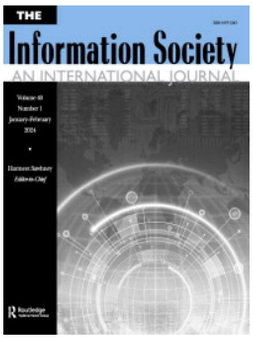

The Information Society
An International Journal

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/utis20

Learning along the Digital Silk Road? Technology transfer, power, and Chinese ICT corporations in North Africa

Tin Hinane El-Kadi

To cite this article: Tin Hinane El-Kadi (29 Feb 2024): Learning along the Digital Silk Road? Technology transfer, power, and Chinese ICT corporations in North Africa, The Information Society, DOI: 10.1080/01972243.2024.2317060

To link to this article: https://doi.org/10.1080/01972243.2024.2317060

© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.

Published online: 29 Feb 2024.

Submit your article to this journal

Article views: 23

View related articles

View Crossmark data

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=utis20

THE INFORMATION SOCIETY
https://doi.org/10.1080/01972243.2024.2317060

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Learning along the Digital Silk Road? Technology transfer, power, and Chinese ICT corporations in North Africa

Tin Hinane El-Kadi

Department of International Development, London School of Economics, London, UK

ABSTRACT

While much attention has been paid to how China's rise as a digital superpower could threaten US hegemony over cyberspace, much less has been written on what the Digital Silk Road, or the presence of Chinese tech firms in developing countries more broadly, means for technological upgrading and development. This article contributes to filling this gap by investigating the technology spillovers emanating from two Chinese tech giants – Huawei and ZTE – in Algeria and Egypt. Using a political economy framework that combines insights from structuralist economic development and techno-politics and drawing on over 70 semi-structured interviews and field-observations, it argues that despite localizing activities that bear the promise of generating significant linkages, the two Chinese tech firms created no meaningful learning opportunities for domestic entities that contribute to technological upgrading. What could at first seem like developmental connections that promote technology transfers are found to be linkages diffusing Chinese infrastructures, hardware, software, processes, and standards that shape distinct digital systems. Without pro-active policies from host governments, the Digital Silk Road risks creating new technological dependencies; locking local ICT actors into activities and relationships captured and defined by Chinese tech giants.

KEYWORDS

Algeria; chinese ICT firms; digital transition; Egypt; linkages; technology transfer; techno-politics

Introduction

Over 2,200 years ago, the movement of people and goods across the Silk Roads facilitated the diffusion of Chinese inventions and technologies to Eurasia, the Middle East, and North Africa. This trade network constituted a channel for Chinese innovations such as papermaking and woodblock printing, which enabled large-scale printing for the first time and transformed information dissemination in Europe (Hernandez 2019). In the twenty first century, Beijing's Digital Silk Road (DSR), the digital component of the Belt and Road Initiative (BRI), could potentially play a similar role in spreading new technologies and practices.

There is a dearth of empirical studies looking at China's contribution to technology transfer in developing nations' ICT (information and communication technology) sectors. The authors have either argued that Chinese ICT multinational companies (MNCs) create significant opportunities for technology transfer (Tsui 2016; Agbebi 2019) or, conversely, that there is weak evidence of such opportunities (Rwehumbiza 2021; Tugendhat 2021), depending on the cases and methodologies used. Such emerging research has tended to use a simple diffusionist technology transfer lens, focusing more on the quantum of linkages rather than a qualitative investigation of their content. By narrowly focusing on the *existence* or *lack* thereof of spillovers, existing research tends to obscure the bargains made in the actual implementation of technology transfers and training programs. What is perhaps as significant as the question of whether Chinese digital companies engage in technology transfer in host developing countries is the role played by spillovers in diffusing specific technological processes, practices, and standards and what this means for structural transformation.

Using a novel political economy framework that combines insights from structuralist economic development and techno-politics, this article examines the technological spillovers emanating from the interaction of two Chinese telecommunication giants – Huawei and ZTE – with local

CONTACT Tin Hinane El-Kadi T.El-Kadi@lse.ac.uk Department of International Development, London School of Economics, 65 Aldwych, London, UK.
© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

configurations of power and skills in North Africa and their grounded effects. North Africa is an interesting region to analyze the developmental implications of Chinese digital MNCs. While North African countries have different political economies, they all share middle-income status and have in common growing numbers of tech-savvy young people, a relatively high rate of internet penetration, and proximity to the EU market, making the region a strategic hub for the DSR. One of the first high-level references made to the DSR was in the 13th Five Year Plan published by the Central Committee of the Communist Party of China (CCCPC) in 2016, which stated the aim to "develop an online Silk Road with the Arab countries and others through high-speed fiber optic networks" (CCCPC (Central Committee of the Communist Part of China) 2016, 71). Algeria and Egypt, in particular, have emerged as two significant markets for Chinese original equipment manufacturers (OEMs) like Huawei and ZTE, the most prominent Chinese digital firms in North Africa. The OEM sub-sector is a high-linkage sector that can theoretically generate significant technology spillovers.

Based on extensive and triangulated field data, drawing on over 70 interviews in Algeria and Egypt, this study finds that Huawei and ZTE, like their US and European competitors, limit meaningful technology transfers to protect their knowledge premiums. What could at first seem like developmental connections that promote technological learning and upgrading are found to be linkages diffusing Chinese infrastructure, hardware, software, processes, and standards that shape distinct digital systems designed around the consumption of Chinese technologies. Without pro-active policies from host governments, the DSR risks creating new technological dependencies; locking local ICT actors into activities and relationships captured and defined by Chinese digital giants.

By providing an empirically grounded account of the multifaceted forces shaping technological spillovers from Chinese digital MNCs and their implications, this study aims to contribute to ongoing debates on China's growing role in the global digital economy, the Belt and Road Initiative, foreign direct investment (FDI) and technology transfer, and South-South investments.

The article is structured as follows. After this introduction, the second section starts by reviewing the literature on technology transfer. It suggests an analytical framework that departs from standard diffusionist models of technology transfer which focus on the occurrence of spillovers while marginalizing the *hidden* politics behind seemingly technical linkages. The next section discusses the study's methodology, and this is followed by the findings, which trace the channels of knowledge spillovers from digital MNCs in terms of three types of linkages: horizontal linkages, vertical linkages, and linkages with local universities and research institutions. The final section concludes and provides policy recommendations to help countries maximize gains from Chinese tech firms for their own digital transformations.

Literature review and theoretical framework

FDI and technology transfer

Technology transfer – the dissemination of technical knowledge and know-how embodied in products, processes, and management (Wahab, Rose, and Osman 2011, 62) – through FDI has long been regarded as a major engine of technological upgrading and structural transformation (Globerman 1979; Markusen and Venables 1999; Amsden 2001; Saggi 2002; Blalock and Gertler 2008; Fu, Pietrobelli, and Soete 2011). The basic premise underlying the existence of technology spillovers[1] is that foreign-invested firms are technologically superior to local ones; thus, their interaction with local economies is assumed to lead to technology transfers which, in turn, lead to productivity gains (Saggi 2002). Given the lower technology base within developing economies, these spillovers may help local industries build up their domestic technological capabilities and catch up with the international technology frontier (Lall 1992; Ning and Wang 2018).

The theoretical literature identifies two main channels through which foreign firms can generate technology transfer. Horizontally, skills and knowledge transfer can occur through labor mobility across firms, including when local firms "poach" skilled workers from foreign firms (Iršová and Havránek 2013; Liu 2008). Vertically, backward and forward linkages help the diffusion of skills, knowledge, and technology as they provide demonstration effects and training to local firms (Blomstrom and Kokko 2001; Liu, Wang, and Wei 2009; Rojec and Knell 2017). Based on Albert Hirschman's work, the theory of linkages conceptualizes the way in which a factory generates demand for primary materials like sand mining in a cement factory (backward linkage), while its outputs, cinder blocks, might be an input for the local construction industry

downstream (forward linkage) (Hirschman 2013, 103). Backward linkages are the most critical mechanism for learning and achieving productivity gains (Javorcik 2004; Blalock and Gertler 2008; Hirschman 2013).

There are also significant sectoral variations in the potential for technology spillovers. Manufacturing and infrastructure building are recognized as high linkage sectors in the literature (Lean 2001; Hirschman 2013). For instance, building digital infrastructure can foster inter-firm spillovers by encouraging industrial clustering and generating a broader supply chain in equipment and component manufacturing and services. Most fundamentally, installing new ICT infrastructure requires the transfer of know-how and skills to operate and maintain advanced technologies (Ockwell et al. 2008). Digital MNCs can thus theoretically provide technical artifacts and managerial skills transfers that contribute to technological upgrading and the building of competitive ICT industries in host countries.

However, the empirical evidence on the transfer of technology through FDI is, at best, mixed. In their seminal study of technology spillovers in Morocco, Haddad and Harrison (1993) found that if domestic and foreign firms compete to capture the same market, the latter does not have the incentive to promote technology linkages. In some instances, foreign firms operated as enclaves with little connection to the local economy (Aitken and Harrison 1999). Measures adopted by foreign companies to limit technology transfer include protecting their intellectual property and trade secrets, hiring mainly foreign workers, and forestalling labor turnover by offering significantly higher wages than local industry averages (Liu, Wang, and Wei 2009). In other instances, research showed that foreign subsidiaries did more harm than good to the local economy by capturing the domestic market and crowding out local competitors without engaging in any meaningful technology transfer (Amendolagine et al. 2013). Any discussion on the developmental potential of foreign subsidiaries needs to tackle the difficult but pragmatic question of whether it is sound to expect technology transfer to occur in the first place, as corporations would naturally be expected to preserve their technological edge. This being said, instances of technology spillovers have occurred. The development trajectories of East Asia's "dragons" are filled with cases of technological learning from foreign firms in a myriad of sectors. Can the DSR contribute to technological upgrading in host countries or does the initiative strictly serve Beijing's interests?

Chinese digital firms and the techno-politics of linkages

With the world's largest online population and a booming digital industry, China has expanded its global digital footprint. Chinese digital MNCs have built the backbone infrastructure used by billions of internet users across the developing world. One estimate suggests that Huawei built 70% of Africa's 4G network (Mackinnon 2019). While the internationalization of Chinese tech firms in developing countries has undoubtedly promoted local economies' catch-up efforts in terms of ICT infrastructure, the role played by these corporations in diffusing knowledge and technology remains under researched.

Two of the few fieldwork-based works looking at technology transfer from Chinese tech corporations are Agbebi's (2018, 2019) studies on Huawei's presence in Nigeria. Based on 29 interviews with staff and beneficiaries of Huawei's training programs in Nigeria, Agbebi points to the existence of dynamic horizontal linkages, finding several instances of trained Huawei staff leaving the firm to join other ventures. She also indicates "considerable backward vertical linkages with local suppliers" (Agbebi 2019, 201), with Huawei Nigeria counting over 500 local partners in its supply chain, many of which receive training from the Chinese tech giant. In a similar vein, Li and Cheong (2017, 764) argue that ZTE and Huawei contribute to technology transfer in Malaysia through partnerships established with Malaysian universities and research centers, through which the Chinese firms have been found to provide courses for local students that led to ZTE and Huawei certifications.

A somewhat different take emerges from the more critical work of Tugendhat (2020), who finds from his fieldwork in Kenya and Nigeria that Huawei, like Ericsson, Nokia, Cisco, and other competitors, treads a fine line between training local engineers and keeping control of its intellectual property. In a subsequent publication, he argues that the Chinese tech giant offers no significant opportunity for technology transfers that could contribute to technological upgrading and stresses that the firm has a "limited impact on knowledge transfer by design" (Tugendhat 2021, 19). Likewise, based on fieldwork in Tanzania, Rwehumbiza (2021) finds that while there is some evidence of local staff and suppliers' training, Huawei Tanzania does not seem to build significant backward linkages with local firms.

These studies provide valuable insights for understanding the developmental implications of Chinese investments in the ICT sector of developing countries.

Yet, the emerging literature adopts a simple diffusionist technology transfer model, which measures technology transfer by the existence or absence of linkages. This framework conceals the idiosyncratic norms, standards, and politics conveyed in the transferred technologies and training programs. Analyzing technology spillovers requires not only observing their occurrence through vertical and horizontal linkages but also scrutinizing what these linkages actually *do* on the ground. In the same way that we cannot expect high-tech firms to willingly share their cutting-edge technology with poorer countries, neither can we assume that the transfer of technology is devoid of political content and consequences. To date, however, there is still a need for a more effective theorization of technology transfer processes to untangle both its technical and political aspects.

In this regard, the techno-politics framework can bring valuable insights into the analysis. From a conceptual perspective, techno-politics unpacks the oftentimes *hidden* political work of technological artifacts and infrastructures (Mitchell 2002; Larkin 2013; Anand 2015). One strand of this intellectual tradition goes back to the work of Langdon Winner (1980), who argued that all technologies, from forks to nuclear power stations, have "politics" embedded into them. In its basic form, techno-politics refers to "the strategic practice of designing or using technology to constitute, embody, or enact political goals" (Hecht 2001, 256). Here technology is defined as both "artefacts and nonphysical, systematic means of making or doing things" (Hecht 2001, 257).

This analytical lens shifts attention from individual innovations to the system of relations in which technology is embedded, emphasizing that the "same" technology can uphold different types of politics as it is negotiated, adopted, and reshaped by various actors to advance their own interests (Edwards and Hecht 2010). Seen from this perspective, power and politics stem from both the social and the technical, with different stakeholders competing over authority by ensuring that some technologies and standards prevail over alternative ones (Hecht 2001). The question of technology standards – the underlying regulations that define how telecommunication networks operate and interwork – is particularly significant in the debate on the role of Chinese digital MNCs in transferring technology to host middle-income countries. Competition over who gets to set technological standards has become intense between China and the US, with China trying to challenge the US-centric cyberspace (Beattie 2019).

Against the backdrop of Chinese tech firms taking a more active role in developing, supplying, and maintaining the physical components upon which future digital infrastructure will rely, a conceivable consequence is that this will speed up the dissemination of Chinese technological standards. Recently, Chinese representatives have been calling for a new standard, which they called "New IP", arguing that the current, US-set protocol of TCP/IP is unable to support the speed of package transfers needed in the upcoming 5G revolution (Smith, Cummins, and Krasodomski-Jones 2021). Underlying this coinage of new technical jargon lies a fierce fight over who gets to set the standards of the next technological wave. The ability to define standards has long been understood as a tool of power, enabling those who set the rules to shape them to their own advantage (Mattli and Büthe 2003; Lee and Oh 2006; Yao, Tan, and Suttmeier 2009). Although international technological standards are approved by multilateral institutions such as the International Telecommunication Union (ITU), the increased number of countries and actors integrated into digital systems built by Chinese tech firms helps amplify China's voice in international standard-setting bodies.

In a study of China's digital presence in Africa, Gagliardone (2019) uses techno-politics to address the question whether China is imposing its internet model on African countries. He finds that China's intervention in Africa's information societies has been driven by the preferences of different African states rather than those of Beijing. This article extends techno-politics to analyze technology spillovers emanating from Chinese tech giants. This opens up a different angle on the transfer of technology from foreign subsidiaries, as the analysis is no longer limited to a binary between the existence or absence of vertical and horizontal spillovers, which diffuse (or not) know-how and technology in ways that are predominantly seen as developmental and unproblematic, but instead questions the more profound and uncertain implications of transferred technologies.

Several possibilities emerge when looking at the issue of technology transfer through this lens. What if horizontal and vertical spillovers are approvingly observed, as argued by Agbebi (2019, 201), but tech firms are building through these linkages markets for staff and subcontractors that revolve around the consumption and use of their products, processes, and standards? In other words, what if emerging linkages are creating "closed-loop systems" that lock local ICT actors into activities and relationships captured and defined by foreign digital giants? As technological

latecomers, could it be that Chinese ICT firms are engaging more in training employees, students, and suppliers than their Western counterparts to promote their own brands? Is the technology transferred by Chinese digital firms creating a separate Sino-centric internet among BRI countries?

To address some of these questions and to keep the technical and the political together, this article adopts a conceptual framework that brings together insights from structuralist economic development – to trace the occurrence of vertical and horizontal linkages – as well as from techno-politics – to understand the *hidden* politics conveyed through these channels. This framework recognizes that only a deeper, empirical engagement with technical processes – rather than assumptions based on preconceived ideas – can allow an adequate understanding of the extent and implications of technology transfer. Thus, by zooming in on the actual process of technology transfer through traceable socio-technical linkages, this conceptual lens enables us to go beyond both depoliticized and over-politicized debates about the developmental role of Chinese tech giants.

Methods

How can we capture technology spillovers and their effects, given the complexity and layers that make up the ICT industry? There is a lack of quantitative data on the contribution of Chinese digital firms to technology transfer. But even with rigorous and fine-grained data, quantitative methods fail to capture the nuances and rich insights that can be gathered through fieldwork (Pack 2006). There is a growing recognition that technology transfer is subject to contextual influences and power dynamics, making qualitative tools appropriate (Autio et al. 2014; Auffray and Fu 2015; Cunningham, Menter, and Young 2017; Demena and van Bergeijk 2019). Furthermore, the conceptual framework of this article, which conceptualizes technology transfer as a complex process emerging from power bargains between different actors, calls for thicker descriptions (Denzin 2001).

Algeria and Egypt were selected because, from Mao Zedong's Three World theory to Xi Jinping's Belt and Road Initiative, the two North African countries have developed and sustained strong relations with Beijing rooted in a shared experience of colonial domination (Pairault 2017, 8). Algeria and Egypt are also the two most important recipients of Chinese FDI in the region, and the two most lucrative markets for Chinese OEMs, like Huawei and ZTE, which specialize in building backbone ICT infrastructure. The two firms have played a key role in setting up 3 G and 4 G networks and will likely continue playing a significant role in the upgrade toward 5 G. Furthermore, Algeria is the only African country counting a Huawei manufacturing plant (Agence Ecofin 2019a), and Telecom Egypt signed a rare contract with ZTE to create a joint technology training center and innovation laboratory (Agence Ecofin 2019b).

This study draws on 71 semi-structured interviews conducted in Egypt and Algeria between October 2021 and March 2022. As summarized in Table 1, interviews included employees, subcontractors, customers of Huawei and ZTE, students and startups receiving training and support from Chinese tech-giants, ICT policymakers, government officials, university faculty/researchers, as well as Western ICT equipment manufacturers including Cisco, Ericsson, and Nokia (see Annex 1 for full interview table). The choice of including other foreign firms in data collection and analysis was taken to avoid falling into the trap of "Chinese exceptionalism", which often leads to accounts picturing Chinese firms as unique and somehow detached from broader sectoral practices (Oya and Schaefer 2019).

Interviewees were selected using purposive sampling in the first stage. Having worked in the Algiers office of Huawei Technologies North Africa, regionally headquartered in Egypt the author developed a large network within the ICT industry in the two countries, which facilitated the author's access to key informants during the fieldwork. This work experience allowed the author to gather first-hand observations on the nature and intensity of the training provided to local workers and dynamics between Chinese and

Table 1. Breakdown of respondents by category.

Interviewee Category	Code	Number of Interviewees
Local subcontractors, suppliers, and customers of Huawei and ZTE	S	11
Current and former Huawei and ZTE engineers and managers	W	21
ICT experts and researchers	E	12
Students and instructors of Huawei and ZTE training programmes	U	11
Engineers and managers of Ericsson, Nokia, and Cisco	C	11
Policymakers	G	5
Total		**71**

non-Chinese staff members. LinkedIn further allowed the author to reach out to engineers working for Huawei and ZTE and beneficiaries of training programs offered by the Chinese firms in Algeria and Egypt. Snowballing from different entry points was used to achieve a large enough sample until knowledge saturation was reached. Being a native Arabic and French speaker and an advanced Mandarin speaker, the author was able to conduct interviews with local, Chinese and other foreign actors in Egypt and Algeria.

Data analysis was not separated from data collection but rather conducted simultaneously. A theory-driven coding strategy was used to identify technology spillovers with codes indicating the mechanisms accounting for horizontal and vertical spillovers and linkages between ICT firms and local universities. Codes were later grouped into themes representing different channels of technology transfer. The author followed an inductive approach to analyze the power dynamics between different actors and the content conveyed in linkages. In addition to interviews and field observations, data was collected during and after the fieldwork from financial and business newspapers and the companies' annual reports. Quantitative data was sometimes also collected from interviewees.

Findings and analysis

Overview of the ICT sector in Algeria and Egypt

Before assessing the main channels of technology spillovers from Chinese ICT multinationals in Algeria and Egypt, some remarks are needed to understand the political economies in which Huawei and ZTE are operating. The Algerian and Egyptian economies are concentrated in low-value-added sectors and suffer from sluggish growth. High chronic youth unemployment, estimated at 30 per cent as of 2020, is a distinctive feature of the Middle East and North Africa region (Statista 2021). Remarkably, about 40% of the region's university graduates are unemployed (World Economic Forum 2017). More than ten years after the mass revolt against authoritarianism, poverty, and lack of economic opportunities, no notable change has materialized in the region. For countries in the region to produce and sustain economic growth and create high-quality jobs for the millions of unemployed workers, they need to undergo structural transformation, the process of moving from low-productivity, labor-intensive economic activities to high-productivity, technology-intensive activities that require advanced skills.

At the same time, the two countries have different political economies. Algeria is a state-dominated economy where hydrocarbons represent 95% of export revenues, constituting the largest source of government income (Elliot and Sahar 2020). Algeria is one of the last remaining countries that are not members of the World Trade Organization (WTO) and it imposes strict control over foreign capital, with joint ventures required in strategic sectors (Laouisset 2021). Historically, Algeria has pursued protectionist industrial policies to encourage the development of local industry, including import substitution policies, and local content requirements. In recent years, the Algerian government has tried to welcome more FDI, but investors' appetite has been limited outside of the hydrocarbon sector (Beladi 2023). The country relies on its public funds to ensure infrastructural catch up including in telecommunications.

In contrast, Egypt has a more market-friendly economy and is more open to foreign capital. Major economic liberalization reforms were introduced as early as 1974 with the implementation of the Open Door Policy (Infitah) (Waterbury 1985). In 2017, Egypt passed an investment law[2] that promotes inbound FDI by easing barriers to entry, offering investors more incentives, and supporting foreign multinational firms' localization efforts. Cairo aims to capitalize on its strategic location bridging three continents, and its market of over 100 million consumers, the largest market in the MENA region, to become a regional trade and investment gateway. The government also intends to attract investment in several mega-projects including the construction of a new national administrative capital for which China is a leading funder (McGregor 2022).

Recognizing the potential of the digital economy to help their structural transition, both countries adopted national ICT plans designed to expand internet connectivity, upgrade workers' skills, and create flourishing knowledge economies. Egypt's ICT 2030 plan prioritizes developing ICT infrastructure, fostering digital inclusion, building domestic capacity, and encouraging innovation (MCIT (Ministry of Communications and Information Technology) 2016). Egypt has positioned itself as a regional leader in exporting information technology services and is home to a vibrant startup scene. Algeria was slower to start its digital transformation but has made significant strides in terms of ICT infrastructure, with bandwidth capacity increasing more than twenty times since 2014 (APS (Algeria Press Service) 2021). By creating the Ministry of Microenterprise, Knowledge-Economy, and Startups in 2020, the government is attempting to break away from the current

hydrocarbon-dependent model toward a knowledge-based model.

The two North African governments are investing heavily in upgrading network infrastructure. Egypt witnessed significant growth in internet usage, increasing from 29 per cent of the population in 2009 to 72% as of January 2020. In Algeria, internet penetration rates were estimated at 63% by the same year (World Bank 2022a). Growth in mobile broadband access is correlated with a surge in mobile-cellular subscriptions and the expansion of 3G and 4G network coverage. Mobile penetration in Egypt stands at 110 per cent and is covered by four operators, Orange, Vodafone, Etisalat, and Telecom Egypt. Algeria's mobile penetration reached 105.8%, distributed between three core operators, Mobilis, Djezzy and Ooredoo (World Bank 2022b). While these rates represent an important growth, the region's internet penetration remains just slightly above the world's average, estimated at 60% (World Bank 2022a). This creates significant demand for ICT infrastructure provided by equipment manufacturers like ZTE and Huawei.

Chinese tech firms and technology transfer

> "Information technology advances rapidly. I hope that Chinese enterprises not only observe local laws, operate credibly, and have sound management but also disseminate their advanced technologies and experience to the local enterprises and employees. We always say that give a man a fish, and you feed him for a day; teach a man to fish, and you feed him for a lifetime. Do you agree with me?"
>
> —Premier Wen Jiabao on a visit to Huawei's Training Center in Cairo in 2009 (MFA 2009)

The above quote of Premier Wen encapsulates well the importance attributed to technology transfer in the localization strategy of Chinese tech firms abroad before and after the launch of the DSR in 2015[3]. But do Chinese ICT firms contribute to bridging the digital divide by providing opportunities for technology transfer? Guided by the theoretical framework discussed above, this section identifies and assesses the intensity and grounded effects of three core types of linkages: horizontal linkages, vertical linkages, and linkages with universities and research institutes (see Figure 1). It argues that while Huawei and ZTE have localized activities that can theoretically generate significant linkages, the two Chinese tech firms created no meaningful learning opportunities that contribute to technological upgrading. Instead, emerging linkages are creating a distinct techno-political regime that risks locking local ICT actors into new forms of dependencies as they reconfigure ICT ecosystems around the use and consumption of Chinese infrastructures, processes, and standards.

Notably, the Chinese state was not explicitly included in the framework. Dominant accounts tend to assume that the Chinese state holds a tight rein over its tech champions, which, in turn, strictly align with large policy plans such as the DSR (Chen 2021; Hillman 2021). Fieldwork data indicated that the presence of Huawei and ZTE, including their engagement in knowledge transfer initiatives, is shaped by a much wider variety of Chinese and non-Chinese economic

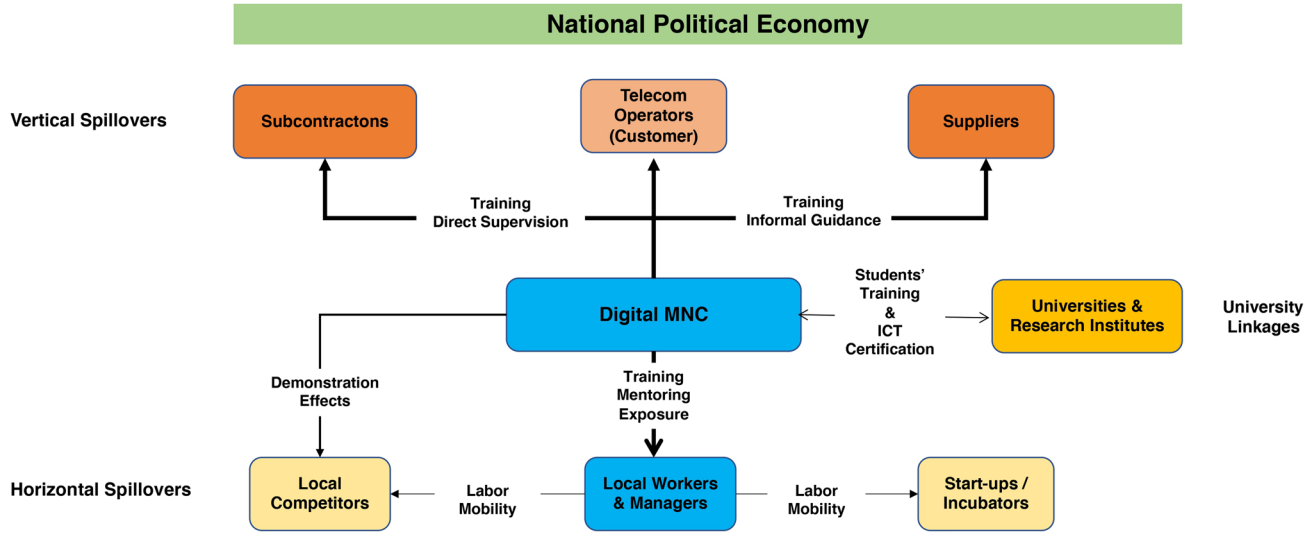

Figure 1. Channels of technology spillovers in the ICT sector.
Source: Author's elaboration.

and political forces. Although the Chinese state, through the DSR, has supported the presence of Chinese tech firms *via* access to preferential loans (Shen 2017), the need to meet commercial imperatives was guiding firms much more strongly than Chinese state political priorities. In terms of policy, Algerian and Egyptian government ICT agendas were more important in shaping Huawei and ZTE strategies to capture markets and increase profits.

Horizontal linkages

As trained workers and managers at multinationals move to domestic firms or start their own businesses, knowledge may be disseminated from MNCs to other firms within the same industry (Iršová and Havránek 2013; Kneller and Pisu 2007). Due to growing labor costs in China, ZTE and Huawei have in recent years localized a bigger share of their labor in North Africa. Huawei employs an estimated 1,000 workers in Egypt, counting both in-house and outsourced contracts and about half as many in Algeria, with about 70% of the staff made up of local employees and the remaining 30% consisting of Chinese and other foreign engineers. ZTE Algeria counts about 200 employees in-house, 70 per cent of whom are locals and 500 outsourced workers, most of whom are local Algerians (W6).[4]

Local engineers and managers at the two Chinese firms, both on in-house and leased contracts, reported going through training programs when they were first hired. The training covered technical and soft skills and continued throughout their employment period, with mandatory tests administered at different stages of their careers. International OEMs also send their local employees abroad for further training. A key motive driving many young engineers to work with Chinese MNCs, and Huawei in particular, is the learning opportunities provided by the companies (W1, W3, W4, W19, W20). When asked to assign a grade from 1 to 5 assessing the quality of the training received by the Chinese tech firms, with 1 indicating low levels of satisfaction and 5 indicating high levels of satisfaction, respondents converged toward a grade of 4. One possible explanation accounting for this high level of workers' satisfaction could be the nature of the ICT industry, a knowledge-intensive sector in which training staff is paramount for firms' operations and profits (Te Velde 2002; King 2013).

The distribution of local managers followed a pyramidal structure in both countries, with local employees well represented at the bottom of the pyramid and Chinese nationals dominating top managerial positions. Similarly to other studies (Auffray and Fu 2015; Oya and Schaefer 2019), this study's findings suggest the existence of a glass ceiling for local employees. At the time fieldwork was conducted, acting CEOs of Huawei and ZTE in Egypt and Algeria were Chinese nationals, while CEOs of Ericsson, Cisco, and Nokia were host country nationals. When questioned about the lack of locals in top-managerial positions, Chinese managers explained that Chinese nationals were more familiar with the firm's work culture, ethos, and processes, giving them an edge in operating projects effectively and in short timeframes (W16).

In the two countries, limited evidence of horizontal spillovers emerged. While, as highlighted by Agbebi (2019), the ICT sector is characterized by high turnover rates, labor mobility tends to occur between foreign multinationals and not toward local firms and institutions. Like Tugendhat (2021), this study found that Algerian and Egyptian OEMs' employees were more likely to move around between Huawei, Nokia, ZTE, Ericsson, and Cisco, among others (C2, C4, C7, W4, W10, W12). About 80 per cent of local workers and managers at Huawei and ZTE responded that they would leave the company for another foreign competitor or to go work abroad. The high salaries offered by international OEMs created a disincentive for local engineers to join local firms or set up their own ventures and constrained the capacity of most local companies to poach talent working for multinationals. This finding is in line with studies that show that MNCs use high wages as a mechanism for labor (and knowledge) retention (Aitken and Harrison 1999; Liu, Wang, and Wei 2009). Most of the younger respondents at Chinese and non-Chinese tech multinationals said that they would go abroad if they were to take up another employment opportunity. Policymakers in both countries expressed concerns about the high rate of locally trained ICT engineers being poached by big tech firms in Europe and the US (G1, G2, G4).

There were few instances of horizontal spillovers, i.e., of respondents indicating the possibility of leaving multinationals to join local firms in the same sector or launch their own firms. In the limited cases found, two main factors account for labor turnover toward national companies: local employees at OEM multinationals leaving to take up higher responsibilities in large national telecommunication firms such as Mobilis in Algeria and Etissalet in Egypt, and those who join smaller local firms and institutions to break away from the hectic workload of international OEMs, especially Chinese ones which are renowned for

operating long hours. Additionally, the small number of surveyed subcontractors operating in ICTs were established by former employees of foreign OEMs, including Huawei and ZTE. Managers of these subcontractor firms reported taking with them useful Chinese work culture and management ethos that helped them better operate their businesses (S1).

Vertical linkages

Technology transfer occurs *via* backward linkages from foreign firms to local suppliers and forward linkages from foreign firms to local buyers (Javorcik 2004; Liu, Wang, and Wei 2009). In Algeria and Egypt, foreign companies undertake the biggest ICT infrastructure contracts. In doing so, they often rely on local subcontractors – to install fiber optic cables, towers, and other infrastructure across various regions of the country, and local suppliers – who provide subsidiary equipment, components, administrative and management services, technical assistance and expertise, logistics, etc. This creates potential for backward linkages, alongside potential forward linkages to the customers who use this ICT infrastructure.

Fieldwork findings in Algeria and Egypt suggest this potential was realized, with the existence of both backward and forward linkages emerging from the two firms' operations in building backbone infrastructure. For instance, interviewed suppliers, subcontractors, and customers indicated that Huawei and ZTE provided them with training similarly to other foreign ICT OEMs (S1-S11). The training covered a few different areas, including the operation of machinery and equipment, technical training on the technologies used, and health and safety measures. Local subcontractors, suppliers, and customers also reported having well-established and long-term relations with the two Chinese tech firms and highlighted no notable differences between foreign companies. The length and intensity of the business relationship are important for technology spillovers because frequent and lasting links create greater training and supervision opportunities and pressure the supplier or subcontractor to learn and upgrade to preserve the business relationship (Auffray and Fu 2015, 293). However, there is a need to look beyond the quantum of linkages to scrutinize their actual content and deeper effects, and here two cases will be analyzed: Huawei's mobile phone factory in Algeria and the provision of digital infrastructure by ZTE and Huawei in the two countries.

The case of Huawei's phone factory in Algiers, one of the flagship Digital Silk Road initiatives in North Africa, illustrates how even linkage-intensive activities like manufacturing can be scarce in knowledge transfer opportunities. The factory opened in the Algiers neighborhood of Oued Smar in 2019 after lengthy negotiations between the Algerian government and mobile phone manufacturers for the localization of production, following the rapid decline in the country's foreign reserves due to declining oil prices. The manufacturing plant was the first of its sort in Africa and one of the few outside of China and was set up as a joint venture between Huawei and Algerian firm AFGO-Tech (Agence Ecofin 2019b). The plant has a monthly production capacity of 15,000 smartphones and started operating with about 40 workers, among which 18 local engineers were sent to China to observe Huawei's factories and learn about production processes. Later the factory expanded to 140 workers as extra production lines were added (W7). Commenting on Huawei's manufacturing endeavors in Algeria, one of the Chinese firm's representatives stated that: "The Oued Smar plant is equipped with the latest generation equipment and uses the most innovative technologies and all of Huawei's know-how" (Djazairess 2019).

This rhetoric tied to developmental imaginaries of seamless spillovers and unhindered knowledge flows tells us little about how mechanisms of technology transfer operate on the ground. A closer examination of the factory's embeddedness with local production networks raises concerns about its rate of technological integration. Strong backward linkages would involve important supply inputs from local firms, a mechanism that would help upgrade local suppliers' technical and managerial capabilities (Javorcik 2004; Rojec and Knell 2018). Yet, Huawei's phone production relied on imported SKD (Semi Knocked Down) and CKD (Completely Knocked Down) kits, which are built in China and then exported to Algeria for the final stages of assembly. According to an Algerian line manager working at the factory: "Every component of the phone was imported from China. Even the phones' boxes and the tape used to close the boxes were purchased directly from China" (W7). The supposed local suppliers, Algerian firms, turned into import companies focusing on the purchase of Chinese electronic and non-electronic components. Forward linkages, in this case, consisted of phone distribution and retail companies, which were tasked with boosting the sales of Huawei devices.

While manufacturing activities are assumed to generate considerable spillovers, the nature of the emerging linkages around Huawei's factory resulted in the flooding of the market with Chinese artifacts without

much technology transfer. When asked about the reasons behind the factory's low rate of local integration, a manager at Huawei Device explained that the firm had the plan to increase local integration to 40% by localizing the supply of the phone's batteries and chargers, but that they had challenges finding suitable firms and startups to partner with (W11). Low levels of local supply seem to be a pattern in Chinese investments in Africa, with other research indicating that Chinese investors tended to prefer having Chinese suppliers along the value chain rather than sourcing locally (Rwehumbiza 2021; Tang 2021). The Algerian government described the practice, which had become the norm across manufacturers from different countries, as "fictitious production" and "disguised import." In January 2021, the factory's activities were suspended due to the government's ban on the import of CKD and SKD kits, and its workers were laid off for an undetermined period (W7).

The picture is similar when analyzing spillovers emanating from digital infrastructure building, Huawei and ZTE's core activity. Effective forward linkages, in this case, would involve the transfer of knowledge to enable customers (e.g., mobile operators) to learn how to use the technologies and to operate them independently, ultimately allowing technological appropriation and customization. While contracts between mobile carriers and foreign ICT equipment producers in Algeria and Egypt include clauses stating that the equipment's seller transfers know-how on how to operate and maintain the equipment, local engineers working for Huawei and ZTE highlighted that they *intentionally* provided minimal levels of details to customers. As explained by a ZTE engineer in the Algiers office: "We probably give our customers just about 50 or 60 per cent of information. ZTE wants to keep control over its technology and sustain the customers' need for its maintenance services" (W10). Customers of Chinese ICT equipment highlighted that the user guide accompanying the purchased technologies would often come in Mandarin only to constrain the extent of knowledge diffusion.

Likewise, effective backward linkages promoting technology transfer would entail significant local provision of infrastructure components, training, and involvement in equipment installation. But, as with the phone factory, fieldwork interviews and observations indicated that the bulk of components used in digital infrastructure built by Chinese OEMs were imported from China. This practice was also observed among non-Chinese OEMs. Unlike Auffray and Fu (2015), who find that the weak absorptive capacity of Ghanian firms plays a major role in hindering knowledge transfer from Chinese firms, Egyptian and Algerian subcontracting firms responded that the training received by Chinese OEMs fell short of meeting their perceived absorptive capacity. The lion's share of training focused on health and safety procedures, while the more technical content entailed learning how to install, maintain, and troubleshoot the equipment of specific ICT equipment manufacturers (S3, S4, S5, S11). In this sense, training provided by Chinese tech MNCs could not be the basis for effective local appropriation or of movement up the value chain. Instead, it primarily serves as socio-technical links creating ecosystems of identifiable local firms that support value retention by the Chinese firms.

Chinese technology companies are emerging as important infrastructure agents with the power to shape digital ecosystems and keep a tight rein over their maintenance, undermining other actors in the process. Local ICT firms reported being marginalized from public infrastructural bids and highlighted that even when they had the technical capacity to conduct the work (e.g., providing and installing data centers, fiber optic cables, antennas, etc.), governments would issue public bids with such high requirements that only large foreign ICT OEMs could bid. These OEMs would win large, attractive contracts, and then subcontract only limited parts of them to local firms, keeping most of the value (S1, S7, S11).

With developing countries like Algeria and Egypt showing an appetite for digital infrastructure provided by Huawei and ZTE, these companies are increasingly defining the conditions under which countries transition toward digital economies. The rapid construction of digital infrastructure without concurrently establishing meaningful backward and forward linkages with the local economy raises serious concerns about a new kind of technological dependency. While Chinese tech firms are helping developing countries catch up in terms of infrastructure for digital connectivity (Cisse 2012; Rwehumbiza 2021), they are concurrently capturing lucrative markets, excluding potential local competitors, and consolidating dominant positions, and conditioning emerging digital ecosystems. Without effective learning opportunities that could lead to technology and skill transfers and ultimately usher in structural transformation, the DSR may only strengthen the global position of Chinese tech multinationals while exacerbating cross-country inequalities.

Far from Beijing's description of the BRI and the DSR as developmental and knowledge diffusion initiatives, empirical evidence suggests that Chinese OEMs primarily try to protect their intellectual

property and profits. This finding echoes the conclusions of Yujia He's study in this special issue on Chinese platforms in Indonesia. The author finds that privately-owned Chinese digital platforms operated overseas largely according to commercial interests, and that China's high-level policy framework had a limited impact on the expansion of these platforms (He 2024).

Linkages with universities

If there is limited evidence of vertical and horizontal linkages emanating from Huawei and ZTE in Egypt and Algeria that are leading to technological upgrading, what about the emerging linkages between these two firms and local universities? University-FDI linkages can support the cross-fertilization of ideas and develop the national innovation base by embedding the existing R&D activity of MNC subsidiaries (Heidenreich 2012; Guimón et al. 2018). Through partnerships with universities, foreign firms can provide training, internships, and certifications to local students, exposing them to cutting-edge technologies and helping them improve their technical and managerial capabilities to match industry practices (Vaaland and Ishengoma 2016).

Although ZTE has several partnerships with educational and research institutions in the region, no other foreign OEM's engagement with universities compares with Huawei. In 2019, the tech firm signed an extensive partnership with the Egyptian government to launch the ICT Talent Bank, its flagship capacity-building program to boost university-industry linkages. The program's ambitions are to create 100 Huawei ICT academies in Egypt, train 200 instructors and 1200 ICT engineers and certify over 4000 trainees (Huawei ICT Academy 2019). Huawei certifications cover several themes like 5 G, cloud, artificial intelligence, big data, switches, and routers. Trainees are selected on a competitive basis from a dozen Egyptian universities, such as Port Said University and the University of Suez, among others. Interviewed Egyptian graduates from Huawei's ICT academy who obtained the training stated that it covered high-quality technical and theoretical content that would facilitate their job hunt after graduating (U9, U10, U11).

While university-FDI linkages are often perceived to be beneficial *per se*, shifting to a techno-politics framework, these training initiatives stop being benevolent capacity-building endeavors but become politically charged projects embodying power and creating winners and losers on the way. Traditionally, the ICT OEM enterprise subsector has been dominated by Cisco certifications. Cisco Systems' technologies have been the standard taught in university curriculums worldwide. Until today, most Cisco certifications remain the gold standard among ICT engineers who recognize that Huawei's certifications are a copy of Cisco's with different codes and nominations. As a technological latecomer, Huawei has been actively trying to reverse Cisco's hegemony through its ICT academies. The Shenzhen-headquartered firm created several incentives to raise the rate of students certified in Huawei technologies, one of which consisted of gifting costly technological equipment to universities that succeed in achieving a significant number of Huawei-certified students per year (U1, U9).

Another strategy to promote the number of ICT engineers certified in Huawei technologies involved providing significant discounts on the certification fees, which tend to be paid directly by students. These certifications can cost between 200 and 600 USD for Cisco certifications and 100 to 500 USD for Huawei certifications (U3, U4, U9). During the COVID-19 pandemic, Huawei made all its certifications free, while Cisco only introduced a 50 per cent discount. With free certifications, many interviewed students in Algeria and Egypt opted for Huawei certifications instead of Cisco's. The director of an ICT department in Algeria explained that OEM certifications are not mandatory in the curriculum but that they are highly recommended electives that make graduates more employable. She highlighted the tense competition between big ICT manufacturers on campus and noted that Algerian curriculums avoid training students on a unique system to avoid creating dependencies (U1, U2). Nonetheless, the fee waivers provided by Huawei to students, along with the free training in its ICT academies, made it an easy choice for university students.

In the race to dominate the ICT enterprise business, Huawei has reached out to local channel partners that are already Cisco qualified and financed their conversion to become Huawei partners (S5, S11). Due to the interrelated and interlocking nature of technological regimes, more engineers trained to install, maintain, and troubleshoot Huawei technologies, and more channel partners selling Huawei products, means that governments, mobile carriers, and local companies increasingly decide to buy Huawei equipment. Chinese firms have thus adjusted national visions for the development of the ICT industry while mapping out and structuring digital communities revolving around the consumption of their artifacts and standards. This finding corroborates Tugendhat (2021), who finds that Huawei's

training centers in Kenya and Nigeria serve to establish a network of trained technicians, distributors, and salespeople qualified in Huawei technologies.

Yet Tugendhat's analysis neglects the important macro ramifications of these micro-level restructurings. Training programs, digital infrastructure projects, and the emanating linkages at the micro-level are closely intertwined with digital technology standard-setting at the macro-level. China's strategy of increasing its weight in digital technology standardization relies on the use and diffusion of its own technical and industrial standards in the physical infrastructure it builds overseas (Peyrat 2012). In practice, technology standards spread from the top through adoption in international standard-setting bodies and from the bottom when MNCs build infrastructures that gravitate toward a common standard to ensure interoperability (Erie and Streinz 2021). Access to and use of digital infrastructures, and the applications that run over them, are regulated by frameworks that are, in turn, shaped by those who design and operate these infrastructures on the ground (Triolo and Sherlock 2020).

Against the backdrop of the technological competition between the United States and China, emerging linkages from Chinese tech firms are diffusing a mixture of infrastructures, hardware, software, certifications, and processes that are reordering digital systems on various scales and shaping new digital geographies. The experience of a final year student in ICT engineering sums up the situation well: "During my first year's internship at a large Algerian state-owned company, there was equipment from different vendors. But during my final year's internship at the same firm, I realized that most of the equipment had changed to become Huawei's" (U7). Thus, what may seem to be developmental endeavors are found to be connections that end up merely diversifying sources of technological dependency.

Conclusion and policy recommendations

Conclusion

If some attention has been paid to the political, geopolitical, and security implications of China's global digital expansion (Fannin 2019; Gagliardone 2019; Feldstein 2021; Ma 2021), what this expansion means for technological upgrading in other developing countries has been underexplored. This study contributes to filling this gap by investigating the technology spillovers emanating from Chinese tech firms through the cases of Huawei and ZTE in Algeria and Egypt. To do so, this article assessed three different types of linkages: horizontal linkages, vertical linkages, and linkages with local universities, through a conceptual framework that combines insights from development economics and techno-politics to examine the quality of linkages and their deeper effects – what linkages *do* on the ground, *how* they work and for *whom*.

The study finds that despite localizing seemingly developmental activities that can produce considerable linkages, the two Chinese tech firms created no meaningful learning opportunities that contribute to technological upgrading. Instead, the technologies disseminated by Chinese digital corporations, from codes to the hardware making up network infrastructures, as well as the know-how embedded in training programs provided to local employees, suppliers, and students, are reconfiguring ICT ecosystems in ways that render the use of Chinese firms' products, processes, and standards ubiquitous. In this sense, Chinese ICT giants are diffusing, both intentionally and non-intentionally, a distinct techno-political regime that risks locking local ICT actors into new dependencies that resemble those with Western powers. Future research ought to respond to recent calls in development studies for redeploying dependency theory to analyze how certain sectors and countries are conditioned by the development and expansion of other firms and countries (see Kvangraven 2021).

The comparison between tech firms headquartered in different countries reveals that keeping a tight rein over intellectual property is by no means a Chinese specificity. In Algeria and Egypt, both Chinese and non-Chinese firms are found to limit knowledge transfer by design to protect their technological edge (Tugendhat 2021). This being said, as technological latecomers, Chinese ICT firms, and Huawei in particular, have been particularly dynamic in public relations activities and training for employees, students, and suppliers in order to promote their own brands and take market space that was previously occupied by US and European firms. Although not yet conclusive, the preliminary findings suggest that with its energetic efforts in organizing ICT competitions, providing scholarships to students and grants to promising start-ups, Huawei may have a greater footprint in skill building than its competitors.

By highlighting the salience of power in technology transfer and connecting micro-processes with broader geopolitical struggles over global digital infrastructure, this article echoes findings made by communication, development, political economy, and internet governance scholars, among others, and responds to calls

to examine China's global digital presence in the Global South from an interdisciplinary perspective. This study provides further evidence that on-the-ground field-based research is critical for grasping the complex dynamics shaping the internationalization of Chinese digital capital (Li and Cheong 2017; Agbebi 2018, 2019; Gagliardone 2019; Erie and Streinz 2021; Tugendhat 2021). The combination of theoretical and empirical work is significant because "global digital China" is notoriously difficult to study due to the inaccessibility of key documents, including memorandums of understanding, contracts, and loan agreements.

It is important to note that this study's findings are limited by the scope of the research and the fieldwork undertaken. It has focused on specific types of knowledge spillovers that may have marginalized more tacit and informal channels of transmission, such as the interpersonal relationships between Chinese and local workers and managers. Another important limitation has to do with the restricted access to private tech MNCs (both Chinese and non-Chinese), which made it challenging to collect more high-level management data and systematically compare practices across firms. Ultimately, further research is needed to better grasp the opportunities and challenges created by localization strategies of Chinese MNCs in different regions and settings. One potential future research direction would look at the question of digital data control in Chinese engagement with other developing countries. While technology transfer that could promote structural transformation is constrained by ICT MNCs, knowledge transfer from North African internet users to these firms may be booming, with Chinese MNCs building much of the region's data centers and cloud systems.

Policy recommendations

This study has a number of policy implications that could be applicable to other countries beyond Algeria and Egypt. The increasingly intricate linkages *via* which knowledge is diffused and absorbed raise concerns regarding the distributive effects of these linkages. Without pro-active policies, the DSR risks exacerbating existing digital inequalities. To reverse current trends, BRI countries ought to adopt a set of digital industrial policies that support technology localization and productive linkages. What follows provides some policy recommendations to improve the three types of linkages assessed in the paper:

First, as the wage premiums offered by MNCs were found to hinder labor turnover, strengthening horizontal linkages may require host governments to introduce financial incentives to help local private and public tech firms align with the salaries and remuneration packages offered by tech MNCs. Such policies would promote labor turnover and poaching, especially of managers, a mechanism long recognized as powerful in promoting domestic innovation and increasing productivity (Beaudry and Francois 2009). Learning from China's own development experience, policies could ensure that emerging tech champions have sufficient financial resources to hire top talents and adopt cutting-edge technical and managerial practices.

Second, to promote vertical linkages – and backward linkages in particular – policies should seek to include local firms in large ICT infrastructure projects to boost learning from foreign digital firms. One way of achieving this would be by requiring consortium bidding between local and foreign firms. Tender winners would have to divide the tasks between them with well-defined compensations for each party and clearly set terms for technology transfers. Furthermore, while joint venture requirements, when feasible, have proven to be powerful vehicles for technology transfer (Blomström and Sjöholm 1999), the case of Huawei's factory in Algiers indicates that without broader local content requirements, these are unlikely to yield significant learning opportunities.

Third, governments ought to move beyond the idea that business-university linkages are inherently valuable, and create dedicated bodies to examine and improve the quality of business-university partnerships. These bodies would ensure that cooperation is leading to effective knowledge transfer and that traineeships and certifications provided to students by tech-MNCs do not simply serve to create future users and repairers of the firms' technologies. Importantly, policies should support universities to improve their internal scientific base, develop indigenous R&D capabilities and adopt curricula that are in phase with technological innovations, rather than leaving them to become fighting grounds between large foreign tech firms.

Ultimately, greater regional collaboration could help smaller economies maximize the gains from global digital initiatives like the Digital Silk Road. The idea of a regional digital policy, such as the one regulating the European Digital Single Market, may be useful for smaller developing countries (Azmeh, Foster, and Echavarri 2020). Moving beyond fragmented bilateral commercial agreements with China and its tech giants would help to level the playing field for all African nations and ultimately enhance opportunities for local agencies to sculpt structures that support inclusive digital development.

Notes

1. Technology spillovers reflect the unintended transfer of technology, while technology transfer has a more intentional/deliberate connotation (Smeets 2008). Similarly, knowledge transfer implies a broader, more general type of knowledge, while technology transfer is narrower and more targeted (Holm et al. 2020).
2. Law No. 72 of 2017. Accessed December 3, 2023. https://www.gafi.gov.eg/english/startabusiness/laws-and-regulations/publishingimages/pages/businesslaws/investment%20law%20english%20ban.pdf.
3. Following China's adoption of its "going out" policy in the late 1990s, Chinese ICT OEMs started venturing out. Both Huawei and ZTE set up subsidiaries in Cairo and Algiers by the early 2000s.
4. The exact number of employees at ZTE Egypt remains unknown. A senior ZTE manager refused to divulge the number of employees in the Egyptian subsidiary, stating that the information was confidential (W12).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This paper is part of a series from the project, "China's Digital Expansion in the Global South", funded by the Faculty of Humanities, University of Manchester, UK. Richard Heeks and Qingna Zhou of the Global Development Institute, University of Manchester, and Xia Han of the Alliance Manchester Business School, University of Manchester, were the facilitating editors.

References

Agbebi, M. 2018. China in Africa's telecom sector: Opportunities for human capital development? A case of Huawei in Nigeria. *Human Resource Development International* 21 (5):532–51. doi: 10.1080/13678868.2018.1512232.

Agbebi, M. 2019. Exploring the human capital development dimensions of Chinese investments in Africa: Opportunities, implications and directions for further research. *Journal of Asian and African Studies* 54 (2):189–210. doi: 10.1177/0021909618801381.

Agence Ecofin. 2019a. Telecom Egypt signs new deal with Huawei, ZTE and China Telecom. Accessed December 3, 2023. https://www.ecofinagency.com/telecom/0908-40385-telecom-egypt-signs-new-deal-with-huawei-zte-and-china-telecom

Agence Ecofin. 2019b. L'Algérie abrite la toute première usine africaine de Huawei, opérationnelle depuis le 22 janvier 2019 (Algeria hosts Huawei's very first African factory, operational since January 22, 2019). Accessed December 3, 2023. https://www.agenceecofin.com/investissement/2801-63550-l-algerie-abrite-la-toute-premiere-usine-africaine-de-huawei-operationnelle-depuis-le-22-janvier-2019

Aitken, B. J., and A. E. Harrison. 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *American Economic Review* 89 (3):605–18. doi: 10.1257/aer.89.3.605.

Amendolagine, V., A. Boly, N. D. Coniglio, F. Prota, and A. Seric. 2013. FDI and local linkages in developing countries: Evidence from Sub-Saharan Africa. *World Development* 50:41–56. doi: 10.1016/j.worlddev.2013.05.001.

Amsden, A. H. 2001. *The rise of "the rest": Challenges to the West from late-industrializing economies*. New York: Oxford University Press.

Anand, N. 2015. Leaky states: Water audits, ignorance, and the politics of infrastructure. *Public Culture* 27 (2):305–30. doi: 10.1215/08992363-2841880.

APS (Algeria Press Service). 2021. L'augmentation du débit internet minimum réalisée grâce à d'"enormes' investissements" (The increase in the minimum internet speed achieved thanks to "huge" investments). Accessed December 3, 2023. https://www.aps.dz/sante-science-technologie/128654-l-augmentation-du-debit-internet-minimum-realisee-grace-a-d-enormes-investissements

Auffray, C., and X. Fu. 2015. Chinese MNEs and managerial knowledge transfer in Africa: The case of the construction sector in Ghana. *Journal of Chinese Economic and Business Studies* 13 (4):285–310. doi: 10.1080/14765284.2015.1092415.

Autio, E., M. Kenney, P. Mustar, D. Siegel, and M. Wright. 2014. Entrepreneurial innovation: The importance of context. *Research Policy* 43 (7):1097–108. doi: 10.1016/j.respol.2014.01.015.

Azmeh, S., C. Foster, and J. Echavarri. 2020. The International Trade Regime and the Quest for free digital trade. *International Studies Review* 22 (3):671–92. doi: 10.1093/isr/viz033.

Beattie, A. 2019. July 24. Technology: How the US, EU and China compete to set industry standards. *Financial Times,* July 24. Accessed December 3, 2023. https://www.ft.com/content/0c91b884-92bb-11e9-aea1-2b1d33ac3271

Beaudry, P., and P. Francois. 2009. Managerial skills acquisition and the theory of economic development. *Review of Economic Studies* 77 (1):90–126. doi: 10.1111/j.1467-937X.2009.00571.x.

Beladi, R. 2023. Algeria.The abolition of the 49/51% law alone is not sufficient to attract significant investment. Accessed December 6, 2023. https://internationalsupermarketnews.com/algeria-the-abolition-of-the-49-51-law-alone-is-not-sufficient-to-attract-significant-investment/.

Blalock, G., and P. J. Gertler. 2008. Welfare gains from Foreign Direct Investment through technology transfer to local suppliers. *Journal of International Economics* 74 (2):402–21. doi: 10.1016/j.jinteco.2007.05.011.

Blomstrom, M., and A. Kokko. 2001. Foreign direct investment and spillovers of technology. *International Journal of Technology Management* 22 (5/6):435–54. doi: 10.1504/IJTM.2001.002972.

Blomström, M., and F. Sjöholm. 1999. Technology transfer and spillovers: Does local participation with multinationals matter? *European Economic Review* 43 (4–6):915–23. doi: 10.1016/S0014-2921(98)00104-4.

CCCPC (Central Committee of the Communist Part of China). 2016. The 13th five-year plan for economic and social development of the People's Republic of China (2016-2020). Accessed December 3, 2023. https://en.ndrc.gov.cn/policies/202105/P020210527785800103339.pdf.

Chen, B.-M. 2021. Digital Leninism: The complex, dangerous relationship between tech giants and the Chinese communist party. Washington, DC: Center for International Private Enterprise. Accessed December 3, 2023. https://www.cipe.org/resources/digital-leninism-the-complex-dangerous-relationship-between-tech-giants-and-the-chinese-communist-party/.

Cunningham, J. A., M. Menter, and C. Young. 2017. A review of qualitative case methods trends and themes used in technology transfer research. *The Journal of Technology Transfer* 42 (4):923–56. doi: 10.1007/s10961-016-9491-6.

Demena, B. A., and P. A. G. van Bergeijk. 2019. Observing FDI spillover transmission channels: Evidence from firms in Uganda. *Third World Quarterly* 40 (9):1708–29. doi: 10.1080/01436597.2019.1596022.

Denzin, N. K. 2001. *Interpretive interactionism*. London: SAGE.

Djazairess 2019. Huawei se lance dans le "Made in bladi". Le numéro deux de la téléphonie mondiale ouvre une usine en Algérie. [Huawei is launching into "Made in bladi". The number two player in the world's telephony industry opens a factory in Algeria]. Accessed 02 December 2023. https://www.djazairess.com/fr/lexpression/308334

Edwards, P. N., and G. Hecht. 2010. History and the technopolitics of identity: The case of apartheid South Africa. *Journal of Southern African Studies* 36 (3):619–39. doi: 10.1080/03057070.2010.507568.

Elliot, S., and I. Sahar. 2020. Algeria's new hydrocarbon law comes into force amid output slump. Accessed December 9, 2023. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/natural-gas/010620-algerias-new-hydrocarbon-law-comes-into-force-amid-output-slump

Erie, M. S., and T. Streinz. 2021. The Beijing effect: China's "Digital Silk Road" as transnational data governance (SSRN Scholarly Paper No. 3810256). Accessed Dece mber 3, 2023. https://papers.ssrn.com/abstract=3810256

Fannin, R. A. 2019. *Tech titans of China: How China's tech sector is challenging the world by innovating faster, working harder, and going global*. Boston, MA: Nicholas Brealey.

Feldstein, S. 2021. *The rise of digital repression: How technology is reshaping power, politics, and resistance*. New York: Oxford University Press.

Fu, X., C. Pietrobelli, and L. Soete. 2011. The role of foreign technology and indigenous innovation in the emerging economies: Technological change and catching-up. *World Development* 39 (7):1204–12. doi: 10.1016/j.worlddev.2010.05.009.

Gagliardone, I. 2019. China, Africa, and the Future of the Internet: New Media, New Politics. 1st edition. Zed Books.

Globerman, S. 1979. Foreign direct investment and "spillover" efficiency benefits in Canadian manufacturing industries. *The Canadian Journal of Economics* 12 (1):42–56. doi: 10.2307/134570.

Guimón, J., C. Chaminade, C. Maggi, and J. C. Salazar-Elena. 2018. Policies to attract R&D-related FDI in small emerging countries: Aligning incentives with local linkages and absorptive capacities in Chile. *Journal of International Management* 24 (2):165–78. doi: 10.1016/j.intman.2017.09.005.

Haddad, M., and A. Harrison. 1993. Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco. *Journal of Development Economics* 42 (1):51–74. doi: 10.1016/0304-3878(93)90072-U.

He, Y. 2024. Chinese digital platform companies' expansion in the Belt and Road Countries. *The Information Society* 40 (3).

Hecht, G. 2001. Technology, politics, and national identity in France. In *Technologies of power: Essays in honor of Thomas Parke Hughes and Agatha Chipley Hughes*, eds. M. T. Allen and G. Hecht, 253–94. Cambridge, MA: MIT Press.

Heidenreich, M. (ed.). 2012. *Innovation and institutional embeddedness of multinational companies*. Cheltenham, UK: Edward Elgar.

Hernandez, K. 2019. Achieving complex development goals along China's Digital Silk Road. (K4D Emerging Issues Report). Brighton, UK: Institute of Development Studies, University of Sussex. Accessed December3, 2023. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14396.

Hillman, J. E. 2021. *The Digital Silk Road: China's quest to wire the world and win the future*. New York: Harper Business.

Hirschman, A. O. 2013. A generalized linkage approach to development, with special reference to staples. In *The essential Hirschman*, ed. J. Adelman, 155–94. Princeton, NJ: Princeton University Press.

Holm, J. R., B. Timmermans, C. R. Østergaard, A. Coad, N. Grassano, and A. Vezzani. 2020. Labor mobility from R&D-intensive multinational companies: Implications for knowledge and technology transfer. *The Journal of Technology Transfer* 45 (5):1562–84. doi: 10.1007/s10961-020-09776-8.

Huawei. 2017. Huawei announces new OpenLab in Cairo to build ICT ecosystem in Northern Africa. Accessed December 6, 2023. https://www.huawei.com/en/news/2017/12/Huawei-New-OpenLab-Cairo

Iršová, Z., and T. Havránek. 2013. Determinants of horizontal spillovers from FDI: Evidence from a large meta-analysis. *World Development* 42:1–15. doi: 10.1016/j.worlddev.2012.07.001.

Javorcik, B. S. 2004. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review* 94 (3):605–27. doi: 10.1257/0002828041464605.

King, K. 2013. *China's aid and soft power in Africa: The case of education and training*. Martlesham, UK: Boydell & Brewer.

Kneller, R., and M. Pisu. 2007. Industrial linkages and export spillovers from FDI. *The World Economy* 30 (1):105–34. doi: 10.1111/j.1467-9701.2007.00874.x.

Kvangraven, I. H. 2021. Beyond the stereotype: Restating the relevance of the dependency research programme. *Development and Change* 52 (1):76–112. doi: 10.1111/dech.12593.

Lall, S. 1992. Technological capabilities and industrialization. *World Development* 20 (2):165–86. doi: 10.1016/0305-750X(92)90097-F.

Laouisset, D. E. 2021. Algeria import substitution policy: The case of the pharmaceutical industry. *Les Cahiers Du Cread* 37 (1):5–39.
Larkin, B. 2013. The politics and poetics of infrastructure. *Annual Review of Anthropology* 42 (1):327–43. doi: 10.1146/annurev-anthro-092412-155522.
Lean, C. S. 2001. Empirical tests to discern linkages between construction and other economic sectors in Singapore. *Construction Management and Economics* 19 (4):355–63. doi: 10.1080/01446190010022686.
Lee, H., and S. Oh. 2006. A standards war waged by a developing country: Understanding international standard setting from the actor-network perspective. *The Journal of Strategic Information Systems* 15 (3):177–95. doi: 10.1016/j.jsis.2005.10.002.
Li, R., and K.-C. Cheong. 2017. Huawei and ZTE in Malaysia: The localisation of Chinese transnational enterprises. *Journal of Contemporary Asia* 47 (5):752–73. doi: 10.1080/00472336.2017.1346697.
Liu, Z. 2008. Foreign direct investment and technology spillovers: Theory and evidence. *Journal of Development Economics* 85 (1–2):176–93. doi: 10.1016/j.jdeveco.2006.07.001.
Liu, X., C. Wang, and Y. Wei. 2009. Do local manufacturing firms benefit from transactional linkages with multinational enterprises in China? *Journal of International Business Studies* 40 (7):1113–30. doi: 10.1057/jibs.2008.97.
Ma, W. 2021. *The digital war: How China's tech power shapes the future of AI, blockchain and cyberspace*. New York: Wiley.
Mackinnon, A. 2019. For Africa, Chinese-built internet is better than no internet at all. *ForeignPolicy.com*, March 19. Accessed December 8, 2023. https://foreignpolicy.com/2019/03/19/for-africa-chinese-built-internet-is-better-than-no-internet-at-all/.
Markusen, J., and A. Venables. 1999. Foreign direct investment as a catalyst for industrial development. *European Economic Review* 43 (2):335–56. doi: 10.1016/S0014-2921(98)00048-8.
Mattli, W., and T. Büthe. 2003. Setting international standards: Technological rationality or primacy of power? *World Politics* 56 (1):1–42. doi: 10.1353/wp.2004.0006.
McGregor, G. 2022. China emerges as lead funder for Egypt's new administrative city. Accessed December 8, 2023. https://www.al-monitor.com/originals/2022/12/china-emerges-lead-funder-egypts-new-administrative-city.
MCIT (Ministry of Communications and Information Technology). 2016. Egypt's ICT 2030 Strategy. Accessed December 8, 2023. https://mcit.gov.eg/en/ICT_Strategy.
MFA (Ministry of Foreign Affairs of the PRC). 2009. Premier Wen Jiabao Talks with Trainees of Huawei Training Center in Egypt. Accessed December 8, 2023. http://nl.china-embassy.gov.cn/eng/zgyw/200911/t20091111_2641062.htm.
Mitchell, T. 2002. *Rule of experts: Egypt, techno-politics, modernity*. Berkeley, CA: University of California Press.
Ning, L., and F. Wang. 2018. Does FDI bring environmental knowledge spillovers to developing countries? The role of the local industrial structure. *Environmental and Resource Economics* 71 (2):381–405. doi: 10.1007/s10640-017-0159-y.
Ockwell, D. G., J. Watson, G. MacKerron, P. Pal, and F. Yamin. 2008. Key policy considerations for facilitating low carbon technology transfer to developing countries. *Energy Policy* 36 (11):4104–15. doi: 10.1016/j.enpol.2008.06.019.
Oya, C., and F. Schaefer. 2019. Chinese firms and employment dynamics in Africa: A comparative analysis (Synthesis report). London: SOAS, University of London. Accessed December 8, 2023. https://www.almendron.com/tribuna/wp-content/uploads/2021/04/file141857.pdf.
Pairault, T. 2017. La Chine au Maghreb: De l'esprit de Bandung à l'esprit du capitalisme. *Revue de la Régulation* 21 (21). doi: 10.4000/regulation.12230.
Peyrat, O. 2012. Normes: Un outil caché de la stratégie économique chinoise (Standards: A hidden tool of Chinese economic Strategy). *Le Journal de L'École de Paris du Management* 6:30–7. Accessed December 9, 2023. https://www.ecole.org/fr/seance/961-normes-un-outil-cache-de-la-strategie-economique-chinoise.
Rojec, M., and M. Knell. 2018. Why is there a lack of evidence on knowledge spillovers from foreign direct investment? *Journal of Economic Surveys* 32 (3):579–612. doi: 10.1111/joes.12207.
Rwehumbiza, D. A. 2021. Huawei's linkages with local firms in Tanzania: Idiosyncratic benefits and risks. *Global Business and Organizational Excellence* 40 (3):20–35. doi: 10.1002/joe.22076.
Saggi, K. 2002. Trade, foreign direct investment, and international technology transfer: A survey. *The World Bank Research Observer* 17 (2):191–235. doi: 10.1093/wbro/17.2.191.
Shen, H. 2017. Across the Great (Fire) Wall: China and the global internet. Doctoral Dissertation, University of Illinois.
Smeets, R. 2008. Collecting the Pieces of the FDI Knowledge Spillovers Puzzle. *The World Bank Research Observer* 23 (2):107–138. doi: 10.1093/wbro/lkn003.
Smith, J., C. Cummins, and A. Krasodomski-Jones. 2021. Good foundations: Why Democracies should care about the wiring of the internet. Accessed December 9, 2023. https://demos.co.uk/wp-content/uploads/2021/03/Good-Foundations-Report-.pdf
Statista, 2021. Share of youth unemployment in the Middle East and North Africa region in 2020, by country. https://www.statista.com/statistics/1259020/menayouth-unemployment-by-country/
Tang, X. 2021. Adaptation, innovation, and industrialization: The impact of Chinese investments on skill development in the Zambian and Malawian cotton sectors. *Journal of Chinese Economic and Business Studies* 19 (4):295–313. doi: 10.1080/14765284.2021.1943734.
Te Velde, D. W. 2002. Government policies for inward foreign direct investment in developing countries: Implications for human capital formation and income inequality. (OECD Development Centre Working Paper No. 193). Paris: OECD.
Triolo, P., and A. Sherlock. 2020. "New infrastructure": China's race for 5G and networked everything has a new catchphrase. Accessed December 9, 2023. https://supchina.com/2020/07/01/new-infrastructure-chinas-race-for-5g-and-networked-everything-has-a-new-catchphrase/.
Tsui, B. 2016. Do Huawei's training programs and centers transfer skills to Africa?. (Policy Brief No. 14). Washington, DC: China-Africa Research Initiative, School

of Advanced International Studies, Johns Hopkins University.

Tugendhat, H. 2021. Connection issues: A study on the limitations of knowledge transfer in Huawei's African training centres. *Journal of Chinese Economic and Business Studies* 19 (4):359–85. doi: 10.1080/14765284.2021.1943194.

Tugendhat, H. 2020. How Huawei succeeds in Africa: Training and knowledge transfers in Kenya and Nigeria. (Policy Brief No. 14). Washington, DC: China-Africa Research Initiative, School of Advanced International Studies, Johns Hopkins University.

UNCTAD. 2012. *Technology and innovation report 2012: Innovation, technology and South–South collaboration*. New York: United Nations.

Vaaland, T. I., and E. Ishengoma. 2016. University-industry linkages in developing countries: Perceived effect on innovation. *Education + Training* 58 (9):1014–40. doi: 10.1108/ET-07-2015-0067.

Wahab, S. A., R. C. Rose, and S. I. W. Osman. 2011. Defining the concepts of technology and technology transfer: A literature analysis. *International Business Research* 5 (1):61–71. doi: 10.5539/ibr.v5n1p61.

Waterbury, J. 1985. The "soft state" and the open door: Egypt's experience with economic liberalization, 1974–1984. *Comparative Politics* 18 (1):65–83. doi: 10.2307/421658.

Winner, L. 1980. Do artifacts have politics? *Daedalus* 109 (1):121–36.

World Bank. 2022a. Individuals using the internet (% of population). February 16, 2024. https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=DZ.

World Bank. 2022b. Mobile penetration per country. Accessed April 12, 2023. https://data.worldbank.org/indicator/IT.CEL.SETS.P2.

World Economic Forum. 2017. The future of jobs and skills in the Middle East and North Africa: Preparing the region for the fourth industrial revolution (Executive briefing). Accessed December 9, 2023. https://www3.weforum.org/docs/WEF_EGW_FOJ_MENA.pdf.

Yao, X., A. Tan, and R. Suttmeier. 2009. Standards of power? Technology, institutions, and politics in the development of China's national standards strategy. *Geopolitics, History, and International Relations* 1 (1):46–84.

Annex 1: List of interviewees

Affiliation	Code	Date	Place
Subcontractors, Suppliers, and Customers of Huawei and ZTE			
CEO of subcontracting firm for major ICT OEM	S1	17/10/2021	Algiers
CEO of subcontracting firm for major ICT OEM	S2	18/10/2021	Algiers
CEO of subcontracting firm for major ICT OEM	S3	22/10/2021	Algiers
CEO of subcontracting firm for major ICT OEM	S4	13/12/2021	Algiers
CEO of subcontracting firm for major ICT OEM	S5	20/12/2021	Algiers
Startup	S6	09/12/2021	Algiers
CEO of subcontracting firm for major ICT OEM	S7	13/12/2021	Algiers
Mobile operator	S8	08/01/2022	Algiers
CEO of subcontracting firm for major ICT OEM	S9	02/03/2022	Cairo
Startup	S10	02/03/2022	Cairo
Subcontractor to Major ICT vendors	S11	15/03/2022	Cairo
Huawei and ZTE Engineers and Managers			
ICT engineer at ZTE	W1	28/10/2021	Algiers
ICT engineer at ZTE	W2	06/11/2021	Algiers
Engineer at Ooredoo with Huawei certification	W3	28/11/2021	Zoom call
Former Huawei engineer	W4	05/12/2021	Algiers
Engineer at Huawei	W5	07/12/2021	Algiers
ZTE manager	W6	22/12/2021	Algiers
Assembly line manager at Afgotech (Algerian Huawei's partner for the factory)	W7	20/01/2022	Phone call
Former Huawei engineer who set up his own business	W8	03/01/2022	Algiers
Engineer at Huawei, the Oran Institute of Telecommunication	W9	06/01/2022	Zoom call
Engineer at ZTE	W10	18/01/2022	Algiers
Manager at Huawei Device – coordinator of phone manufacturing	W11	01/02/2022	Algiers
A senior manager at ZTE Egypt	W12	16/02/2022	Cairo
Junior network engineer at Huawei	W13	17/02/2022	Zoom call
Senior network engineer at Huawei	W14	21/02/2022	Cairo
Training and development manager at Huawei customer	W15	24/02/2022	Phone call
Huawei public relations manager	W16	27/02/2022	Zoom call
Telecom engineer at Huawei	W17	02/03/2022	Cairo
Telecom engineer at Huawei	W18	02/03/2022	Cairo
Telecom engineer at Huawei	W19	02/03/2022	Cairo
Computer engineer at ZTE Egypt	W20	04/03/2022	Phone call
Computer engineer at Huawei's OpenLab	W21	16/03/2022	Cairo
Experts and Researchers			
Economic expert	E1	30/11/2021	Algiers
IT engineer and digital economy expert	E2	30/11/2021	Algiers
Professor of ICTs at the University of Bab Ezzouar	E3	17/11/2021	Algiers
Official responsible for the US-Algeria Trade Chamber	E4	20/11/2021	Algiers
Digital economy expert	E5	15/12/2021	Algiers
Digital economy Expert	E6	19/01/2022	Algiers
Professor of economic innovation at the University of Lille	E7	07/02/2022	Oran
Engineer of digital devices	E8	23/02/2022	Cairo
Researcher focusing on China-Egypt Relations	E9	27/02/2022	Zoom call
Professor of political economy at the American University in Cairo	E10	28/02/2022	Cairo
Professor of economics at the University of Cairo	E11	01/03/2022	Cairo
Senior digital development specialist at the World Bank	E12	10/03/2022	Cairo
Students and Instructors of Huawei and ZTE Training Programmes			
Senior official of the national institute of ICTs, Ucalypthus, Algiers	U1	07/12/2021	Algiers
Pedagogical coordinator at the national institute of ICTs, Ucalypthus, Algiers	U2	07/12/2021	Algiers
Student at the national institute of ICTs	U3	07/12/2021	Algiers
Student at the national institute of ICTs	U4	07/12/2021	Algiers
Student at the national institute of ICTs	U5	07/12/2021	Algiers
Student at the national institute of ICTs	U6	07/12/2021	Algiers
ICT student and coordinator of Huawei ICT academies at the University of Saad Dahleb, Blida	U7	12/21/2021	Zoom call
Senior official at the National School of Computer Science (ESI)	U8	27/12/2021	Algiers
University student and graduate of Huawei ICT Academy	U9	27/02/2022	Cairo
ICT Academy graduate	U10	09/03/2022	Cairo
ICT Academy graduate	U11	04/03/2022	Cairo
Engineers and Managers of Western Competitors			
Senior manager at Ericsson Algeria	C1	21/12/2021	Zoom call
Ericsson engineer	C2	23/12/2021	Algiers
Senior manager at Cisco Algeria	C3	17/01/2022	Algiers
Engineer at Ericsson	C4	29/01/2022	Zoom call
Foreign tech incubator	C5	28/02/2022	Cairo
Foreign tech incubator	C6	28/02/2022	Cairo
ICT engineer at Nokia	C7	08/03/2022	Cairo
Engineer at the Orange Innovation Lab	C8	08/03/2022	Cairo
Engineer at the Orange Innovation Lab	C9	08/03/2022	Cairo
Senior manager at the Orange Innovation Lab	C10	08/03/2022	Cairo
ICT engineer at Ericsson	C11	15/03/2022	Cairo
Policymakers			
Algerian minister with responsibilities for the knowledge economy and startups	G1	28/11/2021	Algiers
Adviser to the Algerian minister of the knowledge economy	G2	28/11/2021	Algiers
Manager at the Egyptian Agency of Investment and Free Zones	G3	22/02/2022	Cairo
Policy Maker at ITIDA – Egyptian agency for informatics and telecommunication development	G4	01/03/2022	Phone call
Former finance minister of Egypt	G5	09/03/2022	Cairo