblen examined Japan ´s industrialisation and argued that traditional values with the adaptation of modern technology were critical for its economic development. The discipline of economic geography examines the ways in which institutions support

or hinder innovation and growth of regions. Increasingly, economic geographers study how space, trust and network relations influence firms in economic development from the lens of institutional economics (Aoyama et al., 2011: 167–168; Gregory et al., 2016: 358–386).

## 3.3 Enabling Conditions

The second assumption shows the necessary conditions for the industry 4.0 development, supposing that country´s institutions promote their adaptation. Drawing on the recent models of industrialisations; Sustainable Development Goals and Agenda 2030, highlight the importance of inclusive sustainable development to combat climate change and inequality. I choose green capital because it focuses on economic growth that meets the conservation of environment using technologies. Given that, the telecom network and internet infrastructure are inevitable to power the industry 4.0 innovations.

### 3.3.1 Telephone and Internet Infrastructure

The telephone network is a network that connects fixed-line telephones or wireless phones - cell-phones. Phone calls are possible through a metal wire or optical fibre so-called “landline network". The telephone network is operated by a company that owns the data and allocates the capacity to transfer the data to "individual callers" when they place a phone call. Technologies have enabled different forms of telecommunication since the twentieth century. The expansion of wires increased the capacity to make several calls at once for a household. For the past twenty years, mobile phones have substituted traditional fixed telephones and a network has used fibre optic cables to transfer data (Newman, 2010: 28-31). Internet is a global network of interconnected computers providing “the information, services, data and programs stored on one computer” that can be accessed by users from a distance. The computers communicate in the network using internet protocol - IP address. Internet protocol allows a computer to

identify from and which computer the information shall be sent across the network (Gregory et al., 2009: 391–392; Newman, 2010:18).

#### 3.3.1.1 Internet Connectivity

The internet connectivity is possible through a means referred to as broadband. There is not a single definition for broadband, but it is broadly regarded as "speed" of internet connection or "data transfer rate". Broadband indicates faster speeds but also the amount of data that can be transferred in any unit of time (Davies, 2015:4). In addition, the Organisation for Economic Co-operation and Development broadband defines broadband as "a minimum speed of 256 kbps" of data sent from network provider to an end user (ibid:4). However, current technology has an advanced much higher speed of internet connection rate. Internet infrastructure can be deployed with either fixed or wireless broadband technologies (ibid:6-7).

##### 3.3.1.1.1 Fixed Technologies

Fixed broadband transmits information using copper telephone line, coaxial and optical cable. Copper telephone line entails the oldest form of connecting internet through a traditional telephone line using dial-up service. Digital Subscriber Line (DSL) replaced dial-up service and provides faster connection access through or without a telephone line. Another form of internet connection is through the coaxial cable of copper wires often provided by cable television suppliers. Optical fibre can transmit information faster "up to 40 gigabits per second" across a distance as many as hundreds of kilometres compared to traditional copper wires (Davies, 2015:7).

##### 3.3.1.1.2 Wireless Technologies

Wireless broadband encompasses various technologies that allow a short and long-distance connection. Wi-Fi, a "short-range technology" provides private or public wireless access whereas WiMAX allows a wireless long-distance connection. Furthermore, mobile cellular technologies with the third generation "3G" and the fourth generation system "4G" has expanded on a large scale. The

recent development of mobile cellular technologies adopts the fifth generation "5G" system (Davies, 2015:7). The technology of 5G is one quality of the industry 4.0 that will revolutionise mobile telecommunication. 5G has the capability of 10 Gb/s data speed, which can support the running of "billions of applications and hundreds of billions of machines" (Rao and Prasad, 2018:150). Mobile internet access is provided in the form of bundle internet with services of "voice telephone subscription" (ibid:7). Satellite broadband can be deployed in less inhabited areas to provide fast internet connection. Satellite instalment however is usually more costly.

### 3.3.2 Green Growth

The recent debate on sustainable development as illuminated in the Brundtland report has changed the focus on "green growth". The term is broadly debated with no generally agreed definition. Green growth can be defined as an urgency to tackle environmental loss due to GDP growth (Hepburn et al., 2015: 1-3). Organisation for Economic Co-operation and Development outlines green growth as promoting economic growth and development and ensuring that natural resources are consistent with environment supply important to human needs *(OECD, 2011).*

In addition, the United Nations Environment Programme underlines a direction of "Green economy" that "improves human well-being" and creates equal opportunities "while reducing environmental risks and scarcities" *(UNEP, 2019).* One of the strategies of green growth is to apply technologies to improve the environment. Studies argue that information technologies (IT) reduce the use of energy resources and the very production waste (Watson et al, 2010; Chuang and Huang, 2018). Employing technological innovation improves environment conservation by lowering energy consumption and carbon emissions (ibid:994). In this context, Chuang and Huang (2015) develops the term "green IT capital" that embraces three following aspects; "Green IT human capital" – labour has

expertise of IT skill with knowledge of environmental protection; “Green IT structural capital” – IT infrastructure with green ideas; “Green IT relational capital” other supportive processes including management and coordination share green ideas to support customer trust (ibid:994).

## 3.4 Reinforcing Factors

The lessons from East-Asian miracle indicated the importance of human capital and collaboration between private and state-owned firms. Thus, technological innovation and human capital are interconnected factors necessary for the development of a country‘s comparative advantage. Evenly, entrepreneurship leads to an increase in innovation hubs. These four elements along with enabling conditions create the reinforcing circle because of their mutual interdependence. These three assumptions influence a country´s national level.

### 3.4.1 Technological Innovation

Development economics views technology as “accumulated human knowledge applied to the production processes” (Cypher, 2014:492). Technology can be copied, classified and transferred. Technology entails knowledge determined by the economic institution, a combination of scientific and mechanical knowledge and human capital such as skills, education and training. It is “a way of thinking” and a “way of doing” rather than being a concrete thing (ibid: 492-493). Technological development is an “experience” derived from the production trying to “solve a problem” (Aoyama et al., 2011:42). On the other hand, innovation describes a new idea or technology that supports economic development. Evolving research on innovation includes not only technological innovations but also new “product development, process or service innovation” (ibid:41). Recent research has focused on sources of innovation driven by market power – “demand-pull” or knowledge – “technology-push” (ibid:47).

### 3.4.2 Human Capital

In classical economics, human capital is one of the necessary factors of production. Recent literature has shown that human capital is an important asset

for economic development (Lee, et al. 2005; Romer, 2018). It is defined as "knowledge, skills and competencies" that are essential for "economic activity" *(OECD, 2007:29)*. Human capital becomes the centre of transforming the economy into a so-called "knowledge-based economy (Drucker, 1992). Human capital was a critical asset for Britain´s economic industrialisation (Kelly et. al., 2014).

### 3.4.3 Entrepreneurship

Entrepreneurship is an ambiguous term that can be interpreted in many forms. The origins are associated with the work of Schumpeter (1942) who viewed entrepreneurship as a novelty in business that generates changes with uncertainties and opportunities for business development. In addition, entrepreneurship is "discovery and exploitation of opportunities" (Shane and Ventakaraman, 2000:217). In this context, entrepreneurship is characterised by the creation of a business that supports innovation, high-tech development, networks and regional growth (Malecki, 1997).

### 3.4.4 Innovation Hubs

Traditionally, clusters were associated with technological innovations defined as "geographically concentrated industries", specialised firms and organisations that cooperate and compete (Porter, 1998:85). Recently the concept of "hub" has aroused in academia due to effects of "technology, innovation and entrepreneurship". Hub has various organisational form "tech or non-tech" established by different actors for example "civil society, government, academic institution or private sectors" (Littlewood et. al., 2018). Increasing research on hubs embodies numerous concepts. Tuukka Toivonen & Nicolas Friederici, (2015) define hubs based on four criteria; 1) Hubs create "communities" where individuals equally share entrepreneurial ideas, collaborate and make decisions, 2) Hubs promote diversity and stimulate "heterogeneous" knowledge, 3) "Hubs facilitate creativity and collaboration in physical and digital space" 4) "Hubs localise global entrepreneurial culture" (ibid)

## 3.5 Effect and Outcome

The fourth assumption takes into account the processes of globalisation. The literature review revealed that ICT advances lower the costs of remoteness, which increases Africa´s integration in the production process through the global value chains. Notably, the global value chain affects the industry 4.0 and mediates a digital economy. Thus, the digital economy is the outcome of the external effects of the global value chain and the interplay with industry 4.0.

### 3.5.1 Global Value Chain

The concept originates from "global commodity chain" associated with the internationalisation of the economy through the linking of the various economic units – "raw material, suppliers, factories, trade and retail" (Gereffi and Korzeniewicz, 1994:96). Global value chain arouses with economic globalisation and the increase of manufacturing in developing countries. The global value chain includes "different production processes located across different countries" (OECD, 2019). Global value chain features fragmentation of production systems, creating opportunities for emerging economies to integrate into supply chains without having a strong "comparative advantage" (Baldwin, 2016). Comparative advantage defines a trade where countries benefit from specialisation on producing goods at lower costs than the countries that they trade with. Hereby, the countries can exchange produced goods that would be costly to make in their country (Ricardo, 1821).

### 3.5.2 Digital Economy

Digitalisation or digital economy has increasingly been debated in the global economy and politics. Its definition lacks a general understanding and difficulties remain in relation to measurement. According to the International Monetary Fund (2018), digitalisation incorporates a broad spectrum of new ICT applications in "business models and products that are transforming the economy and social interaction" (ibid:3). Other organisations such as the United Nations Department of Economic and Social Affair uses the United Nations industry classification

system that identifies the Information and Communications Technology sector and a Content and Media Sector. However, IMF paper highlights that the sector excludes digital platforms provided by big tech companies such as Google, Facebook as well as “platform enabled services” e.g. Uber (ibid:7). Therefore, IMF (2018) identifies the digital sector that encompasses “online platforms, platform-enabled services” and providers of ICT goods and service (ibid:7). Other studies explain that the digital economy can be understood as customers payment for “digitally transferred data” to the producer (Ahmad and Ribarsky, 2018:6).

## 3.6 Impact

The fifth assumption implies the development of industry 4.0 driven by global value chain and digital economy and the impact on a country´s society and economy. To conclude, provided assumptions explained the process of the industry 4.0 development both on a national and global level and reasoned the essential pre-condition for a country to adopt industry 4.0. sector.

# 4 Methodology

## 4.1 Introduction

This chapter explains the methodological approach that was used for conducting this research. It starts by presenting epistemology, method selection and its reasoning. It proceeds with research design, data collection, sampling technique and limitations. Lastly, research ethics and reflexivity are provided.

## 4.2 Epistemology

The thesis is positioned in the epistemology of critical realism. Epistemology is argued to be the core of the methodological approach because it presents “how the knowledge is produced” (Klein, 2005). Thereby, the epistemology constructs the research and determines what the outcome knowledge is. The research is positioned in the epistemology of critical realism which combines real-world – ontology but its interpretation is frequently socially influenced (Della Porta and Keating, 2008:24). The thesis aims to explore the opportunities and challenges of industry 4.0 and reasons that there is a material world that can be controlled by social actions that can be "unobserved and unobservable" but one cannot disregard them (ibid:24). Therefore, the critical realism has the strength of interpreting a real world using our understanding of existing structures not in themselves visible.

## 4.3 Method Selection and Reasoning

The study is exploratory in nature and uses a qualitative instrumental case study method. The qualitative approach offers a detailed analysis by interpreting real-world phenomena and explaining their causal mechanism. The complexity of the case is measured through a strategy of “ideal types” and “internal logic” (Della Porta and Keating, 2008:206). Qualitative research was chosen over quantitative research to avoid dependence on scarce and inaccurate statistical data. Studies have shown a false interpretation of reality and errors in statistical measurement in research on Africa´s economic development (Sandefur and Glassman, 2015; Jerven and Johnston, 2015).

The case study can be defined as an empirical investigation that seeks to understand current world situations and the context especially when the link between phenomenon and the context is not obvious (Yin, 2014:16). The research on industry 4.0 is contemporary and quickly evolving phenomenon, thus the case study stands as an effective method to understand its complex process (Yin, 2014:4 - 12). The study provides an in-depth exploration of industry 4.0 sector, its opportunities and challenges in the context of Kenya, yet when possible other countries 'examples are illustrated. In addition, the case study allows exploring the current series of facts that are restricted or impossible to be influenced (Yin, 2014: 10). For this reason, a researcher can draw "general theoretical principle" (Mitchell, 1983:192). The case study also recognizes the importance of different globalisation phases of industrial development (Yin, 2014:10) and analyses real-life processes in the holistic approach (Stake, 2011: 4-6).

This research uses instrumental case study because the type allows to analyse the case that is of "secondary interest", and rather supports the understanding of the external issues and improves the theory (Mills et al., 2009: 3–4). To illustrate, analysis of Kenya facilitates understanding of the industry 4.0 theory in the external context of Africa and its generalised applicability.

### 4.3.1 Research Design

The thesis´ research design is based on five elements; "1) case study´s questions 2) study purpose, 3) units of analysis 4) linking data to propositions and 5) criteria for interpreting a case study´s findings" (Yin, 2014:29).

1) The study explores the following research questions: 1. What are the opportunities and constraints related to industry 4.0 in terms of enabling emerging economies like Kenya to accelerate the development of industrialisation process? 2. How does the development of industry 4.0 in some African countries unlock conditions for the movement of production processes from more industrialised economies to less industrialised economies?

2) The thesis aims to analyse whether industry 4.0 offers a new model for emerging countries like Kenya to accelerate the development of the industrialisation process. In this connection, the thesis questions the traditions of development models and premises that development policies transform from providing aid to an investment model that supports the economic-based partnership.

3) Kenya has been chosen as a “unit of analysis” because of “ideal types” including the successful development of mobile money, thriving entrepreneurship culture, internet connectivity and name of “Silicon Savannah”. It is important to select a case that illustrates or expands the existing theory (David, 2006:303). The case was limited to questions exploring opportunities and challenges of industry 4.0 innovations chronologically, since 2007 the success of mobile money – M-Pesa, with emphasis on recent years from 2014 to 2019.

4) Data analysis was conducted following a proposition of a conceptual framework. Respective concepts and their "causal relationship” helped to organise the case study analysis. The case study was analysed through a technique of “pattern-matching logic”. The technique compares the primary finding with predicted data that were collected before the analysis and develops what is called the “pattern” (Yin, 2014: 136-143).

5) The collected data were analysed using the strategy of rival explanations to measure the relevance of the findings. The significance of the collected data relied on “direct rivals” and the original theoretical framework. The collected data were explained by either confirming predicted results from primary findings or rejected. When rivals rejected the results, data collection from secondary studies were involved to interpret other possible “influences” (Yin, 2014:140).

Table 2: Summary of Types of Information Collected During the Study

| Data Collection | Units of Analysis | Units of Observations |
|---|---|---|
| Primary data | Semi-structured interviews | 3 Entrepreneurs from Kenya<br>1 Entrepreneur form Tanzania<br>3 Entrepreneurs from Denmark |
| Secondary data | Peer-reviewed journal articles,<br>Official reports and documents,<br>News articles, Audio records | |

### 4.3.2 Data Collection

The quality of the study depends on the validity of evidence sources. The case study analysis collected primary data of semi-structured interviews and secondary data including peer-reviewed journals, official documents, reports, news articles, audio records. Secondary data were collected and sorted based on thematic keywords, concepts and research areas. The analysis strategy of "coding" was used to search for information in databases of Google Scholar, EBSCOhost, and Scopus. The coding process applied key words of "globalisation 4.0", "the fourth industrial revolution", "industry 4.0" in Africa, and thematic codes related to the conceptual framework. Moreover, the strategy of searching through related publications expanded access to other relevant sources.

### 4.3.3 Interview Sampling

Semi-structured interviews applied strategies of snowball and purposive sampling. The snowball technique allowed to access the network of contact persons who have specialised knowledge and working experience with ICT and evolving technologies associated with industry 4.0 in a specific country context (O´Reilly, 2012: 5-6). Beside snowball strategy, the study applied purposive sampling using a professional networking website – LinkedIn. This online service enabled to contact other entrepreneurs who suited the analysis. Semi-structured interviews complement secondary data and provide important evidence as the interviewees

share personal views and direct insight into the case study. The semi-structured interviews were carried out through a communication application – WhatsApp, Skype and Messenger from the 17th of February to the 9th of May 2019.

Table 3: Interview Information

| Participant | Date and time zone in Sweden | Communication platform | Gender | Nationality | Role |
|---|---|---|---|---|---|
| 1. | 17th February, 2019 11:30 | Whatsapp Video | Male | Kenya | Entrepreneur and managing director |
| 2. | 14th April, 2019 14:00 | Skype Video | Male | Denmark | Entrepreneur CEO and founder |
| 3. | 30th April, 2019 12:00 | Messenger | Male | Denmark | Social entrepreneur |
| 4. | 3rd May, 2019 10:17 | Whatsapp | Male | Tanzania | Fintech entrepreneur |
| 5. | 3rd May, 2019 12:23 | Whatsapp | Male | Denmark | Co-founder and director of mobile technology in Kenya |
| 6. | 6th May, 2019 17:02 | Whatsapp | Male | Kenya | Entrepreneur, business and startup consultant |
| 7. | 9th May, 2019 14:00 | Whatsapp | Male | Kenya | Erik Hersman, CEO at BRCK |

### 4.3.4 Sample Size and Limitations

The qualitative research method has no general rules about sample size, instead it is the "nature and scope" of the research that determines the sample (Marshall et al., 2013:12).

Nevertheless, the sample size of interviews in this study depends on "saturation" (ibid:11). The saturation determines the point when a number of interview added to the research becomes redundant, thus it does not increase the quality of the study. The study opted to conduct seven interviews because it noticed that the seventh interview started to exhaust the themes. Therefore, carrying out more interviews is unnecessary. The study also takes into account several limitations. The study sample is dependent only on male respondents that could lead to biased results. Despite many attempts, it was difficult to gather female contacts as the study is also time limited. However, the study received two female contacts and also initiated communication via a professional online network LinkedIn, where none of the respondents was reachable. The reason might be a predominant

representation of men in ICT business also the use of snowball technique and time. Another limitation is the online interviews. While there are positives of using online communication tools, one of the main negatives are the problems with internet connectivity and distant interaction. On one side, taking notes were challenging during poor connection but on the other side, this allowed repetition, creation of trust and natural flow of conversation in contrast to traditional recorded interviews. In relation to distance, the study is also restricted to respondents who work in the ICT enterprise and does not evaluate people from rural areas or with no experience in the ICT sector. Consequently, conducting research directly from Kenya would benefit the weakness of the sample.

## 4.4 Research Ethics

During the phone call interviews, it was important to create unbiased, open and trusted situation. Before the phone call, initial information regarding the research and consent of the interviewee's contribution was sent out either via e-mail, LinkedIn, Messenger, or WhatsApp. Regarding data privacy and the use of digital communication platforms, phone calls were not recorded to maintain the privacy of personal data, deception and unpleasant atmosphere (Yin, 2014:110). Semi-structured interviews were approached by taking notes to pursue flow of conversation, openness and confidentiality. To assure the correctness of taken notes and corresponding answers, a summary of notes was sent to each respondent. Doing so, the study avoids deceptive information, inaccuracy and influence of researcher (Murphy and Dingwall, 2001). Before the interviews, the study prepared a set of questions, yet the conversation format was flexible and adapted to the interviewee´s answers (see appendix). The identity of interviewees is protected as most interviewees wished to remain anonymous.

## 4.5 Reflexivity of Interviews

Reflexivity is one of the most important methods in scientific research. It defines the unconscious awareness of the researcher to continuously question the complexity of the research problem, biases, power, and knowledge production of the whole research process (O´Reilly, 2009:188). Throughout the research process, I had reflected upon the power of technology that unlocks the borders of time and distance. For example, online social networking services like LinkedIn have allowed me to network with professionals across the world. The possibility to reach out to a wide range of experts in the field at reduced costs to transform traditional research practices as it makes it less costly and time friendly. The use of digital communications to conduct interviews not only exemplifies the effects of globalisation but give voices to another non-western perspective. The internet expansion may revolutionise the standard fieldwork method because it overcomes cultural, geographical and time barriers. On one side, technology deconstructs the Western biases of an issue but on the other side, the spread of ICT innovations intervenes in the original culture. Conducting interviews via phone made me also reflect on using a camera or only audio. I felt that interviews with camera facilitated deeper interactions, equality and mutual respect. On the contrary, interviews conducted through audio alienated the interaction with interviewees resulting in more direct exchange of information. This might have an influence on the results of information.

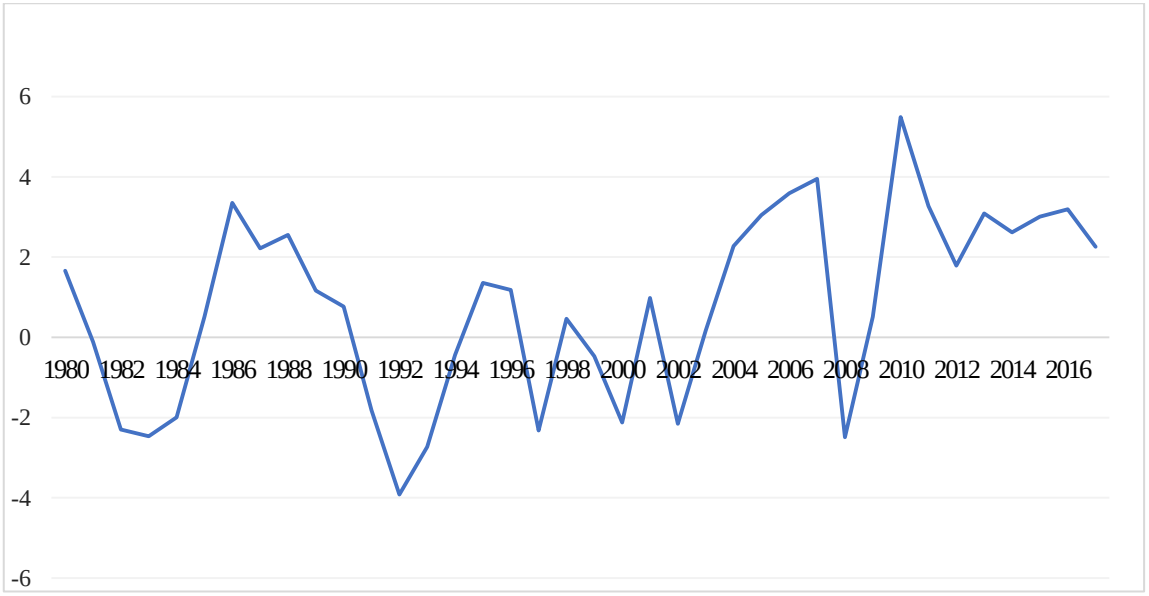
# 5 Case Study

The chapter starts by presenting the selected case of Kenya giving a short general background on the economic development, structural transformation, and implementation of policies. Subsequently, the main part of the chapter presents the analysis of the findings.

## 5.1 Kenya´s Economic Development

Kenya is one of the fastest developing economies of Sub-Saharan Africa. The graph below shows that not until 2004 did the per capita growth rate start to increase after some twenty years of stagnation. In 2008, Kenya´s economic growth was negatively influenced by the global crisis, the violent election in 2007 and a sharp rise in oil prices. As a result, the country had to increase import over export. Agriculture was hit by climate change and service sector particularly tourism was significantly reduced due to security risks. Since 2010, annual GDP per capita has improved and maintained positive growth. In 2012, the economy experienced an economic downturn in agriculture due to poor weather condition, in comparison to the year 2011 when agriculture production doubled due to enough rainfall (*World Bank, 2018:3).* Since 2017, the economic growth has been growing, reaches 2.0 %, with estimated GDP growth of 3.1% in 2018 and a moderate decrease of 2.1 % in 2019. According to the World Bank, Kenya belongs to a category of a lower middle-income country since 2014, yet with accelerating economic development, it plans to transform into a middle-income country *(World Bank, 2018).*

Figure 2 Kenya GDP per capita growth (annual %)




Source: Author´s creation, Data Obtained from World Bank national accounts data, and OECD National Accounts data files, 2019, Data.worldbank.org

The political situation has been strengthened since 2010 when the country accepted a new constitution that has improved the country´s overall development and formed new legislation, judiciary and electors. The government's political, structural and economic reforms have contributed to the country´s steady economic growth. Despite that, prevailing challenges that remain are poverty, inequality, climate change and instability towards the economy´s internal and external effects *(World Bank, 2019).*

The goal of Kenya´s development programme, the so-called Vision 2030, is to advance the country making it a middle-income country by 2030. The government aims to promote industrialization through sectorial transformation. The strategies are to develop competitive and diverse manufacturing and turn Kenya into Africa´s industrial hub by the minimum increase of 10 % of annual GDP (OECD, 2017). Since 2017 government has implemented an economic plan known as Big Four with the objective to enhance structural transformation and support fair jobs creation. The main areas of the Big Four include" manufacturing, universal

healthcare, affordable housing and food security" *(African Development Bank, 2019).*

### 5.1.1 Economic sector

Agriculture is the leading sector accounting for around 34 per cent of the GDP in 2017 *(Statista, 2019).* More than 40 per cent of the total population works in agriculture and in the rural areas the proportion is more than 70 per cent. In addition, agriculture generates 65 per cent of "export earnings" *(FAO, 2017:7).* The industrial sector composed of manufacturing, electricity, water and construction represent roughly 9.3 per cent of GDP and generates 19.6 per cent of employment in the formal sector *(World Bank, 2018: 3–4).* The growth rate in manufacturing was 2.7 per cent in 2018, feebler than in the previous period from 2013 to 2016 it equaled to 3.6 per cent. Nevertheless, the growth in other areas of manufacturing including real estate and construction was higher in 2018 due to private investment and government spending on infrastructure, respectively (ibid: 3–4). The growth in the service sector was 6.5 per cent in 2018 which was lower in comparison to 7.5 per cent in 2017. The subsector of wholesale and retail trade substantially increased but accommodation and transportation decreased. The largest decline was in tourism, the growth rate of 19.6 per cent in 2017 decreased to 14.3 per cent in the first half of 2018. Strong growth was recorded in the real estate and ICT sectors driven by mobile money use and stable residential real estate market (ibid:4). According to its national development plan accepted by parliament in 2008, Kenya aims to reduce its reliance on agricultural export commodities and strengthen the export of services.

However, Kenya´s informal sector generates the highest level of employment, it accounts for 95 per cent of business and entrepreneur activities. Mainly men are employed in the informal sector. Kenya National Bureau of Statistics estimates that employment in the informal sector was around 82.7 per cent in 2014 *(World Bank, 2016:1).* Whereas there is a lack of research on informality and its impact on the country´s economy, the poverty rate in the informal sector is lesser in

comparison to farming. The major areas of the informal sector include “trade, restaurants and hotel” (ibid:1).

Kenya´s Vision 2030 emphasizes increasing investment in the private sector to generate employment as well as to reduce the rural-urban divide. The government reformed legislation to support private businesses and encourage entrepreneurship. For example, in 2016 the government passed the law that allows state companies to be internationally owned and in 2015 it accepted the Special Economic Zones Act to attract local and global investors (African economic outlook, 2017:8).

## 5.2 Findings and Analysis

The chapter continues presenting the findings from the semi-structured interviews. The findings are organised according to the theoretical framework in which each theoretical concept is evaluated by given indicators. The first part addresses the findings of **RQ1: What are the opportunities and challenges related to industry 4.0 in terms of enabling emerging economies like Kenya to accelerate the industrialisation process?** The findings begin with the first assumption and follow the reasoning of the theoretical model as explained in chapter three.

### 5.2.1 Institutions

Development of technological innovations needs to be understood through the lenses of the country's institutional structure coordinated by market and government.

#### 5.2.1.1 Indicator: Institutional Change

Interviewees indicated that Kenya´s significant transformation is characterized by financial technology broadly used under the term Fintech (all interviewees). “Fintech refers to a technology that supports or enables financial services” utilizing the software (Arner et al., 2015:24). Its use has been rapidly proliferated

due to new ICT innovations. For many decades, Kenya and other developing countries have lacked the presence of a strong financial sector in its economic development. Owing to lack of institutional support, people in developing countries are usually excluded from financial services and access to economic and social services. Therefore, there is unmet demand for loans and credits that hitherto have been mainly serviced by the role of donors (Onsongo, 2019: 374-375).

However, findings from the interviews show that this has been changing with the emergence of other non-financial actors (interviewee, no. 4; interviewee, no. 6). The spread of ICT technology and mobile phones allowed access to financial services using a mobile phone, known as mobile money. In Kenya, the service of mobile money is called M-Pesa *(The Economist, 2013).* M-Pesa where "M" means mobile and "Pesa" is money in Swahili (Hughes and Lonie, 2007:63). Estimation shows that 96% of homes located outside of the capital Nairobi own at least one M-Pesa account (World Bank, 2018).

In general, studies reveal that the government of market-oriented policies are critical for the growth of innovation (Burns, 2018; Shäffer, 2018, Amankwah-Amoah, 2019). The use of mobile phones has also been found to stimulate business in Sub-Saharan Africa and increase income per capita provided that government in Sub-Saharan Africa promotes effective policies that support the adaptation of mobile phones (Asongu et al., 2018a; Asongu et al, 2018b; Haftu 2019, Kingiri and Fu). Other studies on Africa argue that technology transfer along with institutional support, give companies in Africa the opportunities to harness the technological potential needed for economic development (Amankwah-Amoah et al., 2018).

#### 5.2.1.2 Indicator: Foreign Transfer of Technology

A Danish social entrepreneur remarked that M-Pesa enables the deposit, withdrawal and sending of money via a feature phone, thus without the need of smartphone (interviewee no. 3). Local institutions adopted external technology

which enabled M-Pesa achievement. M-Pesa has become widely used across Kenya. A Danish co-founder and director of mobile technology in Kenya explains:

> "Network effects are important, you do not want to be on another network if all your friends and family use M-Pesa" (interviewee, no. 5)

The idea of M-Pesa originates from the collaboration of the British mobile operator Vodafone Group, UK Department for International Development (DfID) and the company Safaricom, Kenya´s leading telecommunication provider. Safaricom is owned by the Vodafone Group (UK) with 40 per cent of share and 35 per cent of share by Government of Kenya. The remaining 25 percent of share is controlled by the public *(Safaricom Annual Report and Financial Statements, 2017)*. The project was initiated by the UK Vodafone Group with an attempt to reduce poverty within the agenda of Millenium Development Goals. Accordingly, UK Vodafone Group received a grant from DfID and together with its affiliate, Kenyan Safaricom developed M-Pesa in 2007. Furthermore, M-Pesa was inspired by the existing Safaricom´s service Samabaza that allows a person to buy phone credit known as "airtime" and send it to another person (Kiggundu and Ogola, 2017: 39). This illustrates a combination of external and local knowledge of the established Safaricom service that enables one to buy the amount of calling minutes and send them to rural areas.

Crucially, the Central Bank of Kenya played a key role in authorising the payment system during its development without imposing any regulations. This was possible as Kenya did not have any legislative regulations for non-financial actors other than banks. Accordingly, the presence of no regulators towards non-banking actors such as Safaricom has opened the opportunity to embed its dominant position on the market (ibid.). This naturally leads to the question of why in other African countries, the adaptation of M-Pesa has been less successful including South African, Ghana and Nigeria (Lepoutre and Oguntoye, 2018).

For example, Nigeria, the biggest economy in Africa, has a high presence of mobile phones but only 6 % of the population uses mobile money. This may be explained by the institutional structure of banks and telecoms that perceive mobile money operators as competition compared to Kenya where the banks partner with Safaricom (Russon, 2019). Erik Hersman CEO at BRCK remarks:

> "Government and regulatory agencies allowed M-Pesa while other countries have a strong banking sector" (interviewee, No. 7).

Safaricom has become Kenya´s leading telecommunication provider and has an extensive impact on the economy, society and the individual lives of Kenya (Kiggundu and Ogola, 2017: 47–48). Notably, Erik Hersman CEO at BRCK commented: "It is a problem if you have one monopoly, the government needs to make sure to allow others to come, we also need some competition" (interviewee, no. 7). In this excerpt "one monopoly" describes the Safaricom dominance on the market.

The government institutions have transformed ICT policies compared to the middle of the 90s when the government strictly controlled the internet. The success of M-Pesa has prompted changes to pro-ICT policies that have become the government´s main strategy for development (Kiggundu and Ogola, 2017: 47–48). Furthermore, findings continue with telecommunications and internet connectivity as the enabling conditions that are necessary for the industry 4.0 growth.

### 5.2.2 Telecommunication and Internet Connectivity

#### 5.2.2.1 Indicator: Internet Infrastructure

Kenya has seen an upward surge in internet connectivity in the East Africa region which, until 2009, used to be a region with a poor internet connection to the outside world. Before that the region had to rely on a satellite connection, thus access to ICT was not only slow but also internet data was extremely expensive

compared to the global average (Graham et. al., 2015: 2-3). Findings from interviews conclude that internet connectivity is present but it is not affordable for everyone (interviewees no. 3; interviewees no. 4; interviewee no. 7) The Danish CEO and entrepreneur remarked that it is important to provide cheap internet as it is very expensive in Africa (interviewee, no. 2).

The shift happened when the first out of five international fibre optic cables reached and were installed in Mombasa, Kenya and Dar es Salam, Tanzania, in the summer of 2009. Kenya´s development of four undersea cables – EASSy, TEAMs, SEACOM and LION-2 – were financed through private investments and private-public collaboration as part of the agenda Vision 2030 to boost ICT sector and economic growth. Since 2014, Kenya has launched the project of the fifth fibre optic cable DARE that spans from Djibouti and connect the Kenyan city of Mombasa to the Somali cities of Mogadishu, Berbera and Bosaso and with possible reach to Dar Es Salaam in Tanzania (Kumar and Dahiya, 2017: 778-779, Qui, 2019). Kenyan entrepreneur and managing director comments:

> "With the development of undersea fibre-optic, the main cities have the broadband mobile network and everyone uses M-Pesa" (interviewee no. 1).

The National Optic Fibre Backbone Infrastructure connects the major cities and the government gradually plans its expansion to increase connectivity. In addition to the undersea cables, there are initiatives to bring fixed broadband internet. (The Kenya National ICT Masterplan April 2014 2013/14 – 2017/18: 24). The Kenyan government´s goal is to improve access to public service. The projects of Government Common Core Network (GCCN) aim to build ICT infrastructure including fibre cable extension, wireless broadband with 3G technologies to connect counties and ministries. The development of GCCN is planned to connect all governments departments through a common network to ease the communication process, share database and data flow. The aim is to support the establishment of electronic systems, so-called e-government to facilitate citizens´ access to public services (ibid.: 25–26). Huduma centre is an example of Kenya

program that provides access to online services (interviewee no. 5). According to a Kenyan entrepreneur and managing director: e-documentation has a positive impact; The ICT brings positives with e-documentation, for example health register is more efficient, and it is a transparent way to tackle corruption problems (interviewee no. 1.).

Moreover, from the interview with social entrepreneur the private sector cooperates with the government to enhance internet infrastructure (interviewee, no. 3). For example, the international tech companies Microsoft and Google have invested and launched different projects (interviewee, no. 3). In 2018 Kenya´s Telkom agreed on project Loon that is supported by Google to provide internet to rural areas by positioning balloons across Kenya. The plan is to place balloons into stratosphere approximately 20 km above sea level. Telkom Kenya built ground stations that receive the signal from antenna inside the balloons (*BBC, 2018*; interviewee no. 3).

In addition, communications hardware company named BRCK is the first in East Africa that develops solutions that support local ICT infrastructure (interviewee, no. 1 and interviewee no. 7). BRCK has worked on various scales of engineering projects in areas of connectivity, education and internet of things. It is often the case that imported devices and system do not work with local internet and electricity infrastructure. Thus, the purpose of BRCK is to provide the internet to rural areas where people cannot afford to pay for the internet. BRCK has recently developed a free wireless WiFi network in Nairobi called Moja (Eric Hersman; BRCK, 2019). In countries of Ghana and Tanzania, Danish-based company Bluetown supported by Ministry of Foreign Affairs of Denmark (DANIDA) provides affordable Wi-Fi connection in rural areas (interviewee no. 3.).

#### 5.2.2.2 Indicator: Internet Connectivity

Interview findings underline that internet connectivity in rural areas is limited and expensive. The Danish social entrepreneur explained that he had to withdraw his start-up project from Kenya. His project offered a platform that would connect all

parties in supply chains including small-scale farmers, retailers and drivers to deliver fresh tomatoes. The platform was launched in July 2016 and ended in January 2017. From his comments below:

Mobile data was very expensive and people could not afford capacity on the internet outside of cities.

> "Although, people in rural areas use M-Pesa, it is quite expensive because it charges 1 % fee for sending. There is also a problem with electric power, the internet would stop for vehicles entering areas where there was no network. People do not have a strong internet connection to the outside. The problem is corruption, for example, police members stopped the truck transporting vegetables and confiscated what was contained. Nairobi has 3G and 4G, but in rural areas there is not proper connection. It is not easy to get in touch with people through SMS and it is difficult to communicate efficiently" (interviewee, no. 3).

Similarly, the Danish co-founder and director of mobile technology in Kenya comments:

> "Relatively inhabited areas have internet, generally middle class, a lot of people live in slums have access but not in rural areas" (interviewee, no. 5).

In contrast to the experience of a Kenyan entrepreneur and CEO:

> "Internet connection is fantastic, it can be rather expensive. I have never been at the place without internet. I did not have to worry about not being on the internet. It has rapidly changed. In rural areas, people use Internet Bundle provided by Safaricom, they give you around 5MB for one dollar" (interviewee, no. 6).

The comments imply that there is a large internet divide between urban and rural populations. Reliable internet access for people in rural areas remains costly. However, since 2016, internet access has increased offering many opportunities.

Today, Kenya´s internet inclusion places as the 64th country out of 100 studied countries and as the second country in Sub-Saharan Africa after South Africa in the context of internet inclusion and connectivity according to the Inclusive Internet Index (The Economist, 2019).

### 5.2.3 Green Growth

Findings continue with green growth as another enabler of industry 4.0 growth

#### 5.2.3.1 Indicator: Energy Supply

Energy is an essential ingredient for industry 4.0 development. Erik Hersman remarked that the necessity is to help people to get access to energy, without energy and internet connectivity, technology cannot thrive (interviewee, no. 7) From the discussion with Danish social entrepreneur, electricity is not reliable, neither in rural areas nor cities. In Nairobi, electricity blackouts are common (interviewee no. 3). Yet, Kenya is one of the African countries with extensive potential for renewable energy (Kiplagat et al., 2011).

Access to electricity has substantially improved. In 2014 around 36 per cent of the population had access to electricity while in 2016 the increase reached around 56 per cent (World Bank, the Energy Progress Report, 2018).

The largest private investment is the wind power station set on Kenya´s Lake Turkana, situated in remote Marsabit County. The project estimates generation of 310 MW energy, which meets the 18% of Kenya´s energy demand in 2016 (Obulutsa, 2017:37). Besides, geothermal resources offer a large potential for Kenya growth of renewable energy. In 2018, Kenya built a 630 MW geothermal plant in the Great Rift Valley to supply electricity for 500.000 households and 300, 000 small and medium-sized enterprises (SME) (Yee, 2018). Furthermore, private and public investments into electricity have been important and considerably advanced both Kenya´s energy sector and energy growth. It is however necessary that the funding of wind power comply with energy needs of remote areas. This requires policies that incorporate land rights of communities,

energy infrastructure in neglected areas, and price affordability (Kazimierczuk, 2019: 442–443).

Results from other studies show that increased installments of a grid in rural areas managed by national and private investors do not inevitably improve socio-economic conditions. This is primarily because of the high cost electricity rate around 35 000 Ksh[6] or $412 per household per year which leads to low consumption. Rural population cannot afford and benefit fully from electricity use (Lee et al., 2016). This implies a mismatch between supply and demand. However, new methods of financing lower the cost of electricity. A Danish social entrepreneur explains that decentralised energy with a business model "pay-as-you-go" has expanded to rural areas (interviewee no. 3.). M-KOPA is one of the companies with a "pay-as-you-go" strategy, introduced in 2012. It provides solar power to the homes in rural areas at low costs (World Bank, the Energy Progress Report, 2018). Its system connects devices and mobile payment M-Pesa. It has supplied more than 600.000 homes with solar energy and thereby reduces the dangers associated with using kerosene as a source of energy (Amankwah-Amoah, 2019: 5 – 7, *Sida, 2019*).

Moreover, previous research suggests that connecting rural areas to electricity creates a positive impact on entrepreneurship and is likely to decrease gender inequality. This reveals that electricity brings more advantages for women who run the household (Vernet et al., 2019).

The following section illuminates elements that are interconnected and driving forces of the industry 4.0.

### 5.2.4 Technological Innovation

#### 5.2.4.1 Indicator: Financial Technology

The technological innovations driven by the emergence of mobile money has contributed to the proliferation of technologies such as the internet of things.

[6] Kenyan shilling is the currency of Kenya

The findings suggest that financial technology – M-Pesa is one the most disruptive technologies in Kenya that opened the opportunities for other financial services such as online shopping (interviewee, no. 5 and interviewee no. 6).

M-Pesa has been a catalyst to other sectors including agriculture, health and education (Ndemo, 2017:359). Since 2018, Safaricom has launched M-Pesa Global in collaboration with Western Union Company, which allow people to send and receive money across the world. A Kenyan entrepreneur and managing director explains:

> "Up until now, transferring money from abroad to Kenya has been very costly due to high transaction fees. Kenya has especially the biggest transfer of remittances from its diaspora, Kenyans who reside abroad and study in the United States send money back to Kenya" (interviewee, no. 1).

M-Pesa Global also enables users to transfer money across Rwanda, Tanzania and Uganda. Moreover, the M-Pesa service incorporated PayPal account, a global payment system that enables users to transfer money between M-Pesa and Paypal accounts *(Reuters Africa, 2018).* M-Pesa also launched a product M-Shwari that offers savings and loans. Kenya entrepreneur, business and start-up consultant comments:

> "M-Pesa applies small algorithms to analyse data of users and determine whether it can give people loans despite charging a relatively high interest rate" (interviewee, no. 6).

Results suggest that M-Pesa has a positive impact on both society and economy leading to the expansion of the ICT sector. The following section continues with innovation hubs, entrepreneurship and human capital that are important features of the industry 4.0.

### 5.2.5 Innovation Hubs

5.2.5.1 Indicators: Tech Hub

Africa undergoes the dynamic rise of tech entrepreneur and innovation organisations called “hubs” (interviewee, no 1; interviewee, no.6 and interviewee, no. 7). The number of tech hubs has significantly risen from 117 in 2016 to 314 in 2017 along with the expansion of start-up tech accelerators (Kelly and Firestone, 2016, Sambuli and Witt 2017:5). The birth of the tech scene in East Africa can be exemplified by the hub called iHub, located in Kenya capital Nairobi. It is considered to be Africa´s first tech hub and a breakthrough of co-working space founded in 2010 by Erik Hersman and Juliana Rotich (Marchant, 2017). iHub forms the main place for innovation created with the purpose to connect people and build a community of developers, “young entrepreneurs, designers, researchers and programmers”, anyone with an idea and attempt to support Nairobi and Kenya to be Africa´s tech hub (Gitonga, 2017:17). In addition to iHub, there has been an emergence of other hubs and incubators.

Thereby, Kenya technology sector embraces a multicultural climate of different organisational forms including multinational tech companies, Google, IBM, and Microsoft, “non-profit organisations, donor’s organisations and social entrepreneurs”. A previous study on this subject argues that Nairobi has a hybrid organisational culture in which organisations facilitate different purpose (Littlewood and Kiyumbu, 2018). To explain, iHub was established for non-profit purposes through the funding of donor organisations. It focuses on technology that empowers and gives opportunities to less privileged people. In contrast, the hub called Nairobi Garage represents the pro-profit form that attracts investors and supports high-tech entrepreneurs (Marchant, 2017: 303–322). Given the existence of different drivers, it is critical to understand the role of tech hubs and incubators on socio-economic development (Hain and Jurowetzki, 2018; Littlewood and Kiyumbu, 2018).

### 5.2.6 Entrepreneurship

5.2.6.1 Indicator: Financing and a Personal Network

Kenya has in recent years embraced the world´s tech and entrepreneurship culture and is often referred to as Silicon Savannah (Bright, 2016; Ndemo, 2017; Økland, 2019). The findings show that localized ICT start-ups are mostly established by entrepreneurs who studied in the USA in the San Francisco Bay Area where Silicon Valley is located (interviewee, no. 1 and interviewee, no. 6). Kenyan entrepreneur and managing director points out:

> "People who set up business in Kenya are expats, Kenyans who graduated abroad because local people lack the skill to raise money. There is some investment from the European Union, non-profit organisations, the west such as the United States and Danish government" (interviewee, no. 1).

Furthermore, the Danish social entrepreneur highlights:

> "Western companies do not engage with local people, some of them but most of the companies are run by people coming from outside" (interviewee, no. 1).

Previous research argues that the growth of the tech landscape attracts international financing mainly venture capital with different models of funding (Hain and Jurowetzki, 2018). It suggests the shifting approach of international financing from traditional aid development to pro-profit investment, which also corresponds with results from the interviews. Danish co-founder and director of mobile technology in Kenya likened Kenyan start-up to "rich man´s game":

> "Kenya start-up is increasing but most people here having the potential to build start-ups are rich. There is too much money in computer programming competition events - hackathons from aid organization, private organisations, everyone is involved and some make living just from the idea they enter the competition" (interviewee, no. 5).

Regarding the funding, a Danish co-founder and director of mobile technology comments:

> "It has been difficult to get funding but there is a shift trying to create better tech. It is easy locally to raise money and develop the product, but it is really difficult to get to the next level when you actually have some revenue" (interviewee, no. 4).

Furthermore, Erik Hersman explains:

> "Some type of funding is available equally to locals, but most Kenyans will not report their revenues that skew the number. Perception is that only Europeans get money but that is not true, how much you get depends on the network, how many people you talk to" (interviewee no. 7).

Findings confirm the result from recent evidence (Hain and Jurowetzki, 2018) that Kenyans who studies in the US now return back with technological knowledge and personal networks established abroad. The professional network plays a significant role in Kenya´s tech environment in relation to access to venture capital (interviewee, no. 7).

#### 5.2.6.2 Indicator: The Role of Government

Informants presented that the government does not support start-up companies. A Kenyan entrepreneur, business and startup consultant comments:

> "Local government is terrible at supporting, if you are poor you have to work really hard or be extremely talented to start. It is very difficult, but the talent is there. Facebook gives more voices and people are becoming more recognizable because of content, there is change and people are becoming aware of it but it is definitely more difficult for locals than for internationals" (interviewee, no. 6).

Erik Hersman also notes:

> "Government is not really helpful on the start-up side. It is important if the government can provide fewer frictions for start-ups, take away high tax to promote space like tech" (interviewee, no. 7).

In an interview, a Kenyan entrepreneur and managing director emphasized that there are few African companies that do not want to invest into start-ups because of associated insecurities and government invest more into manufacturing and real estate (interviewee, no. 1).

Kenya government plans to build a global science and innovation hub named as Konza Technology City situated 60 km outside of Nairobi. The project has received a large investment from China and South Korea. With expected openings in 2022, the mission of the Konza Technology City is to become a so-called smart city that forms "technology and science innovation, telecoms, education, data centres" and businesses (Mwaniki, 2017:694). Kenya has also contracted with the Chinese tech company Huawei to support the development of smart city. The project idea builds on the success of the India software industry (Mburu, 2019). Kenyan entrepreneur and managing director opinioned skepticism about the project as inefficient to meet its objective of becoming a high-tech centre (interviewee, no. 1). Recent studies have argued that the project fails to promote benefits equally to society and attract enough foreign investment (Saraswati, 2014).

In conclusion, findings link the development of technological innovation depending on the capacities of small-medium enterprises and business environment. Recent studies suggest that government support increases the development of ICT innovations and SME market competitiveness (Chege et al., 2019).

### 5.2.7 Human capital

#### 5.2.7.1 Indicator: Software Development

Current research stresses that talent with technical expertise is the essence required for a country industry 4.0´s growth (Ustundag and Cevikcan, 2017).

Findings reveal that Kenya´s capital Nairobi has a strong talent of technical developers (interviewee, no. 1; interviewee, no. 4; interviewee, no. 6 and interviewee, no. 7). Erik Hersman emphasises when comparing Kenya to other African countries:

> "South Africa has a lot of money, capital which you need, Nigeria has a lot of people and Kenya has innovation. The interesting ideas come from Kenya, you find people who tend to be experimenting more and then quickly have to expand outside of Kenya because of bigger market to commercialise things" (interviewee, no. 7).

Furthermore, one informant pointed out that Kenya has a strong talent in software development but people do not have experience with business and business side of technology (interviewee, no. 1). Danish co-founder and director of mobile technology in Kenya also explains:

> "Nairobi is the capital of tech in Africa, there is a huge demand for good developers and the supply of them just cannot catch up, there is plenty of mediocre developers but the really good ones demand insane salaries that can compete with high-income countries. It is cheaper to hire developer from Germany because the price of a good developer in Berlin is lower than a good developer in Nairobi, most of the tech start-ups I know move the tech elsewhere" (interviewee, no. 5).

Furthermore, an entrepreneur, business and startup consultant remarks:

> "Kenya is going through an amazing period to develop talent even further, talent is sometimes taken away because talented people would get recruited and lot of them leave abroad" (interviewee, no. 6).

The above comments also relate to the interview with a Kenyan entrepreneur and managing director: "Andela, uses talent to do business in the world" (interviewee, no. 1). Andela, an African start-up based in Nigeria and New York offers the world´s top training programme for software engineering. The selected programmers work for global tech companies in the US (Veselinovic, 2015).

Leaving the reinforcing circle of the industry 4.0 growth, the paragraph ensues with social ramifications as outlined in the theoretical framework.

### 5.2.8 Social Impact

#### 5.2.8.1 Indicator: Data Privacy

The results from interviews suggest that tech companies can make use of consumer´s data because no privacy policy or restriction exists, which also give more dominant companies power over the market (interviewee, no. 5 and interviewee, no. 7). A Danish co-founder and director of mobile technology in Kenya mention:

> "There is no data privacy, it is up to the company how well they protect data, there might be some rules, but I am not sure if they are being followed, there is no such regulation like GDPR in Europe. You can try a lot with start-up, data are sold straight away" (interviewee, no. 5).

#### 5.2.8.2 Indicator: Digital Borrowing

The interview with a Kenyan entrepreneur, business and startup consultant illuminated the problem of borrowing money through mobile money. He noted that gambling companies are making a lot of money, local people are not aware, and the youth get addicted to gambling (interviewee, no. 6). From his words:

> "Online mobile gambling is a new trend, people are gambling small amounts, and there are too many scenarios where people commit suicide. They should put the regulations in place. People are taking loans you cannot come to Kenya to exploit, you need to offer guidance about digital lending" (interviewee, no. 6).

The second part focusses on the **RQ 2: How does the development of industry 4.0 in some African countries unlock conditions for the movement of production processes from more industrialised economies to less industrialised economies?** It follows the theoretical framework in which the effect of global value chain acts on the reinforcing circle and mediates the outcome of the digital economy. The passage discloses the external factor of the global value chain and proceeds with related findings of the digital economy in Kenya.

### 5.2.9 Global value chain

#### 5.2.9.1 Indicator: Africa´s Participation in the Global Economy

Researchers argue that Africa´s transformation from low-income to middle-income economy depends on the increase of agricultural productivity, value creation in manufacturing and higher gains from the export of processed manufacturing (Qobo and le Pere, 2018). The global value chain is one of the strategies that provides Africa with an opportunity to integrate its economy through the global division of labour and distribution of the profits generated from production processes (Lopes, 2013).

Previous studies show that increase of internet connectivity has facilitated East African firms to join global value chain particularly in IT-related services including; tourism, e-commerce and digital business process outsourcing (BPO) (Wood et al., 2018; Wood et al., 2019). BPO is defined as a "service work contracted out to a third party" (Mann and Graham, 2016:1). Kenya touristic companies have improved their efficiency and productivity internationally through web development, online booking platforms as well as online payments (ibid). In contrast, other studies note that small East Africa firms remain on the peripheries, outside of the value chain because of lack of internet and digital competencies (Murphy and Cardomy, 2015; Foster et al., 2018: 78 - 80). The proliferation of ICT has enabled "offshoring" of labour to countries such as India, the Philippines and China. Kenya´s government has since committed to turning

Kenya into a global exporter of IT services and followed a model of India. Kenya´s business outsourcing services include “software development, research and development, finance and accounting” (Mann and Graham, 2016; Ngui and Kimuyu: 216).

5.2.9.2 Indicator: Structural Transformation

Findings from the interviews suggest that Kenya as well as Africa in general, are seeing the emergence of ICT innovations of the industry 4.0 such as financial technology, blockchain and internet of things (interviewee, no. 6; interviewee, no. 1; interviewee, no. 5). Erik Hersman commented that different innovations happen in African tech, ICT is mostly driven by business, and robotics is not seen that often because manual labour is not expensive in Kenya. According to his further comments:

> “Kenya does not have a strong industrial sector. Agriculture is the most impacted. Internet of things technologies is being applied in agriculture. The start-up SunCulture provides low-cost irrigation and applies the internet of things technology to help with water circulation and increase yields. While artificial intelligence (AI) is not so present, there are opportunities for AI as software can reduce the costs and increase efficiency. Nevertheless, artificial intelligence reduces human intervention which leads to the question of jobs that Kenya needs” (interviewee, no. 7).

Regarding the role of government in relation to industry 4.0, Kenyan entrepreneur and managing director mentions:

> “Government invests in the manufacturing industry, more investment is taking place to make products in Africa and reduce import from China. Also, to support export outside of Kenya, agriculture and manufacturing are strongest, the export of flowers and coffee” (interviewee, no. 1).

Previous research on the East-Asian miracle in the study of Indonesia showed that the agriculture sector was an important driver for the country to escape poverty (Djurfeldt and Jirström, 2005). Another study that compared Malaysia and Kenya,

found that Kenya´s agriculture has not recorded as large growth as in cases of Malaysia and Indonesia despite government spending. The reasoning is that Kenya´s spending in the agriculture sector was subsidized unevenly. The Kenyan government allocated money mainly to high-yielding areas and disregarded small farmers in less favoured areas. In contrast, Malaysia provided more equalized spending (Henley, 2012: 35–39). Recent research discusses that in countries like Kenya, labour moves from the agriculture sector and rural areas, not to the manufacturing sector, but instead to services (Rodrik, 2016: 12-13). The service sector provides the main employment. It is argued that Kenya´s manufacturing grows gradually, yet labour moves to services and informal sector which leads to weak productivity growth (ibid:15).

Furthermore, several studies reveal that the increase of production costs in China and other emerging economies offer possibilities for production movement to countries with lower labour costs (Brautigam et ala., 2018; Lin, 2018). In this vein, the pattern of "flying geese" (Kojima, 200) describes China as "leading geese that allocate the lowest parts of the value chain to Ethiopia (Brautigam et alb., 2018: 164–165). These results suggest that from 2012 to 2015 China established ten garments factories in Ethiopia (ibid:41). Accordingly, Chinese investment induces the opportunities for technology and knowledge transfer, so-called knowledge spillovers (Wolf, 2016: 57). For example, in Kenya, the Alibaba Group, the Chinese e-commerce giant agreed with Safaricom to incorporate Aliexpress with M-Pesa accounts *(Africanews, 2019).* The result of the cooperation will enable M-Pesa customers to shop online at Aliexpress and pay through M-Pesa account (ibid.). The following and final chapter section presents the findings relating to digital economy.

### 5.2.10 Digitalisation

#### 5.2.10.1 Indicator: Servicification

Findings from interviews indicate the expansion of digital services. An entrepreneur, business and startup consultant remarks:

> "ICT impacts on every scale, M-Pesa has its app and has been in charge of platforms, there are hailing apps, food delivery such as Uber Eats and recently Egyptian star-up Swvl, new bus transportation is filling the gap between uber and public transport" (interviewee, no. 6). He also explains:
>
> "China comes to market, smartphones have become affordable and frequently used. In the city, everyone has a smartphone and people start to see the benefits of earning. It creates jobs, for example, drivers of motorbikes started using the mobile app" (interviewee, no. 6). Similarly, Kenyan entrepreneur and managing director state:
>
> "Tourism is expanding with companies such as Uber and Airbnb, they are not yet so strong but will make a big impact" (interviewee, no. 1).

Recent evidence demonstrates that Jumia, a Nigerian start-up has built one of the largest African e-commerce companies operating in 14 countries including Kenya *(BBC, 2019)*. Moreover, previous research on ICT in Kenya underlines the offshoot of digital work outsourced to marginal communities (Mann and Graham, 2016). The hybrid pro-profit and non-profit organisation Samasource is one of the examples that outsource digital work from Silicon Valley to Kibera, the largest slum in Kenya. Samasource focuses on an artificial intelligence system that processes the data for self-driving cars. Samarsource has lifted the lives of an estimated
50.000 people in the Global South (Lee, 2018).

# 6 Discussion and Concluding remarks

Findings of RQ1; What are the opportunities and challenges related to industry 4.0 in terms of enabling emerging economies like Kenya to accelerate the development of the industrialisation process?

The aim of this thesis was to explore whether industry 4.0 can offer a new model for emerging economies, in this study using the instrumental case of Kenya, to develop its industrialisation process. The literature review presented a historical outline of past and recent models of industrialisation in the particular context of Africa. The purpose was to understand that Africa has since its independence been imposing models that failed to create a comparative advantage and thus develop the industrialisation process. As mentioned in the literature review, the policy of deregulation under the Washington Consensus in Africa hampered the agriculture sector. In contrast, East-Asia was able to advance industries due to US capital inflow, access to knowledge and an already productive agricultural sector. The analysis agrees with the theoretical assumptions that internet, telecommunication network and energy supply, catalyse infrastructure and hence allow conditions for structural change in Kenya.

The findings show that internet connectivity in Kenya has increased since the development of optical fibre in 2009. The landing of fibre optic has especially strengthened the infrastructure that proliferated access to public service, e-government and overall progress in the bureaucratic system. For example, Huduma centres create opportunities for efficient communication, citizen's participation and transparency to eliminate the level of corruption. As mentioned in the literature review, Kenya skips the traditional steps of industrial development due to the adaptation of mobile money M-Pesa. This corroborates premises of premature deindustrialisation as Kenya experiences a growth of services without firstly developing the manufacturing sector (Rodrik, 2016; Meglio, 2018). This shift is possible due to "globalising processes" (Dicken, 2017) induced by the augmentation of ICT innovations that have reduced the

trade, communication and face-to-face costs (Baldwin, 2018). From the theoretical model green growth being an enabler indicate that Kenya has embraced progressive modernisation to renewable energy that can be further enhanced with the implementation of policies that meet the needs of rural areas. Overall, access to electricity in a two-year period has expanded by 20 per cent. Kenya´s renewable resources such as geothermal and wind energy provide opportunities for the green economy.

Despite this positive development, challenges prevail due to the large internet divide between rural and urban areas. It was found that large investments in the supply of energy to rural population contradict with affordable costs for the household. Decentralised energy applications exemplified by the internet of things offer sustainable and cost-effective solutions. It is important that the government embraces investments into models that support small-medium enterprises and create opportunities for both urban and rural business. This reasoning also applies to internet infrastructure as the analysis shows, due to enabling conditions as theory presented in chapter 3, entrepreneurship combined with tech innovation offers low-costs solutions for rural areas. It is therefore important that the government allows competition, encourages small firms to come to the market to stimulate productivity growth and concurrently labour markets. The analysis reveals that M-Pesa causes a snowball effect because it enlarges services and expands to global markets. However, one dominant large company, like Safaricom, on the market may block the competition. This is consistent to the claims by (Wallerstein, 1979; 2005) that core production processes thrive due to "quasi-monopolies" in this case, political instruments of Kenyan government against production of peripheries, characterised by start-ups firms, small-scale entrepreneurs who are disadvantaged because of incapability to compete with the core. The core – dominant players such as Safaricom prevent small firms to penetrate the market.

Furthermore, analysis shows that once the technological innovation is on the market it can be smoothly reproduced providing the assumptions of enabling

conditions telecom network and internet infrastructure, green capital and reinforcing factors of human capital, innovation hubs. Doing so, the government may migrate the risks relating to wasteful spending, oversupply, inefficiency and likely corruption. Hereby, government initiatives that support the bottom-up approach preclude the profit accumulation of a few big firms that deepen inequality and poverty traps (Harvey, 2018) in rapidly urbanising Kenya capital Nairobi. Allowing conditions for starting firms that now have access to internet stimulate the research and development, scaling up and contribute to Kenya sustainable inclusive growth – Agenda 2030 and Agenda 2063 (Armah and Baek, 2018). Regarding the lessons from the East-Asian success, the cooperation between government and business organisations was vital for achieving successful industrialisation (Wade, 1992).

To answer the RQ1, in comparison to previous development models, industry 4.0 increases research and development allowed through internet and ICT innovations that were previously centred only in the core countries. The thesis argues the enabling conditions - telecom network and internet infrastructure, as well as green capital, considering the country´s institutions catalyses the industry 4.0 development with spin-off effects, applicable also to another country in Africa. In Kenya, technology allows institutional change that motivates new economic and political activities. This finding supports the theory of traditional institutional economics Veblen (1915) who argued that Japan´s economic success was conditioned by modern technology transfer combined with Japanese traditional values.

The analysis shows that M-Pesa drives the innovation space by opening opportunities for transferring remittances and borrowing loans. Technology also transforms the traditional aid model. Sub-Saharan Africa, previously dependent on chiefly foreign aid and unattractive for private economic investment currently arouses the interest of private investors in areas of technologies and businesses. As this thesis has shown entrepreneurship is mostly driven by foreign knowledge transfer. Start-ups are established by Kenyans who graduated from the US

universities and have close personal networks in the Silicon Valley in San Francisco Bay Area. Important findings reveal that the government does not support entrepreneurship, which disadvantages local people to access funding and support for enterprise services. The innovation hubs such as the example of iHub provide opportunities for communities to learn about tech entrepreneurship. It can be claimed that depending on the purpose and accessibility of innovation hubs in other regions of Kenya, increase the inclusive growth. For example, the decentralised system through regional hubs may contribute to positive economic development. Moreover, digital content empowers local people´s participation in business activities.

The study further reveals that Kenya has a great number of talents specialised in software development, but that demand does not meet supply. The analysis indicated that international start-ups employ software developers from Europe, for example Germany because the costs of skilled software developers in Kenya are higher to those in Europe. This evidence supports Baldwin´s (2019) reasoning about remote work, discussed in the literature review.

Moreover, findings reveal that data privacy and digital borrowing are one of the side effects of industry 4.0. Regarding data privacy, tech companies in Kenya do not follow any policy that would protect the user's data. The Economist, (2019) argues that large tech companies such as Facebook and Google access control over citizen´s data that give them a leading position on the market. The market power enables a company to increase prices without the risk of losing its users because of no competition (ibid.). Thereby new opportunities for taking loans through mobile money have aroused the issue of online gambling. The Economist, (2018) mentions that technology provokes new market actors "digital lenders" that provide microloans and often are not authorised (ibid.). This confirms the importance of regulative policies to prevent segregation, abuses and suicidal behaviours. As mentioned in chapter 3 the impact of industry 4.0 will depend on a country´s stable institutions and legislations. Policies that support human capital

and social benefits are inevitable to reduce persistent inequality and unemployment.

2. Findings RQ2: How does the development of industry 4.0 in some Africa countries unlock conditions for the movement of production processes from more industrialised to less industrialise economies?

Regarding the effect of global value chains, this study reviewed the previous research and concludes that Kenyan IT services have been involved particularly in the export of low-value labour (Murphy and Cardomy, 2015). The digital platforms have helped well-established East African companies to participate in the global value chain even without strong competitiveness (Mann and Graham, 2016). These findings are consistent with (Baldwin, 2019) as global value chains are more fragmented and allow offshoring of services from developed to developing country due to reduced costs of remoteness to exploit the benefits of lower costs labour. The evidence indicated that the lack of competencies in project management and business skills prevent from moving to higher-value IT services. It can be argued that on the global level, the country economy capitalises on the time and distance to technology capital within the global value chain.

With regards to structural transformation, the analysis outlined scenarios of other researchers to explore the interconnected features of industry 4.0. Firstly, If East-Asia is any guide, Kenya and at large Sub-Saharan Africa may not industrialise without agricultural growth (Djurfeldt and Jiström, 2005; Henley, 2016). Secondly, the increase of production costs in China elevates China´s position in the global value chain opening the opportunity for countries with lower costs of labour. Ethiopia indicates some signs of "flying geese" but it needs to develop a strong competitive advantage else it remains a supplier of inexpensive labour and basic material for Chinese advantage (Giannecchini and Taylor, 2018). According to the third scenario, Kenya experiences labour shift from agriculture directly to services (Rodrik, 2016). It is therefore likely that these constellations show main

challenges; unequal spending in agriculture that agrees with the theory of economic inequality - widening income gap (Kuznet, 1995), low competitive advantage in manufacturing and informal sector. Possibly, decentralised management of spending in agriculture, Chinese knowledge transfer in Kenyan manufacturing due to the global value chain and advanced ICT innovations formalise firms' services mediate the opportunities for structural transformation. Therefore, envisaging the experiences from Asia (Kucera and Jing, 2018) digital services in Africa may increase the overall productivity and complement manufacturing given the technological innovation and human capital are provided.

The study has been unable to show the movement of production processes of goods. However, the outcome suggests that it is primarily the increasing production process within services that forms the digital economy. Hence, in response to RQ2, the production moves into digital servicification. The access to financial services generates growth of market share due to the use of digital platforms. Findings disclosed that Chinese mobile phones are sold to the African market, which offers the potential for China to become the world´s phone producer for Africa (The Wall Street Journal, 2019). It was suggested that the use of smartphones is expanding at affordable prices and unlock the ways for international companies such as Uber and Airbnb to enter the African market. The study observed that digital platforms are scaling up across Africa (interviewee, no. 6). For example, digital platforms operate in transportation (Glovo and SafeBoda), logistic (Sendy), food delivery (Uber Eats) and tourism (Airbnb) and online shopping (Jumia).

## 6.1 Policy Implications and Concluding Remarks

The results underlined several observations for drafting a policy. Overall, the research showed that ICT innovations of industry 4.0 stimulate Africa´s share in the global economy. Africa starts access to international capital. The service sector allows the export of low value IT service work which may enhance Africa ´s development of comparative advantage. Digital platforms offer the opportunity to reduce the share of the informal sector by formalising it through mobile payments. This would contribute to the welfare and enhanced transparency would reduce tax avoidance.

The Kenyan government needs to focus on providing incentives for entrepreneurship and secure bottom-up support of human capital by investing in education and training business competencies, while distributing evenly the resources in the agriculture sector and social services. The analysis showed that M-Pesa is one of the examples of industry 4.0 technologies that drives services, business and consumption. The potential for Kenya and general Africa is demography. The reasoning is that young population adapt fast to the use of ICT innovations and hence consumption motivates business to expand in relation to market demand. The important findings suggested the movement of production within services due to greater access to financial services.

Industry 4.0 implies the replacement of the workforce in manufacturing by machines, therefore upskilling of labour is desirable because the manufacturing will become digital with new business processes. The government efforts should strengthen institutions that promote decentralized management in energy, internet connectivity with access to innovations hubs to preclude deepening of inequality conditioned by the skills gap between education and market demand. Given the growth of digital platforms, the government needs to adopt policies to protect the personal data of citizens. It is necessary for the government to provide support for small firms. Donors can help by enhancing economic investment so that local people can develop skills and entrepreneurial learning. This may be secured via the cooperation with regional innovation hubs.

## 6.2 Further research

This research was exploratory with the purpose to understand catalyzing industry 4.0, and its rising position in the academic discipline of international development studies. A comparative analysis of other countries such as India and regions of South East Asia provide a room for further research. There are abundant questions in relation to industry 4.0 such as opportunities of regional value chain and its relation to Africa´s digital economy and industrialisation. More research on this topic needs to be undertaken such as women participation in the digital economy.

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# 8 Appendices

## Appendix 1 - Development of Theoretical Framework

| Past models of industrialisation | **Policy** | **Objectives** | **Africa** | **Latin America** | **Asia** |
|---|---|---|---|---|---|
| | **Import substitution industrialisation 1950s - 1980s** | Developing countries replace import of foreign goods for domestic production to support national industrialisation and reduce dependency on developed countries | | | |
| | **Modernisation Rostow model 1960** | Modernisation happens in five phases from *traditional society to mass consumption* | | | |
| | **Dual-sector model 1954** | Sector shift from subsitence agriculture to industrial sector increases labour productivity | | | |
| | **Washington Conseunsus 1980s** | Neoliberal policies of free trade, denationalisation and deregulation | Lack of competitive advantage | Large debts | East-Asian private-state ownership, manufacturing for export |
| | **Post-Washington Consensus** | Establishement of donor´s and receiver´s aid - developed and developing coutnries | Disregard social, historical and country-specific needs | | |
| | **Millenium Development Goals 2000** | Reduce extreme poverty | Improvement of socio-economic characteristics | | |
| | **Sustainable Development Goals 2015, Agenda 2030** | Sustainable inclusive growth end all forms of poverty | Increase value added manufacturing and sustainable industrialisation | | |

| | Perspective on Global Economy | Characteristics | Africa | Latin America | Asia |
|---|---|---|---|---|---|
| *The link between sector and economic development* | **Structural Transformation** | Sectorial changes lead to economic development, intra-sector changes service sector, advanced services | Weak comeptitive advantage | Less competitive advantage | Strong competitive advantage (manufactruing, services, advanced services) |
| | | | | | |
| *Global economy* | **International Division of Labour** | International divison of labour exchange of goods, capital and labour, monopolisation | Peripheries | Semi-pheripheries | Core (Japan)and Semi-pheries |
| | **Globalisation"interconnectedness and speed" economic activities shifted across geographies** | Open market, access to the knowledge, financial services opposed to uneven development, skill-gap, favours few at the expanse of many | | | |
| *Global Value Chain* | **Globalisation 1.0 and Globalisation 2.0** | North-South divide, innovation clustered in the North high communication costs | | | Japan, Hong Kong, Singapore, Taiwa, Korea |
| | **Globalisation 3.0** | Reduced costs of communication, creation of global supply chain through offshored manufactuting | South Africa | Brazil | India, China, Indonesia, Thailand |
| | **Globalisation 4.0 data capital** | Reduced face-to-face costs - computerised productivity and offshoring of service, reshoring of manufacturing | Other peripheries integrate into global value chain (Kenya, Pakistan, Bangladesh, Ethiopia) | | |

## Appendix 2 - Interview questions

1. How do you perceive the growth of industry 4.0 technologies in Africa, Kenya, what are the effects? In which ways do you recognize the influence of industry 4.0?

2. What would you say about the tech scene and start-up ecosystem in Kenya or Africa in general?

3. Who provides support to start-ups? How do international companies cooperate with start-ups/small-medium enterprises? What is the ratio of international tech companies and local tech start-ups?

4. Which ICT technologies of industry 4.0 enter the African market? What opportunities do they create?

5. What would you say are the biggest challenges of industry 4.0 in the context of the private and public sector? What are the main limitations, barriers of industry 4.0?

6. Is there any inter-regional cooperation between tech-firms in Africa?

7. Do you see African countries integrate into the global economy?

8. What is the role of government in relation to industry 4.0? How does Kenya government support access to ICT within society? Have ICT innovations been used within a larger population, in which ways in terms of e-government, education, public services?

9. How do people experience ICT in urban and rural areas?

10. Does government provide any education, programmes in relation to expanding ICT technologies? Have there been any major changes in labour market?

## Appendix 3 - Analytical Framework for Case Study

| Research Question 1. | | | |
|---|---|---|---|
| | Indicator | Literature | Interview |
| Embeddedness<br>Openness | 1. Market openness<br><br>2. Institutional environment<br>3. Private-public partnership Promotion of ICT policies<br>4. Foreign and local collaboration: UK Vodafone Department For International Development (DfID) and Safaricom Kenya´s leading telecommunication operator, respectively<br>5. Mobile phones stimulate business in SSA provided that government´s openness and support of ICT technology<br>6. Government´s support market oriented policies and allow entrepreneurs and specialists to come | 1. Asongu and Nwachukwu, 2018;<br>2. Amankwah-Amoah, 2019<br>3. Lepoutre and Oguntoye, 2018;<br>4.1. Kiggundu and Ogola, 2017:47-50;<br>4.2. Schäfer, 2018<br>4.3. Kiggundu and Ogola, 2017<br>4.4. Kingiri and Fu, 2019<br><br>5. Asongu et al., 2018<br><br><br>6. Burns, 2018 | |
| Telecom networks and internet infrastructure | 1. Development of fiber optic cables<br>2. Fixed wireless broadband internet<br><br><br>3. Loon project instalment of balloon will<br>provide 4G technology<br>4.1. Microsoft 4Africa<br>4.2. Poa! Interent in Kibera | 1.Kumar and Dahiya, 2017: 778-779<br>2. The Kenya National ICT Masterplan April 2014 2013/14 – 2017/18: 24-25<br>3. ITU, 2018<br><br><br>4. ITU, 2018 | Entrepreneur from Nairobi (No 1.)<br>Erick Hersman (No 6.) |
| Green growth | 1. Private investment into green energy is and will be important for future green growth<br>2. The Green Growth and Employment Programme (GGEP) 2016-2020 Denmark-Kenya partnership | 1. Kazimierczuk, 2019<br><br>2. The National Environment Management Authority (NEMA) | |
| Disruptive Innovation | 1. ICT Technology has a positive impact on SME in Africa and increases productivity in both informal and formal sector<br>2. M-Pesa expands and offer other services | 1. Amankwah-Amoah et al., 2018<br><br>2. Ndemo, 2017<br>3. Gosavi, 2018 | M-Pesa provides loans despite charging quite high fee (No 5.) |

| | | | |
|---|---|---|---|
| | 3. M-Pesa positive impact on socio-economic development | | |
| Venture and Human Capital, Entrepreneurship and Development of Hubs Clusters | 3. Hubs in Kenya play significant role for innovation, entrepreneurship<br><br>4. Investment into R&D and human capital supports the technological landscape<br>5. Foreign investment into local innovation creates opportunities for new business models and substitute the required institutional support | 3. Marchant, 2017<br>3.1. Littlewood and Kiyumbu, 2018<br>3.2. Økland, 2019<br>3.3. Danquah, 2018<br>Friederici, 2018<br>4. Amankwah-Amoah,2019<br><br>5. Hain and Jurowetzki, 2018 | Funding to start-up and SME is provided by private sector over government (No. 1; No. 4; No. 5)<br>Diaspora, Kenyans who study abroad come back to set up business<br>Entrepreneur from Nairobi |
| Societal Results | 1. Increase of living standards and job opportunities<br>2. Increase of automation will negatively impact people with low educational level while expanding the income inequality<br>3. STEM education a powerful trend<br>Tech become highly-skilled over low-skilled labour, which opens space for populist politics<br>4. Tech dominant power questions democracy, society and personal data protection<br>5. Formal and informal sector | 1. Lee et al., 2018;<br><br>2. Means, 2018<br><br>3. Levy, 2018<br><br>4. Feenberg, 2012, Marchant<br><br>5. Fu et al., 2018<br>Mendi and Mudida, 2018 | |
| **Research question 2.** | | | |
| Data manufacturing | Example of non-profit business Samasource that use artificial intelligence and machine learning technologies to outsource digital work in Kenya | 1.BBC News, 2018, 2019<br>1.1. Busines Daily Africa, 2019 | |
| Global Value Chain | Outsourcing of digital work, e-commerce,<br>M-Pesa Global | Wood et al., 2018<br>Rodrik, 2018; Rice, 2013<br>O'Neill, 2019<br>Africa News | |