



Chain upgrading, technology transfer, and legitimacy: The Schumpeterian character of China in the information and communication technology sector in SSA

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ABSTRACT

Drawing on technical change and technology transfer theories, we explore the Schumpeterian character of China in the information and communications technology (ICT) value chain in sub-Saharan Africa (SSA). Using data collected from various online sources, including the International Telecommunication Union (ITU) and World Integrated Trade Solutions (WITS) databases, we establish three key findings. First, relative to the traditional Global North sources, China has become a major source of ICT in SSA. Second, over the past two decades, Chinese firms operating in SSA have adopted a Schumpeterian character to gain legitimacy in the communities in which they operate. Third, with the easier transfer of ICT from China, local ICT firms in SSA have upgraded their value chains from only delivering information services to becoming important players in the financial sector, including the provision of mobile money transfer services. We conclude that China's expansive size, coupled with its ability to produce technologies for low-income economies, is likely to ensure that it will remain the dominant source of ICT innovations for SSA.

1. Introduction

China's economic engagements with SSA have been associated with the relatively high and sustained economic growth that most African countries have experienced in the last two decades. Notable among these engagements is the rise in the transfer of ICT from China to Africa (Hanlin and Kaplinsky, 2016; Kaplinsky, 2013a). Nevertheless, the socioeconomic importance of ICT products from China in SSA is strongly debated in the extant literature. Some studies argue that Chinese ICT is not only appropriate for Africa's factor endowment but also has the potential to upgrade and drive digital connectivity in most African countries (Tang, 2021). Chesbrough et al. (2021) support this school of thought by indicating that, over the past four decades, Chinese firms have developed core competencies and dynamic capabilities, which may favor a digital technological upgrade in the Global South.

Another school contends that technologies from the Global South are in many ways inferior and unreliable for business and economic growth (Eckaus, 1955; Emmanuel, 1982). However, this argument was made in an era, from the 1950s to the 1980s, when technological progress was viewed from the perspective of the development of physical artifacts,

mostly in the form of industrial machines (Stewart, 1982). Global ICT progress was at a nascent stage and was not the subject of discussion in the standard technology transfer literature until the turn of the millennium. A third group of scholars appears to be indifferent to the pros and cons of Chinese ICT in SSA. However, they observe that Chinese technologies can only be appropriate and pro-poor if they can lead to the birth of new disruptive ideas that can engender a chain upgrade in SSA (Fu et al., 2011; Hanlin and Kaplinsky, 2016; Botchie et al., 2018). What is missing among these three schools is any consideration of the nature of the disruptiveness of Chinese technologies in SSA. Fortunately, Huawei's growing engagement with Africa appears to be presenting an opportunity for the latter to develop its ICT sector (Hungerland and Chan, 2021).

Kaplinsky and Morris (2018) further explain that China's engagement with SSA is Schumpeterian in character, as the former supports countervailing and unrecognized processes of inclusiveness in local communities in SSA. Over the past three decades, this has manifested in China's engagement in the technological progress in SSA, as the former supports the transfer of low-cost ICT innovations to create new markets that are inclusive of poor consumers and small-scale producers

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(Kaplinsky, 2013a). However, despite the potential Schumpeterian character of China in SSA, it has not received much attention in the standard technological transfer literature. While Muchie and Patra's (2020) study is one of the few that have analyzed the pro-poor nature of the Sino-African relationship, their study is in the context of technological patency and intellectual property rights in SSA.

From a Schumpeterian perspective, we make a novel contribution to the theory of technical change by analyzing the role of China in supporting the transfer of ICT to SSA. This study makes three main contributions to the literature. First, it provides useful insights into the "creative destruction" thesis by showing the nexus between China's Schumpeterian character and business legitimacy in the ICT sector in SSA. Second, this study contributes to technical change theory by unpacking the role of Chinese ICT in the value chain upgrade in SSA. Third, the study elucidates the spillover effect of China's Schumpeterian character on those at the base of the pyramid in SSA. The remainder of this paper is organized as follows: in Section 2, we review technical change theory and the Schumpeterian philosophy to understand the importance of technological progress at the base of the pyramid. The literature on technical change, technology transfer, and upgrades is also reviewed in this section. Thereafter, we discuss the methodology and explain the data collection approach and analytical methods in Section 3. The findings on China's Schumpeterian footprints in SSA are discussed in Section 4. Finally, we discuss our findings and their associated implications for theory and conclude the paper in Section 5.

2. The Schumpeterian schema and technical change

Solow (1957) pioneered the concept of technical change to illustrate any shift in a given production function. Solow's work served as a basis for other studies to investigate the biases and directions of technical change (Hicks, 1963; Kennedy, 1964; Solow, 1968; Solow, 1957). These studies have concluded that technical change can be "neutral" or can take several directions. A neutral technical change can increase the productivity of factor inputs, including technologies, in equal terms. However, technical change can also be biased toward a specific factor, such as capital, labor, or technology (Ruttan, 2001). In the Global North, on the one hand, where wages are high, more capital is required to maximize output and profits (Ruttan, 2001; Botchie, 2015). In the Global South, more labor is required, as wages and technological progress are low (Ruttan, 2001; Botchie, 2015).

To avoid complications in the analysis of technical change, it can be graphically illustrated with capital (K) and labor (L) as factor inputs that produce a given output (Clark, 1985; Bhalla, 1992). This linear model helps to determine the optimal combination of factors (Botchie, 2015; Clark, 1985). Fig. 1 is a graphical illustration of how to determine the

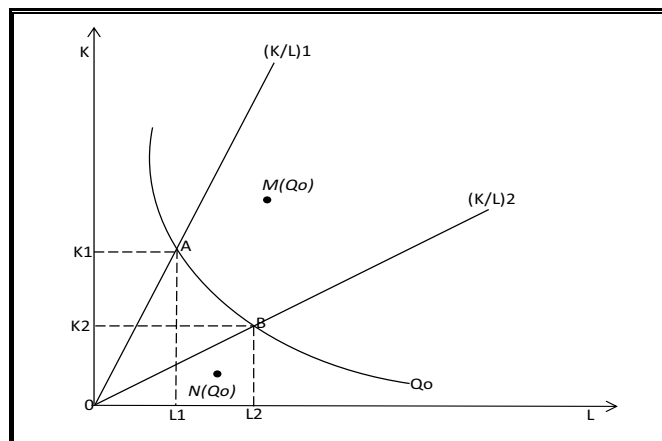


Fig. 1. The production function.
Source: Clark (1985, page 81).

optimal combination of factors, specifically capital (K) and labor (L), in a production function (Botchie, 2015). The isoquant Q_0 represents different combinations of factor inputs that produce the same level of output. This helps in determining the factor intensity and substitutability of a given production function (Botchie, 2015; Clark, 1985). At Point A, more units of capital are used relative to labor to produce a given output. This production system can be described as labor-saving (or capital-intensive). However, Point B uses more units of labor relative to capital to produce the same level of output. Thus, this production system is more labor-intensive (or capital-saving) (Botchie, 2015; Clark, 1985). Therefore, technical change can also be labor-saving, capital-saving, or neutral.

In the 1970s, theories of technical change began to prioritize the processes involved in developing and commercializing new products in the service sector (Kaplinsky, 2011). Until then, technical change had been considered to be exogenous to production systems. Schumpeter's (1939) groundbreaking work on the distinction between inventions and innovation clarified the concept of technical change. He argued that technical change involves the act of innovation, which results in a change in the amount of output produced from the same quantity of a given input (Kaplinsky, 2011; Webber et al., 1992). For him, technical change occurs in many different shapes and includes not only the technological advancement of products and processes but also the firm's innovation philosophy, ranging from radical innovations that can change aggregate demand and supply to minor changes in existing products and processes (Kaplinsky, 2011; Webber et al., 1992). This was his basis for creative destruction, as innovation laggards were outpaced by developers of disruptive technologies. Schumpeter (1939) further argues that technical change is a continuous process in which past and present innovation activities contribute to shaping those of the future. This may engender innovation trajectories that influence innovation activities and economic development for considerable periods (Dosi, 1982; Freeman, 1982; Freeman and Louçã, 2001).

Technical change, as a continuous process, is endogenous and associated with capitalism (Petrakis et al., 2020; Villanueva, 2018; Kaplinsky, 2011). Under capitalism, a firm's decision to commit resources toward research and development (R&D) is often a function of its readiness to innovate for super-normal profits and property rights and to gain a first-mover advantage status in a given industry (Schumpeter, 1939; Hill and Hult, 2017). However, Kaplinsky (2011) cautioned that over time, the innovations induced by supernormal profits would be eroded when copied through diffusion and competition. Likewise, an inventor's property rights could expire or be used without permission in economies with weak institutions (Kaplinsky, 2011). Kaplinsky (2011) further indicates that inventions do not necessarily translate into innovations, as they may never be used or may stand on the shelf for many years.

In earlier studies, Prahalad and Hammond (2002) and Prahalad (2005) advised monopoly-focused firms from the Global North to ignore those at the base of the pyramid, as the collective buying power of the bottom billion could provide sustainable and profitable business opportunities. By implementing Prahalad's recommendation in China and India, where income levels were significantly low, General Electric significantly increased its profit margins in the 1980s (Fernandez and Underwood, 2006). General Electric's success inspired other tech companies, such as Apple Inc. and Microsoft, to explore Asian markets to maximize production and globalize sales of their innovations (Zhu et al., 2021; Yu et al., 2019; Mourao, 2018; Chataway et al., 2014; Kaplinsky, 2011).

2.1. Technology transfer

Recent endogenous growth models show a strong correlation between international trade and its associated linkages with knowledge and technology transfer (Coe and Helpman, 1995). The earlier literature shows that the underlying principle of the growth model is that

international trade, particularly in capital goods, is an important motivating factor for technology transfer from the north to the south (Coe and Helpman, 1995). The consensus in the literature is that the transfer of technology from the Global North to the Global South, particularly in China and India, has not only led to the development of the technological capabilities of the latter but also served as a basis for Chinese firms to develop technologies that are appropriate for other developing countries, particularly those in SSA (Hanlin and Kaplinsky, 2016).

However, the extant literature seldom focuses on south–south technology, even though China has become the leading source of technology to most parts of the Global South, especially SSA. Although there is a growing body of literature on the Sino–African relationship, little attention has been given to China's pro-poor technology transfer strategy to SSA. Studies such as those by Kaplinsky (2013b, 2019), Botchie et al. (2018), Foster (2009), Bräutigam and Gallagher (2014), and Bräutigam (2011) are among the few that have attempted to explore China–Africa technology transfers. However, these studies focus mainly on the appropriateness of Chinese technologies and not necessarily on the pro-poor technology transfer strategies. This study goes a step further to analyze how the Schumpeterian character of China can foster chain upgrades through technology transfer in the ICT sector in SSA.

2.2. From chain upgrading to global value chains

The concept of upgrading in chain analysis has often been used to highlight the paths required for businesses to move up the value chain (Kaplinsky, 2013b). The upgrading process is examined through the lens of how ICT knowledge flows within a given value chain (Gereffi, 2019). Two theories are associated with the concept of upgrading: core competencies and dynamic capabilities. On the one hand, Core competencies are the optimal combination of productivity factors, including capital, skilled labor, and technology, which distinguish a firm from its rivals in a competitive market environment (Kaplinsky, 2013b). This theory suggests that firms need to analyze and examine their competencies to determine which of their attributes are unique. Hsiao and Hsu (2018) added that a firm's core competence must provide value to the end user and must not be easy to emulate, with barriers to entry.

On the other hand, the term, “dynamic capabilities” suggests that corporate profitability cannot be sustained in the long run by controlling the market (Teece and Pisano, 1994). It must be borne out of efficient internal and external processes, which facilitates learning and the capacity to reconfigure a firm's past operations for future upgrading processes (Helfat et al., 2007; Helfat and Martin, 2015; Kaplinsky and Morris, 2000). Thus, firms need a combination of dynamic capabilities and core competencies to upgrade, as this will facilitate efficiency and growth in a competitive market (Humphrey and Schmitz, 2002; Vicol et al., 2019; Baglioni et al., 2020). In its quest to introduce new technological innovations, China, over the years, has transferred dynamic capabilities and core competencies to local firms in the Global South (Chesbrough et al., 2021). The extant literature on China–African engagements seldom considers the role of Chinese firms in developing core competencies and dynamic capabilities for firms in SSA. China's unique Schumpeterian approach vis-à-vis transferring technological innovations may not only lead to the development of dynamic capabilities and core competencies but also legitimize its operations in the ICT sector in SSA.

2.3. Firm legitimacy

Some studies assert that a firm can be legitimate when it operates legally within a business environment (Abländer, 2020). However, some laws are outdated and may not have global applicability (Sløk, 2020). This means that, although a firm can seek legitimacy through the legal system, it may not be socially desirable (Dacin et al., 2007). Existing studies show that firms that gain business legitimacy from their clients mostly render services and/or products that are acceptable and

satisfactory to the society in which they operate (Neuhäuser and Siebke, 2020; Deephouse et al., 2017).

Therefore, the standard literature not only uses business acceptability, appropriateness, and satisfaction as proxies for measuring business legitimacy (Deephouse et al., 2017; Parent and Deephouse, 2007) but also considers sustainability-related services (Nagy et al., 2012). Deephouse et al. (2017) further indicated that a firm's activities might not necessarily aim to gain legitimacy, but that the positive spillover effect could lead to firm legitimacy in a business environment. Scheuer (2019) posits that these spillover effects show a firm's social identity, which can be accepted (or rejected) by society.

To achieve legitimacy, firms express their social identity by undertaking active community engagement activities, including the provision of basic infrastructures, such as schools and hospitals (Scheuer, 2019). Thus, the more society develops an interest in a firm's business operations, the more legitimate the firm becomes (Scheuer, 2019). This study assumes that multinational companies (MNCs) can achieve legitimacy in a host country by combining technology transfer with effective community engagement activities.

2.4. The nexus between chain upgrading, legitimacy, and the Schumpeterian ICT transfer

Schumpeter (1939) defined creative destruction as a process of industrial transformation in which new innovations are introduced into the market at the cost of existing ones. Although it has not been paid much attention to in the standard literature, the mode of engagement of Chinese ICT firms in Africa appears to be Schumpeterian in character. We assume that the perceived Schumpeterian behavior of Chinese ICT firms in SSA is inspired by their quest to penetrate the market at both the top and bottom of the pyramid. At the top of the pyramid, they may undertake business partnerships with local ICT firms to transfer industrial technologies to the ICT sector in SSA. Access to these technologies could encourage chain upgrades through knowledge exchanges between Chinese and local ICT firms (Fig. 2). At the bottom of the pyramid, we assume that Chinese ICT firms may not only engage with the local community through the sale of affordable and accessible ICT but also contribute to the development of the communities they engage with. We argue that in their quest to gain legitimacy for their business activities, Chinese ICT firms undertake business partnerships with local ICT businesses, diffuse cheap and accessible technologies, and undertake various community programs in SSA (Fig. 2).

3. Method

Given that we seek to analyze the Schumpeterian behavior of China in the ICT sector in SSA, we adopt an exploratory qualitative research approach to gain insight into the role of China in technology transfer and upgrade in the ICT sector in SSA. We conduct our research on the ICT sector in SSA, as it is the fastest growing sector in the region. Over the past three decades, the sector has contributed an average of 10 % of the total output of the service sector in SSA (GSMA, 2021; Myovella et al., 2020). We collected data from both archival and online databases for our research. Our decision to complement archival data with online data was inspired by the difficulties in interviewing key informants from China. Second, official Chinese data sources seldom publish disaggregated data on specific sectors of the economy (Foster, 2009). For instance, the Ministry of Industry and Information Technology of China publishes only aggregated data on the country's global operations. This approach can bias the data, as published reports can be subjective and often lack detail (Foster, 2009). This notwithstanding, we focused on well-established data sources with credible international reputations. For instance, in 2020, Huawei employed Bureau Veritas, a reputable quality assurance company, to conduct an independent review of its sustainability report (one of our data sources) before it was published (see Huawei Sustainability Report, 2020). Furthermore, our data

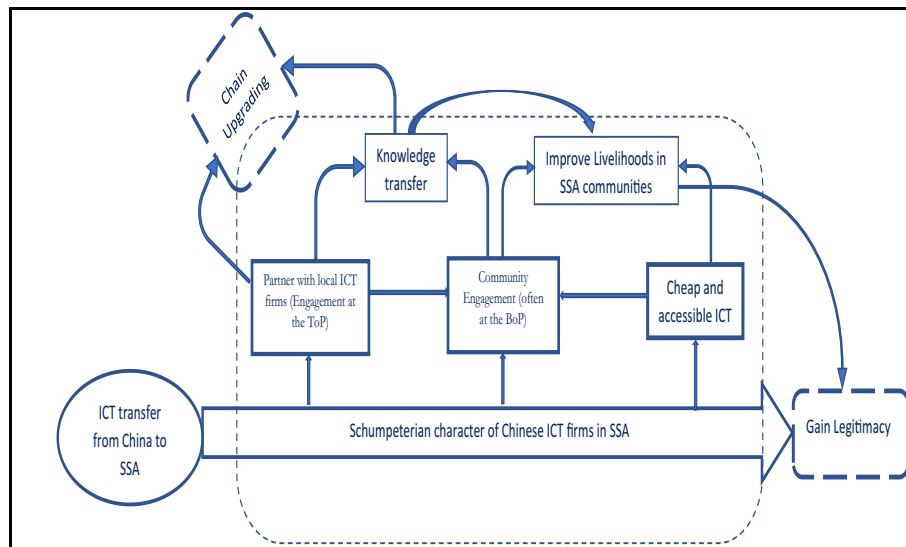


Fig. 2. Conceptual model of the Schumpeterian character of Chinese ICT firms in SSA.
NB: ToP implies top of the Pyramid; and BoP implies base of the pyramid.

provide important insights into the rapidly growing presence of Chinese firms in SSA's ICT sector.

3.1. Data collection from online databases

Data collection from the online databases was performed in three stages. First, we demonstrated the growing presence of Chinese ICT products relative to those from the Global North in SSA by collecting secondary data from the World Integrated Trade Solutions (WITS) database. The WITS database enabled us to collect data to show the growing presence of Chinese ICTs in SSA. Our criteria for collecting data from the WITS database are based on the Standard International Trade Classification Revision 4, Product code 76, which describes the movement of ICT products from one country to another.

We then narrowed our research to collecting secondary data from the International Telecommunication Union (ITU) database on the extent to which consumers in SSA relied on the ICT sector in SSA. Time series data were collected between 2005 and 2009 on indicators such as households with Internet facilities at home, mobile cellular telephone subscriptions, and active mobile broadband subscriptions. The data collected on each of these indicators, measured per 100 inhabitants, were used to elucidate the importance of the ICT sector in SSA.

3.2. Archival data search

The archival data were collected from multiple sources. The collected archival data were employed to determine whether Huawei had legitimized its operations by exhibiting a Schumpeterian character in its operations in SSA and to ascertain whether, with access to Huawei ICT products, local ICT firms in SSA were able to achieve chain upgrades.

To explore the Schumpeterian character of Huawei, archival data were collected from published Huawei sustainability reports, the Huawei website, and other credible and globally recognized business and economics Internet portals, including Bloomberg. Our choice to use these data sources is based on the fact that they, among others, report the various socioeconomic activities that Huawei undertakes in various countries in SSA. Marshall (2011) and Wong (2015) reported that Huawei is currently the main source of ICT products in SSA. Unbeknownst to millions of ICT users, technologies from the two Chinese ICT firms are pervasive and serve as the backbone of the ICT infrastructure in most SSA countries (Kaigwa and Wu, 2015). We focus on the community

engagement projects undertaken by Huawei in SSA. These include projects aimed at training and development activities, partnerships with local ICT firms in SSA, and the establishment of pro-poor infrastructural projects, including schools and hospitals.

Second, to understand the product upgrading trajectory of local ICT firms in SSA, we conduct an archival data search via Ghana's National Communications Authority to trace how local ICT firms have upgraded their products over the past two decades of Huawei's engagement in SSA. We use Mobile Telephone Network (MTN) as a case study because it is currently the largest mobile telecommunications company in SSA. We collected data on the various services in which MTN employed Huawei technologies to provide services to its customers. Collecting our data using this approach enabled us to understand how the ICT value chain had been upgraded over the past three decades. Second, data from the GSMA report are used to demonstrate how ICT products (mostly from China) are spurring upgrades in the ICT sector in Africa. The GSMA is one of the most credible industry organizations that champion the interests of mobile network operators globally.

4. Results and discussion

Analysis of our data showed insightful findings on China's Schumpeterian character in community engagement and value chain upgrades in the ICT sector in SSA. First, we find our evidence to be consistent with earlier studies (see Hanlin and Kaplinsky, 2016; Kaplinsky and Morris, 2018; Martuscelli, 2020), which show that China has overtaken the Global North to become the main source of ICT in SSA. Second, our data confirm that due to the growing imports of ICT products from China to SSA, businesses have been able to upgrade their ICT value chain to include financial products such as mobile money transfer services. Although this study does not provide sufficient evidence to show a relationship between Chinese ICT and chain upgrades in the ICT sector in SSA, it is instructive to note that MTN Ghana has been able to upgrade its value chain during an era when Chinese ICT imports far surpassed those from its traditional Global North sources. There is also evidence that MTN has employed technologies from Huawei to upgrade its chain. Third, China's Schumpeterian character has legitimized its operations in the ICT sector in SSA. To substantiate this claim, we present the evidence below.

4.1. South–South ICT trade

The rise of China, coupled with its capability to develop accessible and affordable technologies that are less reliant on infrastructure, means that in the current Fourth Industrial Revolution, China will continue to serve as the main source of technology to SSA countries (Botchie et al., 2018; Kaplinsky, 2019). Our findings confirm these assertions, as Fig. 3 shows evidence that, until 2012, the sources of ICT to SSA have been in the Global North. However, beyond 2012, the value of ICT imports from China into SSA has surpassed that from the Global North. While the value of ICT imports from China to SSA rose from US\$ 3 million in 2012 to US\$ 4.6 million in 2018, those of the OECD countries declined from US\$ 4.5 million to US\$ 1.8 million during the same period (Fig. 3). The spread of ICT technologies has been a spillover effect of the growing Sino–African economic engagement over the past four decades.

Although Africa still lags in the access to and application of ICT, subscription to ICT-related products is on the rise in SSA. For instance, between 2005 and 2019, the number of households with Internet subscriptions at home rose from an average of 3 people per 100 inhabitants to 16 people per 100 inhabitants. Within the same period, the average number of households that subscribed to mobile cellular phone providers rose from 25 to 76 per 100 inhabitants. Similarly, there was an increase in the number of people subscribing to mobile broadband in SSA (see Table 1). Relative to the pre-millennium era, the presence of Chinese ICT in SSA may have contributed significantly to easier access to ICT products in SSA.

4.2. The Schumpeterian footprints of Huawei in the ICT sector

Founded in 1988, Huawei is the largest Chinese multinational telecommunications company. The company started manufacturing phone switches before venturing into the construction of ICT infrastructure. By following the Schumpeterian philosophy, Huawei used the bottom-up approach as a mode of entry into the Chinese market (Li and Reimers, 2015). The company first introduced its ICT products into the Chinese rural economy and then started spreading its operations in the 1990s to Chinese cities after it had achieved economies of scale in the rural economies in China. Huawei's success is inspired by the fact that the company imports ICT products from the Global North and re-engineers them to provide tailor-made ICT solutions to consumers in China.

To ensure legitimacy in Huawei's ICT service delivery, our archival

Table 1

Access to ICT in SSA relative to other developing countries.

Indicators (per 100 inhabitants)	2005–2009	2010–2014	2015–2019
<i>Households with Internet at home</i>			
SSA	3	9	16
Other low-income economies	18	39	56
<i>Mobile-cellular telephone subscriptions</i>			
SSA	25	58	76
Other low-income economies	61	105	114
<i>Active mobile-broadband subscriptions</i>			
SSA	3	7	26
Other low-income economies	10	26	63

Source: Based on computations from the International Telecommunication Union Database.

data show that Huawei prioritizes openness and transparency, ubiquitous connectivity, operational integrity, and cybersecurity and privacy as the most important priorities in delivering services to its customers (Fig. 4). To this end, the company has adhered to high global cybersecurity standards over the past 30 years, including the General Data Protection Regulation of the European Union, to ensure the integrity of data protection (Fig. 4).

The structure of Chinese rural and urban communities is similar to that of SSA. Therefore, Huawei's success in Chinese communities facilitated its engagement in the rural economy in SSA. Our findings show that, similar to its operations in China, Huawei is making tailor-made business and socioeconomic contributions that target poor communities to gain legitimacy in SSA. In delivering these tailor-made solutions, the company engages with those at the bottom and top of the pyramid.

4.3. Engagement with the top of the pyramid

We observe that at the top of the pyramid, Huawei (1) engages with governments (including key institutions) and supranational institutions and (2) partners with local ICT firms to undertake ICT projects in SSA.

4.3.1. Engagement with governments and supranational institutions in SSA

Over the past two decades, Huawei has engaged with African

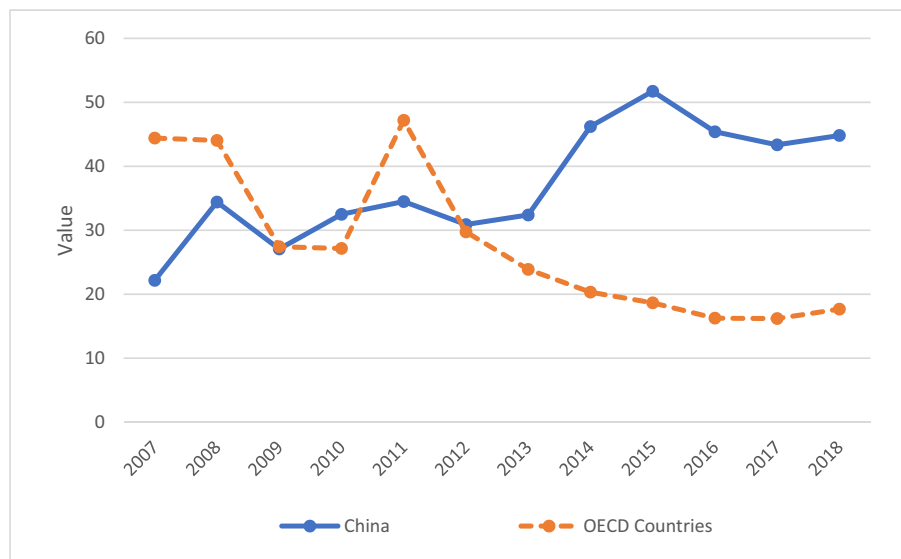


Fig. 3. Main sources and value of ICT to SSA (USD 00,000).

Source: World Integrated Trade Solutions, SITC 4, Product Code 76, Accessed 6/06/2021.

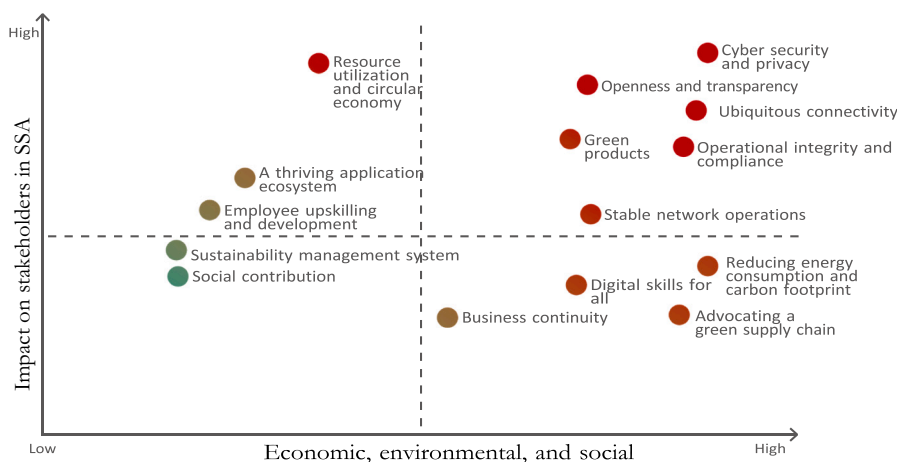


Fig. 4. Huawei's sustainability matrix in SSA.

Source: Adapted from the 2018 Huawei Sustainability Report.

governments to undertake various infrastructure projects in SSA. Cissé (2015) reported that Huawei established R&D centers in Nigeria and South Africa to pioneer technologies that were appropriate for rural communities in both countries. Huawei provided a cloud exchange data center in Nigeria to ensure high reliability and simplicity in terms of data protection and privacy (Table 2). The company also provided the Zambian Railway Limited with a cutting-edge global system for mobile communications railway solutions to renovate the Chingola–Livingstone line in 2016 (Table 2). This contributed to the upgrade of the Chingola–Livingstone line to the European Train Control System Level standard.

We further find that Huawei strategically engages with supranational organizations in SSA to implement projects in the region. For instance, in 2012, an agreement between the African Union and Huawei enabled the latter to complete a fusion cloud desktop solution for the former (Table 2). This facility enabled the African Union to secure all sensitive data using a well-protected storage-sharing system (Table 2). Our archival search also showed that Huawei released a joint white paper with the African Telecommunications Union to help drive ICT development in rural communities in SSA in 2021. Similarly, Huawei and UNESCO launched a technology-enabled open school for all projects in 2021 to support student learning during the pandemic (Table 2).

4.3.2. The Huawei–local ICT firms' partnership in SSA

Our findings also show that Huawei's partnership with leading ICT vendors is one of the mechanisms of entry into the ICT sector in SSA. The spillover effect of these partnerships is Schumpeterian in nature, as they provide local ICT vendors with cheaper and wider access to ICT and its related products (Huawei Sustainability Report, 2020). However, the local ICT vendors learn from the use of the Chinese ICTs when they adopt them (Huawei Sustainability Report, 2020). Unlike firms from the Global North, Huawei's method of engagement is quite creative and often disruptive, considering that on a long-term basis, they engage with the community where they operate through partnerships with local vendors. This fosters trust and confidence in the community for Chinese ICTs.

For instance, the company partnered with Vodacom and the MTN group to develop 2G and 3G services for the 2010 World Cup (Table 2). This partnership provided a wider coverage of World Cup games to most African countries, especially those in deprived communities in SSA. Huawei further supported Cell C and Telkom with core network products and UA5000 integrated access devices for the World Cup Media Center, respectively. The company complemented these services with intensive training programs for the staff of Vodacom, MTN, and Cell C to ensure that they would be able to use the installed technology (Table 2).

Meanwhile, as mentioned earlier, Cissé (2015) reported that Huawei supported MTN to establish R&D centers in Nigeria and South Africa.

In 2004, Huawei partnered with the Nigerian Ministry of Communications to develop the US\$ 200 million Rural Telephony Project. This project increased rural access to the Internet from 6 % in 2002 to 15 % in 2007 (Foster, 2009). Huawei further collaborated with the African Union Headquarters in Ethiopia to establish a data center infrastructure. As part of the collaboration, Huawei supplied storage equipment, servers, and layer 1 telecommunications equipment that carried hardware-related operational data (Wilson, 2019).

4.4. Engagement with the base of the pyramid

Over the years, the company's drive to ensure ubiquitous connectivity has focused on the bottom billion users in SSA. Examples of such business activities include the implementation of the National Rural Telephony Project-Phase 1 in 2012, upgrading of the rural telecom network in Sierra Leone in 2006, and completion of the "RuralStar"-powered mobile network project in Nigeria, Kenya, and Ghana (Table 2). The common outcomes of these projects are that they promote digital inclusion by providing easier access to information and affordable mobile telephony in rural communities in SSA. In 2018, Huawei developed digital and telemedicine platforms to provide medical care to rural communities in Kenya. This significantly reduced the medical costs for over 200,000 people in rural communities in Kenya. In 2017, the company built one of the largest SchoolNET education clouds to support education in Ethiopia. Huawei also provided job-training programs to Nigerians in 2018. In partnership with its local operator, the Rain and Click Foundation (a non-governmental organization), Huawei further launched the DigiSchool project in South Africa (Huawei, 2020). This was in response to the government's call for every child to be able to read well by Grade Three (Huawei, 2020).

4.5. From technology transfer to chain upgrade

Our findings show that the ICT sector in SSA has significantly upgraded its value chains from providing only communication services to including financial services, such as mobile money transfers. Our desktop data compilation on MTN attests to this fact (Table 3). After 2010, the communications value chain for MTN Ghana was upgraded to include financial products. This was the period when the imports of Chinese technologies to Africa had begun to surpass those from traditional sources—the Global North. Huawei became the leading foreign provider of ICT products during this period (Cissé, 2015).

The spillover benefit is that local businesses in Africa are now able to

easily transact both locally and internationally (GSMA, 2021). Fig. 5 shows that mobile money interoperability has increased from US\$ 15 billion in 2015 to US\$ 68 billion in 2020. During the same period, mobile money interoperability via mobile phone services increased from US\$ 3 billion to US\$ 13 billion. We also found that active mobile money accounts had increased from 5 million in 2006 to 300 million by 2020 (Fig. 6). With social distancing and working from home becoming the new norm, we expect this figure to increase significantly in the next decade, as the demand for mobile transfers is expected to rise.

Extending previous studies on value chain upgrade and business legitimacy, our study draws on technical change and technology transfer as theoretical lenses to unpack the Schumpeterian character of China's intervention in the ICT sector in SSA. The China–Africa engagement, predominantly through trade and investment, is happening in the framework of a disrupted worldwide economy. This disruption is occurring from two main perspectives. First, the change in the center of gravity of global growth is shifting from the Global North to the Global South, with China at the forefront of this growth (Mohan, 2021). Second, over the past four decades, China has developed accessible and inexpensive technologies that are appropriate for other developing countries, particularly those in Africa (Mohan and Tan-Mullins, 2019). The China–Africa engagement has been discussed extensively in available studies; however, the Schumpeterian nature of this engagement has not received much attention in the standard literature. Using Huawei as a case study, this study has demonstrated the Schumpeterian character of Chinese MNCs in the ICT sector in SSA.

The existing literature on Schumpeterian innovations is based exclusively on the assumption that new entrepreneurs can create new ideas to develop products that often disrupt an existing market (Mathews, 2018; Chu et al., 2020; Feng, 2019). However, “creative destruction,” as championed by Schumpeter, manifests not only in the application of new ideas but also through appropriate and innovative service delivery to society. This study shows that China expresses its Schumpeterian behavior in SSA by using trade with engagement at both the top and bottom of the pyramid. Huawei's manifestation of the Schumpeterian behavior ensues in four forms:

Until the turn of the new millennium, there was an increasing orthodoxy in the Global South that the most superior forms of technologies originated only from the Global North, whereas technology arrangements with the Global South were unbundled with aid, trade, and investments (Eom et al., 2018). These engagements were not only exercised through financial payments in convertible currencies but also weakened the purchasing power and competitiveness of countries in the Global South, including those in SSA.

The growing south–south relationship has significantly changed the former technological arrangement that existed between SSA and the Global North. As shown in Fig. 3, the value of ICT exports from China to

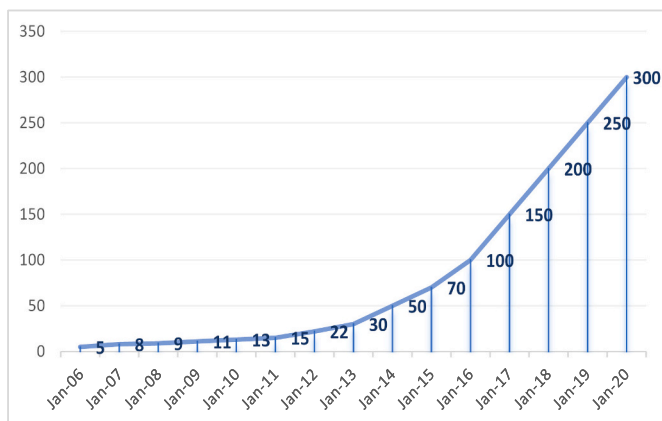


Fig. 5. Growth in active mobile money accounts (millions).

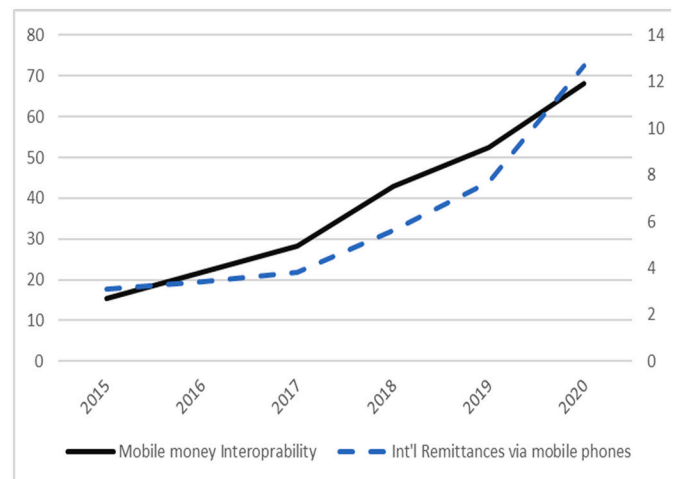


Fig. 6. Growth in bank interoperability and remittances via mobile money (\$ billions).

SSA has far surpassed that of the Global North. We agree with the school of thought that posits that rising imports of Chinese technologies to SSA are accessible, affordable, and less reliant on infrastructure and skills (Wang et al., 2020; Botchie et al., 2018; Hanlin and Kaplinsky, 2016; Kaplinsky, 2013a). This follows Schumpeter's “creative destruction” philosophy, as the accessibility and affordability of Chinese technologies (see Kaplinsky, 2016) are the key motivating factors for the shift toward ICT products from China. The neoclassical technical change theory stipulates that capital-intensive technical change mostly occurs in the Global North (Stewart, 1982; Clark, 1985). However, with cheaper alternative sources of technology from China, a performance that is often associated with capital-intensive technical change can also occur in the Global South.

Second, our analysis elucidates how Chinese MNCs, such as Huawei, have adopted the Schumpeterian philosophy over the years to gain legitimacy through engagement with clients at both the top and bottom of the pyramid in SSA. At the top of the pyramid, Huawei undertakes important projects with key government and supranational institutions. The network installation partnership between Huawei and the African Union is a very good example of this. We also find that the company duly engages with governments in African countries to develop various development programs, including the development of ICT infrastructure. Some of these activities have led to the legitimization of Huawei's operations with the top bureaucratic class on the continent to the extent that the company has been given contracts to install the technologies required to store the continent's sensitive data (see Table 3). Evidence from our archival search further shows a growing partnership exists between Huawei and local ICT firms in SSA. The benefits of this partnership are twofold.

First, it encourages knowledge exchange between Huawei and local ICT firms: while the latter develop their capacity and obtain ICT transfers from the former, the former also uses the partnership to gain legitimacy in its operations in the ICT sector. Second, Huawei partners with local ICT vendors to undertake pro-poor business projects, including extending the network infrastructure to rural communities. This novel approach has not only served as a conduit for local ICT vendors to access ICT from China, but it has also resulted in the rapid diffusion and adoption of Chinese ICT at the bottom of the pyramid. We observe that this has inspired society to accept Chinese-made ICT products in rural communities in SSA. The Huawei “RuralStar” project is also a good example of this. By gaining legitimacy in the African market, Huawei now operates in more than 40 countries and controls 40 % of ICT products in SSA (Tang, 2021). Our evidence supports the claim that a firm can gain business legitimacy when it is accepted in a given society

(Neuhäuser and Siebke, 2020; Deephouse et al., 2017; Dacin et al., 2007).

China's presence in the ICT sector in SSA has helped local ICT firms in SSA develop core competencies and dynamic capabilities in many ways. Access to ICT, coupled with the training and development activities that Huawei has provided to local ICT firms in SSA, has contributed significantly to the development of core competencies in the ICT sector. In addition to learning from Huawei, over the past three decades, local ICT vendors have relied on Chinese technologies to build on their past experiences to upgrade their technologies (see Table 3). One of the resultant effects is the upgrade of the ICT sector from only communication as its primary product to include other products such as mobile money transfers (Fig. 4). Local businesses in most SSA countries are now able to conduct international financial transactions within a few seconds. For instance, GSMA (2021) reports that mobile money services spur local farmers to insert themselves into the global value chain, as they can transact business with international partners within a short period. Communication and networking within the global value chain have also become easier for local ICT firms. Thus, this study has extended the upgrading literature by showing that appropriate technology transfer is one of the key prerequisites for chain upgrading (Rigo, 2021).

5. Conclusion

Our study contributes to the literature on technical change and technology transfer. First, it extends the south–south cooperation literature by showing that China uses trade with active engagement with both the bottom and top of the pyramid to engage with stakeholders in the ICT sector. This slightly deviates from the existing literature, which posits that China employs aid, trade, and foreign direct investment as a means of cooperating with SSA (Kaplinsky, 2013b; Kaplinsky, 2019; Botchie et al., 2018). In addition, the rapidly growing volume of Chinese ICT exports to SSA means that the former will remain the main supplier of ICT for the latter.

Second, we provide a theoretical basis for studying the south–south engagement in the ICT sector from a Schumpeterian perspective. While the extant literature emphasizes innovation as a function of technical change (Kennedy, 1964; Solow, 1968), our study shows, from a Schumpeterian standpoint, that the importance of technical change in chain upgrades cannot be ignored. We take this position because the evidence adduced in this work shows that local ICT firms, over the past two decades, have adopted ICT products from Huawei to create new disruptive products, including mobile money transfers. However, we

Appendix A

Table 2
Schumpeterian activities of Huawei in SSA.

Year	Nature of engagement	Countries	Type of engagement	Impact	Source
2016	Engagement with the base of the pyramid	South Africa	Huawei has been very active in building the capacity of the poor in ICT in various African societies. These include: 1. Providing cutting-edge training on the use of Huawei technologies, including 5G, LTE and Cloud Computing, to students. For instance, 20 South African students were admitted to Huawei's prestigious global training programme to undertake ICT training.	Poor students who in had no chance of accessing ICT are now able to make sophisticated ICT technologies for a better livelihood.	Huawei website. In Building Futures: South Africa's 5G DigiSchool - Huawei
2017	Engagement with the base of the pyramid	Ghana, Algeria, and Nigeria	The Huawei "RuralStar" Solution provided internet connectivity to the unconnected users in remote communities via Rapid Network Rollouts in Rural Regions	The RuralStar-powered mobile networks have boosted the rural economy and improved the welfare of those living at the base of the pyramid. For instance, farmers in	https://www.huawei.com/uk/technology-insights/publications/huawei-tech/89/how-technology-is-connecting-unconnected

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believe that future studies should unpack the extent to which Huawei influences technical changes in the ICT sector in SSA.

Third, our study contributes to the literature on chain upgrading by providing relevant insights into how Chinese technologies can promote chain upgrades in SSA. The spillover effect is that chain upgrades equip firms to insert their operations into the global market. The global value chain literature will be enriched if future studies can focus on the extent to which Chinese MNCs can contribute to chain upgrades in the ICT sector in SSA.

Our study has implications for technology transfer and market insertion in SSA. First, our perspective draws attention to the importance of adopting the Schumpeterian philosophy when investing in SSA. The structure of most countries in SSA requires investment strategies that follow the "creative destruction" thesis. For instance, this study has shown that pro-poor technologies that are accessible, affordable, and less reliant on infrastructure and skills should be considered when making technological investment decisions in SSA. Often, such technologies must be disruptive to make the firm distinctive and satisfy the needs of potential adopters at the base of the pyramid. Second, the implementation of digital-technology-driven policies in the business environment in SSA must be given more priority, as it has the potential to enhance firm competitiveness and chain upgrade.

By emphasizing the relationships between technical change, chain upgrades, and business legitimacy in the ICT sector in SSA, this study analyzes the Schumpeterian character of China's intervention in the ICT sector in SSA. Our work may serve as a benchmark for deepening the understanding of the Schumpeterian character of Chinese engagement in key economic sectors in SSA. While our study has generated insights into China's distinctive mode of engagement with firms in SSA, it is neither exhaustive nor without limitations, which, in turn, creates fresh opportunities for further research. First, our findings are limited to desktop research. While our theory focuses on technical change and technology transfer, we encourage similar studies on chain analysis to ascertain whether additional insights and findings can be generated with other theories, including appropriate technology and technological fit theory. A more expansive set of cross-country empirical data may be needed to fully unpack China's Schumpeterian character in Africa. Determining the relationship between business upgrades and Chinese ICTs in SSA would further enrich the upgrade literature.

Data availability

Data will be made available on request.

Table 2 (continued)

Year	Nature of engagement	Countries	Type of engagement	Impact	Source
2017	Engagement with the base of the pyramid	Ethiopia	Huawei helped Ethiopia build North Africa's biggest SchoolNet Education Cloud - a unified management education cloud platform.	remote regions in the countries can now have access to agricultural information, and children are also able to gain access to education resources through the Internet. Education through ICT	Tesfaye (2020)
2018	Engagement with the base of the pyramid	Kenya	Developed digital and telemedicine platforms.	Has significantly reduced the medical costs of over 200,000 people in Kenya	https://www.huawei.com/br/technology-insights/industry-insights/outlook/mobile-broadband/wireless-for-sustainable-healthcare-a-reality-in-kenya https://www.huawei.com/ke/news/2021/9/tech4all-digital-inclusion-digital-technologies
2019	Engagement with the base of the pyramid	East Africa	Huawei partners UNESCO on the TECH4ALL programme.	1. Assist in enhancing Digital Skills among teachers through the use of Huawei's DigiTruck to teach teachers on the application of ICT in teaching and sharing of educational resources. 2. Equipped teachers to better teach in rural/urban communities in SSA	https://www.huawei.com/ke/news/2021/9/tech4all-digital-inclusion-digital-technologies
2021	Engagement with the base of the pyramid	Ghana	Through the provision of multiple ICT training programmes, Huawei was able to create the Seeds for the Future Women in Tech program in Ghana,	This ongoing project has already trained 50 female college students in AI applications.	Huawei 2021 Annual Report
2010	Engagement with the top of the pyramid	South Africa	Huawei provided significant support to the local telecom companies during the 2010 World Cup. These include: 1. Provision of 2G and 3G services to Vodacom and Mobile Telecom Network (MTN) for transmission purposes 2. Core network products were provided to Cell C. 3. Telkom was furnished with UA5000 integrated access devices for the World cup media centre. 4. Staff of Cell C and MTN were trained on the usage of Huawei ICT products during the World Cup. 5. Huawei's World Cup communication assurance project teams developed a four-level assurance mechanism, consisting of On Site, War Room, Representative Office, and Headquarter.	Capacity building and better internet access for the World Cup.	Huawei website
2012	Engagement with the top of the pyramid	Ethiopia (African Union)	1. Huawei installed the ICT infrastructure for African Union. 2. Huawei provided AU staff on how to use the developed infrastructure. 3. Huawei developed aFusion Cloud Desktop Solution, which offered computing, storage sharing, and resource allocation through cloud data centres for African Union.	Public sector: Enabled efficient delivery of administrative services, including optimised services and lower and cheaper power consumption technologies	Cave, 2018
2013	Engagement with the top of the pyramid	South Africa, Nigeria, Uganda	1. Huawei installed first commercial LTE TDD network for MTN Nigeria, MTN Uganda, Telkom South Africa	Efficient delivery of services	
2013	Engagement with the top of the pyramid	South Africa	1. Huawei partnered with the Passenger Railway Agency of South Africa and supplied the latter with the latest digital wireless communication system for their commuter railways.	Efficient communication within the Railway sector in South Africa	Huawei Website
2014	Engagement with the top of the pyramid	Kenya	1. In Nairobi-Kenya, Huawei built Africa's first modern "Safe City" system. This project include: I. The deployment of 1800 HD cameras and 200 HD traffic surveillance systems across Nairobi. II. Equip and support 9000 police command centres III. Build 195 police stations for proper monitoring and expedite resolve of cases.	1. Better traffic surveillance 2. Nairobi police are now having the capacity to conduct better policing in the Kenyan capital. 3. Enhanced security services 4. The system worked during Pope Francis' visit to Kenya in 2015, where more than eight million people welcomed his arrival. 5. The regional crime rate dropped by 46 % by 2016.	Huawei Website

(continued on next page)

Table 2 (continued)

Year	Nature of engagement	Countries	Type of engagement	Impact	Source
2016	Engagement with the top of the pyramid	South Africa	Huawei used its powerful and open digital platform to support the South Africa Ekurhuleni Metropolitan Municipality's Critical Services to become a smart city with a zero downtime	6. In 2016, the number of international tourists travelling to Kenya rose by 13.5 % year-on-year. This has made the Ekurhuleni Municipality one of the most efficient cities in South Africa	https://e.huawei.com/cz/publications/global/ict_insights/201810190908/smart-city/201901190928
2017	Engagement with the top of the pyramid	Kenya	Huawei helped Safaricom in Kenya to implement the approach of value driven network deployment of fiber to the home (FTTH) network; and jointly expand broadband networks for the latter.	This has allowed Safaricom Kenya to be more competitive and achieve business success.	https://www.huawei.com/en/news/2017/8/Kenya-Safaricom-FTTH-Network
2017	Engagement with the top of the pyramid	Kenya	Provided a digital railway solution to support the Mombasa-Nairobi railway to become more efficient.	The Mombasa-Nairobi railways began to operate more efficiently and connected households, and cities	https://www.huawei.com/en/news/2017/6/digital-railway-solution-mombasa-nairobi
2019	Engagement with the top of the pyramid	Nigeria	Huawei collaborated with the Federal government of Nigeria to provide ICT training to <i>training of 935 participants across 101 MDAs</i> .	Supported capacity building for public servants in Nigeria	https://von.gov.ng/2022/03/07/federal-government-huawei-sign-mou-on-ict-training-programme/
2016	Engagement with the top of the pyramid	Nigeria	Huawei partnered with MTN-Nigeria to set out a unified strategy for creating new digital entertainment platforms to house the entertainment triangle: music, videos, and games.	1. This project incentivised MTN-Nigeria promotes music, videos and computer games on their digital platforms. 2. 90 % of local content are now being streamed on the platform. 3. The MTN-Nigeria platform has been expanded enough to steam 2000 new songs monthly.	https://www.huawei.com/sg/technology-insights/publications/win-win/26/mtn-nigeria-let-me-entertain-you
2016	Engagement with the top of the pyramid	Nigeria	1. Huawei supported Business and Technology executives of Etisalat to develop an IT management excellence roadmap. 2. Huawei provided support to Etisalat to enhance customer satisfaction. This includes the provision of Cloud and Big Data 3. This helped Etisalat to develop a well-structured service and vendor management systems with a standardized O&M for multi-vendor solutions.	This has made Etisalat one of the most reliable mobile telecommunication networks in Nigeria.	https://carrier.huawei.com/en/success-stories/services/software-service/managed%20bss-etisalat
2017	Engagement with the top of the pyramid	Nigeria	Smart Electric Metres: Huawei's AMI Solution deploys smart electric meters that support multiple electricity theft detection and metering methods.	This project led to significant increase in revenue, reduction of line loss, improved operating efficiency with better customer satisfaction.	https://e.huawei.com/uk/case-studies/global/2017/201710131134
2018	Engagement with the top of the pyramid	South Africa	Huawei helped Cell C to transform from the fragmented legacy environment by offering its award-winning best-of-suite next generation BSS architecture to the company.	This project led to a significant improvement in operation efficiency.	https://carrier.huawei.com/en/success-stories/services/software-service/managed%20bss-cell%20c

Table 3

MTN (previously Spacefon) upgrading trajectories in the ICT sector in Ghana.

Year	Name of organisation	ICT chain upgrade process	Sources of technology
<i>MTN</i>			
1996	Spacefon Areeba	Global system for mobile communication and Caller IDs	Europe
1998	Spacefon Areeba	General Packet Radio Service (GPRS); and expansion of service to northern Ghana	Europe
2004	Spacefon Areeba	SMS/Voicemail/Call holding and Same charges to calls to other networks	Huawei, China
2006	MTN Ghana	Launched electronic recharge/ fixed mobile and expanded to the 10 (now 16) regions in Ghana	Huawei, China
2008	MTN Ghana	Launched dynamic tariffing	Huawei, China
2009 to date	MTN Ghana	Launched Mobile Money service	Huawei, China
2016 to date	MTN Ghana	4G Service introduced	Huawei, China
2019 to date	MTN Ghana	Mobile money interoperability	Huawei, China

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