Investments in the digital silk road

Kazakhstan's Diversification from the Natural Resource Sector:

Strategic and Economic Opportunities

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Chapter 5. Investments in the Digital Silk Road

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Abstract

This chapter discusses opportunities for the new digital economy, a strategically important factor of the economic growth for contributing to the Central Asia Digital Silk Road concept. Focusing on new opportunities for international cooperation, including the development of digital technologies, the chapter also draws attention to the fact that technology advancement causes changes in the economic system which may result in digital inequality. It argues that the O&G industry can become a key driver of growth and development and could potentially boost competitiveness across all sectors. The authors consider a set of public policies in ICT-related sectors in Kazakhstan. These policies are focusing on diversification from the O&G sector, supporting domestic companies and research, encouraging export-oriented projects, and pushing companies to join international initiatives.

Introduction

In the past 25 years, Kazakhstan has succeeded in attracting direct investments, predominantly in the natural resource sector, worth about 300 billion US dollars (NBK, 2018), and established effective cooperation with major transnational corporations, catalyzed through implementation of institutional reform and democratic transformation (see Baldakhov & Heim, 2020, this volume). Government initiatives have demonstrated commitment to structural reforms and are intended to improve the economy's resistance to external shocks, while digitalization is recognized as a critical factor in ensuring the sustainable development of the country. *Digital Kazakhstan*, a State Program ratified in 2017, forecasts that one-third of the gross GDP growth of 6% will be directly related to the development of information and communication technology (ICT). To implement the program *Digital Kazakhstan*, the state has planned digitalization centers for each state body or institution, including governmental agencies. The program is

essential for the country as the world is entering the era of the New Digital Economy (NDE)[1] where co-creation of value[2] invades every process, from product design and engineering, over-manufacturing and logistics, to services, and thus digital information is the top priority. This means that analysts now need to be more concerned with network effects while planning investment projects, in detail as well as in general, with transactions, modes and fixed nodes, acquisition and greenfield investments (Buckley, 2016).

Despite the possibilities of modern ICT, it cannot solve all the problems associated with managing network interactions due to the eclectic behavior of value chain actors, which increasingly are not firms, but complex and unstable nodal structures. These chains become fragmented into specialized tasks, which are geographically dispersed across the nodes of global value chains[3]. In Kazakhstan, there is an understanding of this problem and actions are being taken to integrate local enterprises into global value creation hubs. An example of such a node is the Karachaganak Petroleum Operating B.V. (KPO)[4]. Recently, the consortium created has implemented a long-term digitalization program (Karachaganak news, 2018). However, most companies in Kazakhstan are still on their path of realization that in NDE they will have to turn to a business process of re-engineering again so as not only to improve performance processes but also re-establish an organizational interface between such activities (Bodrožić & Adler, 2018). With the growing popularity of business process re-engineering in the 90s, business actors grasped the role of intra-corporate networks, the necessity of reducing vertical (strong) links and enhancing horizontal (weak) ones, which has led to an emergency of matrix

[1] The new digital economy (NDE) is emerging from a combination of technologies, mainly from the ICT space, that are becoming pervasive across mechanical systems, communications, infrastructure, and the built environment (UNCTAD, 2017).
[2] Co-creation puts the spotlight squarely on consumer-company interaction as the locus of value creation (Prahalad & Ramaswamy, 2004).
[3] Dispersed business networks that are organized and coordinated by global firms as a common project of independent suppliers, which has its certain time frame and sequence of actions (Smorodinskaya & Katukov, 2017).
[4] The Karachaganak project brings expertise and knowledge from five oil & gas companies – ENI, Royal Dutch Shell, Chevron, Lukoil and KazMunayGas.

organizational structures. By the third decade of the 21st century, the global economy will have come to the need for such re-engineering throughout, at every level from an individual business process to the national and global economy. A feature of re-engineering in the NDE environment is the inclusion of all countries, firms, and processes in GVCs – a direct consequence of the widespread adoption of ICT, especially the Internet and cloud technologies.

Digitalization is usually considered as a means of ensuring the growth of productivity of the economy and the well-being of citizens, but, like any other technology it also exhibits features that limit the advantages and may even undermine developing countries' economic performance. New technologies can present a double negative impact to low-income countries: the benefits from the production of labor-intensive products are reduced and the ability to compensate for their technological disadvantages by unskilled labor is reduced (Rodrik, 2018). The growth of investments, which is currently a driver of economic growth, contributes to the reduction of the impact of this technological shock on the Kazakhstani economy as new MNEs market entries create new opportunities for local enterprises. In the settings of NDE the role of modern MNEs changes to become a «meta-integrator», able to leverage knowledge within and between the different constituent affiliates of its international network, which requires efficient internal markets and well-structured cross-border hierarchies (Narula, 2014). This creates an indigenous labor force with a suitable level of training and skills, to be able to participate in this *meta-integration* with the least transaction costs and disruption to the lives of ordinary people (Dunning & Lundan, 2008). New role needs in management methods based on representative models which describe node operation in value co-creation chains and take into account the roles of the appropriate country institutions (see Baldakhov & Heim, 2020, this volume). At the same time, the R&D community can advise on economic theory adaptation to the reality of a new digital service economy.

Kazakhstan eagerly explores opportunities of the NDE in parallel with other advantages embedded within the processes of globalization. WTO accession, expansion in cooperation with

MNEs and changes in the regulatory and legal environment create incentives for foreign investors, while new local industry development institutes promote local companies to play the more important role in the infrastructure projects implemented in the country. Prompt incentives provided to improve the national education system, and the foundation of new universities (including private) like the public International Information Technology University established in Almaty in close cooperation with the Carnegie Mellon University (USA) or public Kazakh-British Technical University[5] in Almaty, mitigated the shortage in ICT professionals. Nevertheless, the R&D environment is not yet developed enough to exploit the full potential of the educational system, which needs a flow of duly funded research projects. The level of R&D expenditure is still shallow, accounting for approximately 0.2% of GDP (see below), which might constrain implementation of economic development programs, including scientific programs of digitalization and the application of ICT technologies.

From the theoretical perspective, the promotion of digital economy investments will require adaptation of management theories since studies so far have focused on the digital transformation of single industries (Kretschmer & Claussen, 2016). Business system architecture also needs to be compatible with ICT architecture, so that a respective computer cluster node reflects every business system component, or every business cluster node, is reflected in a respective ICT cluster node.

In this chapter, we use the model of NDE in resource-rich countries (Heim, 2019) to study diversification of the ICT cluster by linking it with the O&G cluster, integrating this poll with national clusters of other countries, thus making use of the mutually beneficial cooperation within the international cluster system. This approach can be used to interpret the BRI, an initiative in understanding what this means for frontier states as receivers of action, investment,

[5] An idea to establish KBTU belongs to the former President of the RK, Nursultan Nazarbayev, who had a number of meetings with official representatives of the UK. This activity resulted in the Memorandum of Understanding signed by the two states in November 2000. British Prime Minister Tony Blair and Nursultan Nazarbayev became patrons of the university.

and infrastructure. Countries-receivers of BRI are exposed to direct (physical, economic) and ancillary (social, environmental, political) benefits and costs (Sternberg *et al.*, 2017). Assessment of such advantages and disadvantages in a cluster node model may be useful for BRI projects.

New Digital Economy Institutions

As this overview of the literature on institutional theory has revealed, the focus of the analysis is an organization or economy, both approached from the point of view of utility maximization. Therefore, classical institutional theory does not consider networks of different actors and value as a purpose of economic exchange. Of particular interest in understanding the role of institutions in a multiple-stakeholders' environment is the implications of institutional theory for political science, particularly as seen in the works of Ostrom (1990, 2005), on the governance of common-pool resources. She studies the role of institutions in the complex and interrelated resource-integration and service-exchange collaborative management of natural ecosystems organized around shared purposes (as cited in Vargo & Lusch, 2016). This is a similar point of view on institutions to that which was adopted by the theory of value co-creation which will be discussed further in relation to institutional theory. The purpose of institutions from the value co-creation perspective is to enable cooperation and coordination in ecosystems, as well as to reconcile conflict in the increasingly complex and inter-related integration of resources (Vargo & Lusch, 2016). These structures can be viewed at various levels of aggregation such as micro-, meso- and macro-levels (Lusch & Vargo, 2014). In these structures value flows from one actor to another and is created through multiple levels of interactions which are not fixed and evolve over time (Vargo, Wieland & Akaka, 2015).

Institutional theory itself cannot explain all aspects of emergency of digital and tertiary sector of the economy, including effects government policies of home countries. Therefore,

institutional theory needs to be linked to other theories in order to explain more recent trends in the global economy. In the next paragraphs of this chapter we will discuss the main trends in the economic development of Kazakhstan to make the reader familiar with institutional development in the country.

Information and communication technology advancement causes changes in not only production processes, but also in the architecture of economic systems, affecting processes of internationalization, direct foreign investments, and industrial policies[6]. A critical issue here is the interoperability[7] of economic actors that act within global networks, and distributed production systems that extensively use outsourcing within their national industrial clusters and readily cross borders in search of assets, markets, and efficiency. ICT has contributed significantly to creative destruction[8] through the emergence of some new firms and industries and the decline of others. It impacts industrial organizational structures and has obvious implications for employment. Directly and indirectly, ICT can also reduce market friction and transaction costs, and affect competitive positioning, with resulting impact on productivity improvement and economic growth (OECD, 2011). However, in the academic literature we do not find strong evidence that ICT helps reduce transaction costs. On the contrary, in the NDE era, due to the growth in volumes of data and information, transaction costs increase according to the amount of costs associated with cybersecurity, information costs, cost of digital transformations etc.

NDE holds considerable promise for businesses able to take advantage of new technology and mitigate risk. Large and small companies that rely on the new tools of the NDE, in both developed and developing countries alike, can make their organizations more efficient, as well as

[6] Industrial policy can be defined as strategic efforts of a government to encourage structural changes and development leading to fostering competitiveness via growth in manufacturing and the related services sector (Aiginger, 2007; Altenburg, 2011).

[7] Interoperability - is the ability of entities of an organization to work together that covers aspects ranging from the technical to the business level (Li & Liu, 2018).

[8] Creative destruction as a process of industrial change that increasingly revolutionizes the economic structure from within, destroying the old one and creating a new structure (Schumpeter, 1934)

serving customers more effectively, and push through innovative business transformations. While large companies might have access to more comprehensive data than higher-level platform owners or end users, access to all the world's relevant data by the end user is not required to speed up innovation or carve new market space within NDE (UNCTAD, 2017).

Research suggests the structure of the digital economy in resource-rich countries (Heim, 2019). This model demonstrates the intersection of the three cluster nodes involved in the extraction of natural resources (See Figure 5.1). Moreover, the activities of actors are carried out in the field of the NDE, where the behavior of actors is influenced by other digital institutions. Through the ICT industry, the data produced by the O&G industry and the oilfield service industry can be converted into information necessary for process control, which indicates the mutual interest of the parties in aligning the technological level of the collaborating cluster nodes.

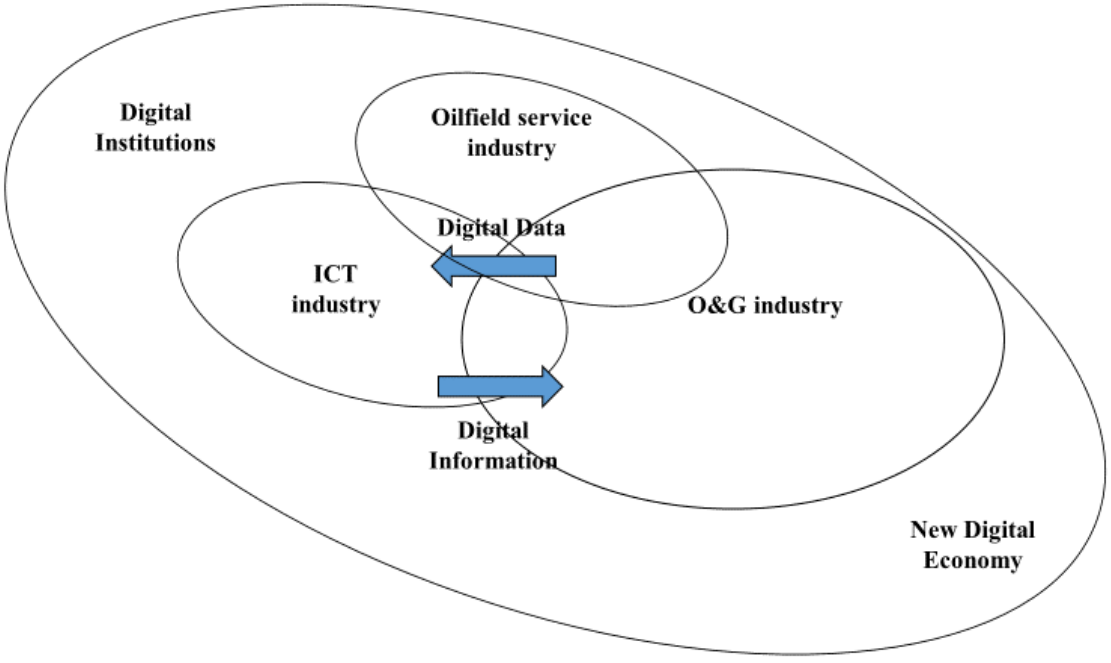

Figure 5.1. NDE in resource-rich countries. (Source: Heim, 2019).

ICT technology is relatively undeveloped in Kazakhstan, especially in SMEs, in which the level of adoption is very low. The main gaps are lack of financial resources for investments in ICT equipment and services, which leads to a lack of modern technologies, as well as skills gaps. The reason why SMEs often cannot access financial resources is their inability to provide evidence of long-term financial stability and ability to pay the loan back (Heim *et al*., 2018). Kazakh companies are attempting to participate in the digital economy, but knowledge and financial resources are available to big players only, usually state-owned. That is why digital technologies[9] now mainly develop with state support. For instance, NOC "KazMunayGas", a National Oil and Gas Company (NOC KMG) started an ambitious project of transformation and digitization of business processes. A shared services center (SSC), one of the first in Kazakhstan, has recently been created. Dmitry Basisty, Deputy General Director, KMG Global Solutions B.V., in the interview with Irina Heim said:

> *"The key point of such organizational structure is dedication of certain auxiliary business functions of the national oil and gas company to separate companies to have manufacturing facilities free to focus on the core activities – oil and gas exploration, production, transportation, refining, etc."*

Some of the companies in the O&G industry are advanced from the ICT development standpoint; however, there are others in which ICT does not exist, companies with only basic technologies. In Kazakhstan, there is an intensive activity of *meta-integrators*, MNEs taking part in a joint KPO project. International O&G giants - ENI, Royal Dutch Shell plc, Chevron, Lukoil and KazMunayGas (National Oil company of Kazakhstan), managed to put their efforts in a relatively small area of less than 300 square meters to invest in project 22 $ bill. KPO, in cooperation with operator companies, identified several digitalization initiatives that are important

[9] Digital technologies include 1) advanced production equipment, robotics and factory automation, 2) new sources of data from mobile and ubiquitous Internet connectivity, 3) cloud computing, 4) big data analytics, and 5) artificial intelligence. These technologies and processes are based, in one way or another, on advanced ICT, so that the driver of the NDE is the continued improvement in ICT (UNCTAD, 2017).

for the project in Kazakhstan, as well as for parent companies. Digitalization is an important initiative for KPO, as well as for its employees, subcontractors, but also for development of local businesses and creation of conditions for new business[10].

Institutional theory is a reliable tool for filling in this knowledge gap, since NDE, and any of its actors, is a complex system for which survival is the main goal, and in order to ensure their survival, organizations must comply with rationalized and institutionalized expectations of their environment and adopt the expected structures and management practices (Geppert, Matten & Walgenbach, 2006). Since Chinese internet-firms see the digital Silk Road as an opportunity to seek government support (Shen, 2018), this is one of the reasons why an institutional view is useful (Ramamurti & Hilleman, 2018).

Technological Digital Divide

In the mid-1960s Gordon Moore, a founder of Fairchild Semiconductor, observing evolution of semiconductor technology, predicted that the number of the components (transistors, resistors, diodes or capacitors) in an integrated circuit would double approximately every two years, which turned out to be one of the most successful predictions in modern history (Mack, 2011). Over the last fifty years, the increase in the density of transistors and their number on a single chip, has become a drive for the exponential growth of processor performance, and the use of economies of scale has made it possible to quickly reduce the cost associated with their performance. The demand for chips ensured steady growth of the sectors of the economy related to microelectronics: precision engineering, optical instrument production, the production of ultra-pure materials and other aspects of it. The expanded capabilities of electronics promote R&D in new digital technologies. Simultaneously gross revenues of ICT-dedicated industries as well as a number of

[10] Karachaganak news (2018). Available at: http://www.kpo.kz/fileadmin/user_upload/karachaganak_news_2018/NOVOSTI_SENTJABR__2018.pdf

the ICT applications grow exponentially, and investing opportunities emerge respectively. It is worth noting that costs and energy consumption by the ongoing ICT race grow at a roughly equal pace. Microelectronics is becoming an important industry as NDE is based on the continued exponential improvement in the cost-performance of ICT, mainly microelectronics (UNCTAD, 2017).

The growing complexity of the chips entails a growing digital divide between developing and developed countries in terms of participation in high value-added activities. The cost of the most advanced semiconductor factories now exceeds 10 billion US dollars, with individual tools approaching $100 million. This rocketing cost of entry means that now only four companies in the world have the capacity to make semiconductor chips at the technological leading edge: Intel (USA), Samsung (Korea), TSMC (Taiwan) and Global Foundries - USA/Singapore based (Jones, 2017). Developing and transition economies, including Kazakhstan, are net ICT importers for this reason; the digitalization paradigm makes the task to eliminate the so-called technological digital divide[11] more challenging and requires governments to amend economic policy with particular emphasis on intensified investments in digital infrastructure and R&D.

Peter Drucker stipulated that it is technology import-export balance, not the national trade balance, that determines the national welfare at a particular life stage of a nation (Drucker, 1992). In the NDE era, the conclusion can also be extended to the export-import balance of ICT. Countries unable to create and export assets with a significant ICT will need to spend a significant part of their incomes on the exports. Historically uneven distribution of technology creation centers, and under-developed R&D in developing and emerging countries are the main reasons for digital inequality. Research into the role of ICT in development (ICT4D) is often based on the concept of the "digital divide" which can be defined as "lack of technological access or ownership existing between individuals, households, companies and regions" (OECD, 2001; Dey & Ali, 2016). The

[11] Digital divide between technological levels of domestic and foreign enterprises.

digital divide has long been a significant concern of Governments, the international community, and researchers (UNCTAD, 2010). Most of the research has focused on reasons for the digital divide between individuals, households, regions, communities and countries; e.g. infrastructural bottleneck (Rao, 2005), gender (Cooper, 2006), socio-economic development (Çılan *et al*., 2009) or skills and interests (Min, 2010). However, ICT can also help companies in emerging countries to better compete in the global economy (Salnikova, 2013). For instance, Rimmel and Diedrich (2000) claimed that in business-to-business operations, companies use internet technologies to integrate their value chains, where the largest impact can be achieved by SMEs. Levy and Powell (2003) studied internet adoption strategies of SMEs in the UK Midlands and found little evidence that SMEs do more than develop websites and adopt email. Ntwoku, Negash and Meso (2017) studied personal computers' and internet diffusion by SMEs in Cameroon, the environmental factors that negatively affect institutionalization of e-commerce in Tanzania (Kabanda & Brown, 2017). Previous research also included studies of the determinants of ICT adoption SMEs within transition economies of Czech-Polish region (Hanclova, Rozehnal, Ministr & Tvrdikova, 2015), business performance monitoring software for SMEs in Chile (Lind, Sepúlveda & Nuñez, 2000), as well as impact of initiatives to pursue a higher degree of ICT and e-technology adaptation by SMEs (Milis, 2008).

According to Qureshi (2015), the effect of ICT on development can be studied at the individual, organization, country, region, and the world level. Investments in R&D, including ICT-related, are important for overcoming the digital divide, but also for economic development (Fraumeni & Okubo, 2005). Global statistics show that lack of R&D funding is specific not only to Kazakhstan but to most emerging and transition economies that affect macroeconomic indicators. Figures 5.2 and 5.3 below are dynamic diagrams of R&D expenditure measured in a percentage of GDP for the period from 2005 until 2015 (Figure 5.2), and current account balance measured in a percentage of GDP for the period from 2005 until 2017 (Figure 5.3) for six countries with low, medium and high R&D expenditures. The period selected for interpretation is

remarkable for signs of the global financial crisis of 2008 in the middle, accompanied by the drop in prices of natural resources, and the high volatility of many currencies.

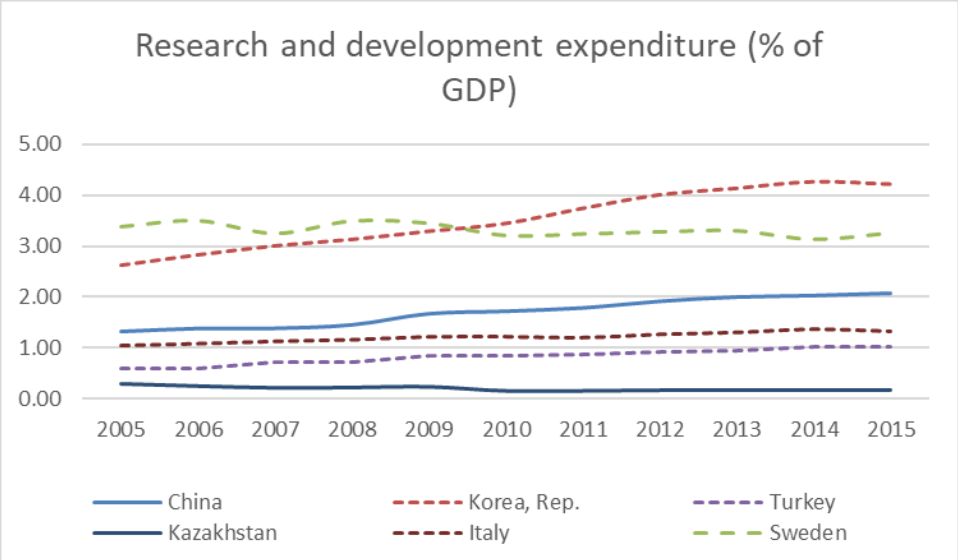

Figure 5.2. Research and development expenditures for selected countries, percent of GDP. (Source: Authors, own processed data based on World Bank (2018))

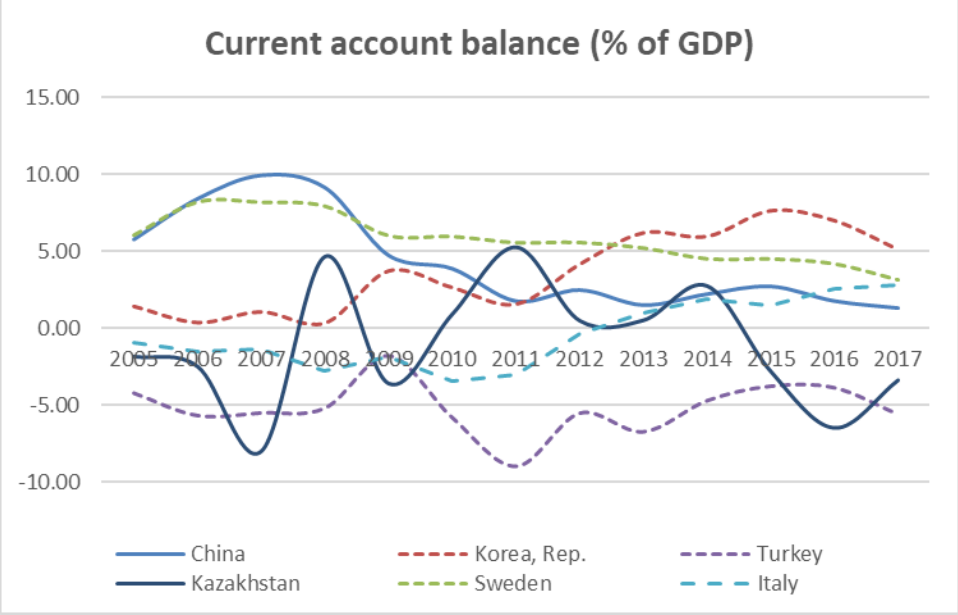

Figure 5.3. Current account balance for selected countries, percent of GDP. (Source: Authors, own processed data based on World Bank (2018))

Research suggests that there is a positive and significant relationship between volatility, R&D intensity and the various patent related measures - especially when the innovation measures are filtered to distinguish the very innovative firms from the less innovate ones (Mazzucato & Tancioni, 2012). To reduce the technological digital divide through innovations and improve overall economic development, policy in Kazakhstan should be focused on diversification from the O&G sector, supporting domestic companies and research in ICT-related sectors, encouraging export-oriented projects and pushing such companies to join international initiatives (see Han & Ghobadian, 2020 and Selmier, 2020, this volume). Without involvement in international R&D projects, no emerging economy can implement the strategy to minimize the economic discontinuities between developed and developing economies due to the unavoidable increase of ICT expenditure which follows an upward trend (Figure 5.4 below).

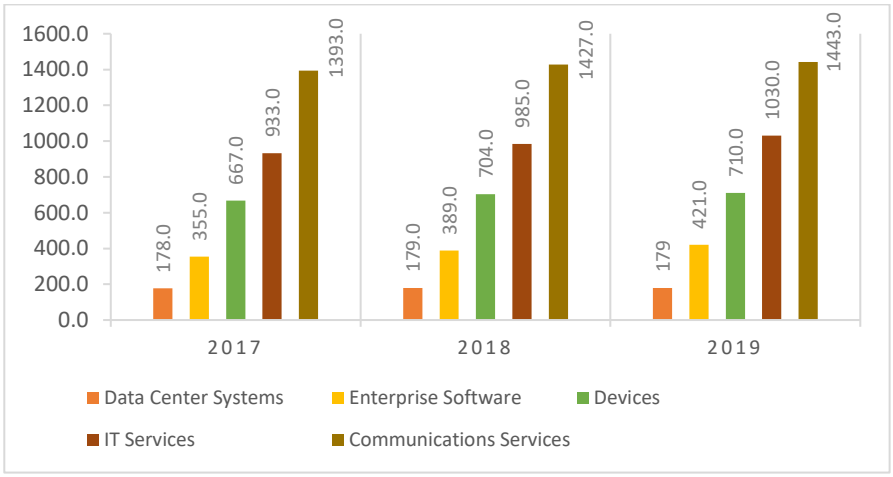

Figure 5.4. Worldwide ICT Spending Forecast, Bln US dollars. (Source: Authors, own processed data based on Gartner)

In previous decades companies and states were able to achieve positive growth with limited application of ICT components for the selective automation of key individual processes. During digital transformation, almost every nation and company needed to apply ICT technologies. For instance, in the O&G industry, critical to the economy of Kazakhstan, the next generation of ICT

technologies applied by O&G companies could reduce cost by approximately 20 percent, at an oil price of about 70 USD per barrel (Choudhry *et al*., 2016). Provided this is the case, the forecast is that digitalization of the O&G industry could lead to the reduction of capital expenditures by approximately 20 percent. Taking into consideration the capital-intensive character of the O&G industry, there is a great motivation to make the most of the digital transformation (Verdu, 2017).

The sample of 49 countries, including Kazakhstan, with R&D expenditure over 0.5 percent of GDP, except for the US, is provided in Figure 5.5 below. Average R&D expenditure as a percentage of GDP, the median of a current account balance as a percentage of GDP, the median and standard deviation of the current account balance were calculated for each country.

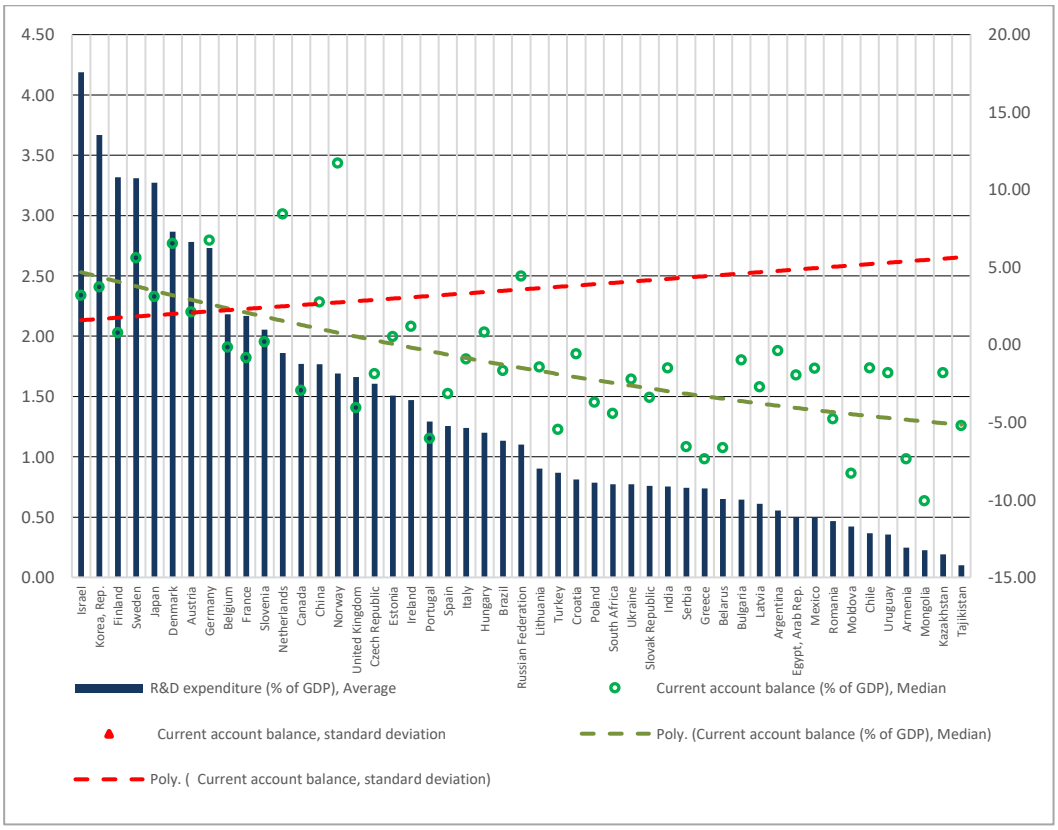

Figure 5.5. Research and development expenditures and the sustainability of the economy for countries. (Source: Authors, own processed data based on World Bank (2018))

As illustrated by the diagrams above, the current account balance dynamic shows a correlation between total R&D expenditure and current account fluctuations. Countries with

median R&D expenditure was less than the world average (about 2% of GDP) in the period between 1996 and 2015. The average current account balance, usually, has greater volatility or was negative.

It can be concluded that Kazakhstan needs to increase investments in R&G, including ICT and especially its digital component, as digital technology is interesting not only as an information- and communication-related process, but as an innovation activity cycle. This cycle requires a whole host of other technologies, as well as infrastructure, and physical and intellectual assets; it should be considered in terms of interaction among all concurrent technological, institutional, and social change (Grübler, 2003). Investment in new technologies with predominantly digital components will decrease the technological digital divide.

Since the emerging outline of the NDE is still unclear, digital inequality (being the difference between those involved in the digital world and those uninvolved) sharpens the inequality between countries that are still stay behind the cutting edge of digital transformation. Although it is still unclear what advantages NDE will give to average users, those who are capable of accumulating, accessing, and analyzing big data would accrue greater advantages (UNCTAD, 2017). Developing, transition and small countries, having no such capabilities, stand on very unfavorable grounds. Digital technology implementation inequality is evident even in Europe, which explores only 12 percent of its digital potential: the UK operates at 17 percent of its digital potential, while Germany, at just 10 percent. The recognized leader in digitalization, US, explores about 18 percent of its potential illustrated as a digital threshold. The Netherlands and other countries are European net digital service exporters[12], while Italy is a net importer. In general, Europe's digital capability is far beyond that of the US, while much of Europe relies on the import of the US technology for its own digital development (McKinsey, 2016).

[12] A net exporter is a sector that contributes to the growth of the economy via the trade balance, and therefore should provide more employment and business opportunities (McKinsey, 2016).

Digital ICT invasion in every NDE aspect and influence on institutional structures and local content policy (LCP) in resource-rich countries such as Kazakhstan puts new requirements on economic cluster structure analysis methods, and the examination of MNEs performance as the principal FDI source. MNEs entering a market effect every business actor, through its technology, including IT, and governmental bodies and agencies in emerging markets have to take measures to enhance the competitiveness of local companies. For this reason, Kazakhstan was the first post-Soviet state to promote the competitiveness of local industry through the National Agency for Development of Local Content (NADLoC)[13], an industrial subcontracting node and quality improvement accelerator for the local IT-focused companies (see Sabirov & Shakulikova, this volume).

The Digital Silk Road

ICT is a broad area affecting every aspect of human activity. However, the NDE it provoked is far from a revolutionary form of economic structure, and digitalization is now not a fundamentally new phenomenon. Information had not changed its role principally since the age of the Great Silk Road when goods and knowledge moved alongside the routes crossing Central Asia and the territory of modern Kazakhstan. The information used within the exchange of goods was crucial for the trade itself and the key decision making by governors. But only electronic computers "made us understand that information is a form of energy, like electricity, and a source of energy for intellectual labor" (Drucker, 1992). The Great Silk Road gave birth to the intensive use of digital information, too. Musa Al-Khwarizmi, a scholar from Central Asia who lived in the 9th century BC modified Indian digits and transformed them into Arabic numerals. Further, he invented algorithms and algebra and these spread inventions across Asia and to many other countries (Arger, 2015). A few centuries later the decimal number system spread across Europe also and achieved the current status.

[13] Since 2018 - Qazaqstan Industry and Export Centre JSC or QAZINDUSTRY.

The beginning of the Digital Era as we see it today can be identified as of July 1948, when The Bell System Technical Journal published *A Mathematical Theory of Communication* written by Claude Shannon (1948). In the article, Shannon presented the modern concept of information, and showed how to measure the indefinite phenomenon of information quantitatively, with absolute accuracy. He demonstrated the essential unity of all information media, pointing out that text, telephone signals, radio waves, pictures, film and every other mode of communication could be encoded in the universal language of binary digits, presenting the idea that information can be transmitted without any error once it becomes digital[14]. The proof of possibility to measure information and its entropy made it possible to combine advances of many sciences that resulted in digital information and communication systems. Therefore, speaking about digitalization, we should remember that digitized information always contains some entropy as understood by Shannon, one of those "who changed the world so that the old one after transformation is neglected" (Gleick, 2011).

Kazakhstan entered The Digital Age in the year of Shannon's article publication (1948) when the Sector of Mathematics and Mechanics was established to join the development of mathematical methods of data processing and transmission. Later, the Sector matured into the Institute of Mathematics and Mechanics, Kazakhstan National Academy of Sciences, and made a fair contribution to the global science and IT progress. The work of world-famous institute members Amerbayev and Akushsky and many others laid the foundation for a computer that was the first to reach the speed of 1 million operations per second in the early 1960s (Malinovsky, 1998). Afterwards, the academic and industry research institutes developed computer modeling in high-energy physics, geophysics, economic management, etc., but the research activities had shrunk by the early 1990s from funding shortages. Consequently, imported ICT products

[14] Waldrop, M. M. (2001). Claude Shannon: Reluctant Father of the Digital Age. Available at: https://www.technologyreview.com/s/401112/claude-shannon-reluctant-father-of-the-digital-age/

conquered the emerging ICT market. Programs which provided necessary automation solutions with minimum adjustment became most popular in Kazakhstan (Pack, 2012).

Nonetheless, the Kazakhstan country-wide innovation system demonstrates its ability to create projects that meet international standards. An example of such a project is the development of digital technology used to model and optimize oil pumping practices in a pipeline section, by integrating the SmartTrans software and the SCADA system.

Private initiatives in a framework of public action encourages restructuring, diversification, and technological dynamism beyond what market forces on their own would generate (Rodrik, 2007). Through appropriate industrial policy, Kazakhstan has made good progress in the development of communication and technologies related to data acquisition, storage, and application. The telecommunication services market has been growing on average

Case study: Smart Oil Transportation Program

KazTransOil, an operator of main pipelines in Kazakhstan in cooperation with leading Kazakh Universities research centers and Kazakhstan National Academy of Science, has used digital technology to model and optimize oil pumping practices in a pipeline section by integrating the SmartTran software and the SCADA (see Table 5.1 below). This system will help the operator to digitize transportation systems in order to solve energy efficiency problems while transporting oil. The program uses real-time data to control and manage oil streams in the pipelines. It is integrated with SCADA and ACEM – another important ICT technology for the O&G industry. The program also uses real-time operational data (process equipment operation modes, oil pumping volumes and parameters, etc.) from SCADA. In addition to KazTransOil, the consumers of the technology are supposed to be the Caspian Pipeline Consortium, the Kazakhstan-China Oil Pipeline, the North-Western Pipeline Company Munaitas and Karachaganak Petroleum Operating B.V. (Astana Times, May 2018). Kazakhstani researchers developed digital technology to optimize "hot" oil pumping, i.e. the movement of heat-transfer oils under high temperature conditions. They have constructed an algorithm for solving the problem of changing temperatures and throughput. For this purpose, the dynamic programming method has been used to find a minimum cost for energy consumed. The "hop" oil pumping process has been investigated by determining the optimal operating conditions for pumps and preheaters (Beysembetov *et al*., 2017).

Such initiatives between the research universities and O&G sectors can become an important part of the New Silk Road project, boosting development of the O&G infrastructure in the Central Asian region. Development of the energy infrastructure in Eurasia meets China's interests in diversification of routes of energy supplies (IENE, n/d).

Table 5.1. The convergence of technologies in the O&G industry.

Technology	Current adoption
Communication: 3rd party data transfer devices, hard-wired connected equipment, radio, wireless, satellites	In the upstream sector, telecommunications infrastructure is extremely limited or absent In the downstream sector, communications are negatively impacted by large metal constructions
Central data and control systems: supervisory control and data acquisition systems (SCADA)	Central data and control system at plants Old technology with many technical barriers still dominates
Historian systems	Transfer cross-functional data into a single centralized location. Built on outdated databases, dependent on the quality of data from other outdated systems
Industrial internet	Companies are replacing older equipment by IoT-enabled smart sensors. This gives O&G companies, much like any other industry, the potential to perform greater analytics and obtain business insights
Security infrastructure and industrial control systems	As the industrial internet becomes more and more embedded in the O&G technology ecosystem, the demand for security infrastructure will grow Security concerns are related to possible impact scenarios in the interconnected ecosystem.
Asset management systems	Nowadays, O&G companies have the opportunity to implement better asset management systems Limitations of these systems can include integration between procurement systems and asset maintenance data, still widely using Excel files stored on individual computers; no integration of this information is available With the installation of IoT-enabled sensors, analytics can help to improve asset performance

Source: Author, adapted from Industrial Internet Consortium (2015).

8 percent annually since 2010; the offer of special telecommunication services, like satellite tracking, satellite terminal control, and Internet access, has also been expanding. Gross investments peaking at 2 billion US dollars in 2012 had shrunk for 4 years thereafter but have been following an upward trend since 2016 due to growing demand for communication services and the need to replace outdated equipment (Shinkeeva, 2018). More than 82 percent of households have access to the Internet. Yet, the technological gap between local and foreign companies is

substantial. Figure 5.6 below shows fluctuations of the Kazakh ICT market. However, large areas and potential capabilities of the country make us believe in the recovery of the market and renewed interest of investors in the future.

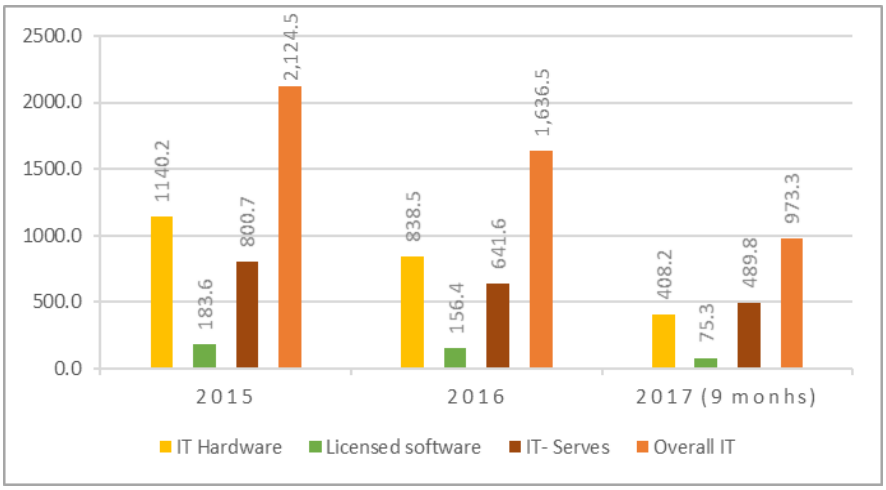

Figure 5.6. ICT expenditures in Kazakhstan, 2015-2017, million US dollars. (Source: Authors, own processed data based on ITK)

Global ICT giants are optimistic about the digital future of Kazakhstan which is illustrated by INSPUR[15], China, intending to create there a supercomputer and cloud cluster, as well as training and study centers and laboratories established by Hewlett-Packard, Cisco, Intel, Konica Minolta, Microsoft (KazNU, 2018).

Digitalization in the financial sector is the key trend worldwide. It will change the ways in which financial institutions operate and will give more opportunities for cross-border cooperation. Far beyond the internet application, fintech companies such as the big data technologies, artificial intelligence, and blockchain are increasingly used in bank, insurance, and other financial institutions. Some experts predict that Kazakhstan's e-commerce market will double to 2 billion

[15] Inspur is a leading global data center and cloud computing solutions provider. Among the world's top three server providers, they deliver and deploy robust, performance-optimized, purpose-built solutions to major data centers around the globe to address important emerging fields and applications. Source: https://www.inspursystems.com

US dollars by 2020. There are three reasons for the high-speed development of e-commerce in Kazakhstan: the rise of internet penetration, convenient payment tool and a lower cost for the goods delivery infrastructure. The key point for cross-border e-commerce cooperation between China and Kazakhstan is the huge requirement of consumer commodities which mainly rely on imports mainly. The high-tech products, daily necessities and light industrial products mostly come from the United States, Germany, Japan, Russia, China, and other countries. The related statistics show that clothing, footwear, sporting goods, and household goods from Russia account for 3-4% of the national e-commerce market, while Kazakhstan accounts for less than 1%.

Case study: Fintech and E-commerce

On April 24, 2018, China CITIC Bank[1] Corporation Limited and Shuangwei Investment Co Ltd[1] bought 60% of the share capital of Altyn Bank JSC from Halyk Bank[1] of Kazakhstan JSC successfully. CITIC Bank acquired 50.1% of the shares and Shuangwei had 9.9%. At the same time, the Kazakhstan shareholder continues to own 40% of Altyn Bank's shares and reserves certain rights in accordance with the shareholder agreement signed between the parties.

The China CITIC Bank ranks 7th in terms of assets in China and is represented in 130 countries. Altyn Bank, formerly known as subsidiary of HSBC Bank Kazakhstan, has been operating in the banking market of Kazakhstan since 1998, was acquired and has been fully owned by the Halyk Bank since November 2014. Altyn Bank, a licensed corporate and retail bank, has branches in Almaty, Astana, Atyrau, Aktau, and AIFC. It also ranks 13th in terms of assets and has the highest credit ratings among commercial banks in Kazakhstan.

This transaction allows Halyk Bank to play a key role in implementing initiatives in the building of the Silk Road Economic Belt. It will promote financial cooperation as well as digitalization. The CITIC bank paid particular attention to fintech area and launched a series of platforms, for example, the digital bank and risk control system based on big data and cloud platform. The CITIC bank has also built China's first blockchain-based Letter of Credit System online.

There are three important parts in Altyn Bank digital promotions. Firstly, the Altyn Bank launched the first full-scale digital bank, the Altyn-I, in Kazakhstan, with a full range of financial services for individuals. All products and processes are transferred online, from accounts and issuing a debit cards, to international currency transfers or receiving an unsecured loan. The Altyn-i MasterCard credit or debit card can be linked to the Apple Pay service using the preinstalled wallet application on the iPhone or other Apple device. Secondly, the strategic alliance between the largest banks of Kazakhstan and China will help the Altyn Bank to expand opportunities in banking technologies, cross-selling, trade finance, treasury operations, payments in RMB, and will also attract key Chinese clients working in Kazakhstan.

The Altyn Bank has joined the Chinese Cross-Border Interbank Payment System (CIPS) as an indirect participant. The system is designed for international settlements in Chinese yuan and allows foreign market participants to make payments in yuan directly to Chinese partners. Major shareholder of the bank, China CITIC Bank Corporation Ltd., being a direct participant of CIPS, provides the indirect participation for Altyn Bank.

(continued)

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Thirdly, combining with its own fintech framework, CITIC Bank will strengthen the sharing of matured technologies such as the payment tools, mobile banking and big data application, and will support the Altyn Bank to expand the business as well as to build the platform. These steps allow the bank to introduce to their customers in Kazakhstan the financial services similar to those offered by China CITIC Bank to its clients in China.

China and Kazakhstan signed the *Memorandum of Understanding on E-commerce Cooperation* between the Ministry of Commerce of the People's Republic of China and the Ministry of National Economy of the Republic of Kazakhstan in 2018. In line with this memorandum, China and Kazakhstan will build up an e-commerce cooperation mechanism in the innovative regulation of customers, preferential tax policy and construction of the infrastructure. The two countries will also jointly boost the cooperation of Silk Road e-commerce, strengthen experience sharing, carry out personnel training and promote the dialogue between government and enterprises. They will support further cooperation of enterprises between the two countries in the e-commerce area and expand cross-border trade of featured products by e-commerce in particular, so as to offer more development opportunities and spaces to SMEs of the two countries, as well as continuously improve trade facilitation and cooperation levels, and further boost sustainable and steady development of bilateral economic and trade relationships. An example of cooperation in this area is a framework agreement on strategic cooperation signed between KTZ Express, a subsidiary of Kazakhstan Railways, and the Chinese companies Huawei and Ili Baitexing Commercial Trading (Sha, 2019). The pact is aimed at the development of cross-border e-commerce using the capabilities of Kazakhstan's logistics infrastructure. It will be based on using the capabilities of the logistic infrastructure of *KTZ Express*, dry port *Altynkol*, SEZ *Khorgos*, port Aktau, transport and logistics centers, and airports.

KTZ Express plans to serve the transit flows arising from China and the EU's courier services, which are expected to attract more than 1 million tons of cargo per year. The transport of commercial packages in transit will be carried out by *KTZ Express*. The two parties also discussed the organization of between four and ten container trains per month.

Policies to improve digital connectivity between the countries in Central Asia have led to Digital Silk Road initiative, first announced in March 2015 in the news release issued by the National Development and Reform Commission, and later in July 2015 at the China-EU Digital Cooperation Roundtable in Brussels. Among proposed plans was the establishment of an Internet community that would facilitate cross-border e-commerce and internet-banking through development of soft infrastructure. However, this is one of the less discussed aspects of the New Silk Road, perhaps because investments in the hardware infrastructure have so far dominated.

According to Ren Xianliang, Vice Minister of the Cyberspace Administration of China, the Digital Silk Road should be undertaken in addition to implementing the *Internet Plus* plan,

whereby everything will be connected to a superfast broadband network (Huanxin, 2015). The Digital Silk Road is meant to give Chinese telecommunication companies access to new markets along the Silk Road. By improving the infrastructure in Central Asian, the initiative offers "mutual benefits" while showcasing Beijing's green economic model (Wu, 2017). In addition to commercial motivations, the new fiber optic Silk Road could also have geopolitical and strategic implications. For landlocked countries such as Kazakhstan, this could mean greater access to international data networks, at a cost averaging a tenth that of satellite communications, and with a bandwidth significantly enhanced by fiber optic technology (Rolland, 2015).

Initiatives of the New Silk Road, including the Digital Silk Road will open new opportunities for international cooperation, including the development of digital technologies. BRI intends to promote global economic growth and has already fueled discussions on globalization and prospective aid in mitigating economic development inequality between emerging and mature economies (ACCA 2017).

Digitalization of the O&G Industry

After the oil price plunge in 2014, the global O&G industry faced the tendency of a long-term low-price environment, with organizations looking beyond short-term tactics and taking a more proactive and strategic approach e.g. digitalization. Now, organizations face a new disruption - new technologies disrupt the existing industry value chains and entirely change the way companies operate in many industries, including O&G. Technological innovation - including the adoption of NDE - along with macroeconomic trends and changing consumer behavior are transforming the way resources are consumed and produced (McKinsey, 2017). Harnessing new technologies is essential in enhancing the operational excellence of the companies in the new O&G market dynamics. They now have opportunities to achieve further efficiencies through adopting new technologies. According to the Cisco report *A new reality for oil & gas* (2015), "integration IT-

OT technologies[16] and business processes has become imperative to boost operational effectiveness and ensure survival".

According to the Industrial Internet Consortium (2015), currently the O&G industry is beginning to experience the convergence of new emerging technologies such as big data, analytics, and intelligence systems, cloud computing and mobile technology, as well as social media (see Table 5.1 below). As a result, the industry is demonstrating higher levels of performance, and optimization that results in a higher return on investments for the O&G companies, leveraging these new technologies. Digitalization has been driven primarily by the emergence of NDE, latest data available for analysis that were previously not possible to capture, real-time data. O&G companies created remote operation centers where transactions with primarily large investments are analyzed, but old technologies still dominate in the O&G ICT architecture.

According to an Accenture survey (2013), O&G companies struggle for complete and timely assessment of the impact of operational decisions on corporate performance. They have started to invest in the new technologies to achieve a higher return on investments, but still much more needs to be done to realize these outcomes. These technology trends are internet of things, mobility, cloud computing, and big data analytics. The examples where analytical technologies can potentially drive better business outcomes are summarized in Table 5.2 below.

To conclude, ICT is a tool that not only constitutes an industry in its own right but which also permeates all sectors of the economy, where it acts to integrate and enable technologies. ICT has a profound impact on society, and its production and use have essential effects on the development of economic, social, and environmental areas (Caperna, 2010). The next section will give an overview of the ICT developmental Programs in Kazakhstan.

[16] Operational technology (OT) – technology, which is used in specific operational processes, such as supply chain, manufacturing, transportation. In the O&G, operational technology is also referred to as industrial control systems (Cisco, 2015).

Table 5.2. The points where analytics can potentially drive better business outcomes in the O&G value chain.

Upstream operations	Downstream operations	Corporate operations
Forecast and production commitment	Optimize integrated value chain	Optimize cash flow to meet planned capital expenditure commitments effectively
Efficiently deliver unconventional plays	Configure the supply chain to enable cost reduction	Enable management of contingent labor
Improve working standards		Measure and manage market risk at a commercial level
Manage equipment supply chain	Measure and manage market risk at commercial and logistics levels	Improve working standards
Execute capital projects to time, budget, and scope	Improve working standards	Execute capital projects to time, budget, and scope

Source: Authors, adapted from Accenture (2013)

Local ICT industry Development

So, what are the limitations of local companies' development in Kazakhstan? According to the "Local content management framework" (2004) – an Agip Kazakhstan North Caspian Operating Company NV, or Agip KCO (since January 2009 - North Caspian Operating Company BV, or NCOC) an internal document – managers of the company see a number of potential barriers related to local development which can be applied to both, the ICT and the O&G industries. First of all, weak domestic skills and/or supplier base - low domestic capacity levels, are insufficient to meet business needs.

The ICT sector in Kazakhstan is currently underdeveloped in comparison with some other emerging economies (see Table 5.3). As a result, the demand for ICT goods is mostly covered by imports, and the share of the LC is exceptionally low for IT equipment. As discussed above, this means future comparative disadvantage for the country when the natural resources will be exhausted. For IT services, often considered to be more local, the share of LC was only 30 percent (Government of Kazakhstan, 2010). In the Program, the Government had set ambitious targets: to achieve a share of LC of 10 percent in equipment and 80 percent in services by 2014. Reaching

these targets required developing the infrastructure, as well as a number of policy changes, including improving the business environment and fostering skills development.

This also assumes development of local ICT capabilities (see Table 5.4 below). The barriers for local development are listed below.

- Lack of appropriate technical skills base in labor force
- Inadequate or outdated equipment
- Weak technology base i.e. limited IT infrastructure
- Lack of understanding of international tender processes
- Insufficient awareness or poor practice on health, safety, and environment (HSE)
- Inadequate knowledge of international commercial practices on HSE
- Inadequate knowledge of international commercial practices, e.g. financing etc.
- Import laws

Table 5.3. The share of ICT goods as a percentage of total merchandise trade in 2012-2018

	2012	2013	2014	2015	2016	2017	2018
Czech Republic	14.53	13.11	13.42	13.54	12.72	13.33	15.10
Hungary	17.45	14.77	11.92	11.62	11.38	11.18	11.34
Kazakhstan	0.44	0.33	0.84	0.19	0.16	0.13	0.11
Russian Federation	0.31	0.42	0.80	0.81	0.60	0.63	0.47
Ukraine	1.10	0.93	0.96	0.82	0.95	0.93	0.98
China	27.06	27.42	25.94	26.56	26.50	27.07	27.31

Source: Authors, adapted from UNCTAD statistics.

This demonstrates that ICT can be a barrier not only in LCD, but also in the competitiveness of Kazakhstan's O&G companies and the whole energy sector. This raises the question as to how

the level of ICT adoption in the energy sector can be effectively increased. The government of Kazakhstan has recognized the importance of technological change disrupting the economy, launching a *Program of Information and Communication Technologies Development in the Republic of Kazakhstan in 2010-2014* (Beisenova, 2010), a Program *Information Kazakhstan – 2020 for 2013-2017 years.* At the end of year 2017 it also launched a Program *Digital Kazakhstan* which aim is to accelerate industrial development in Kazakhstan, and more specifically, the transition of the Republic of Kazakhstan to an information and innovative economy with the formation of a competitive export-oriented national ICT sector.

Table 5.4. Local goods share in ICT technologies in Kazakhstan.

Indicators	2009	2014
Share of Kazakhstani content in overall IT-market	7 percent	Not less than 32 percent
Share of Kazakhstani content in IT services	30 percent	80 percent

Source: Authors, compiled from Government of Kazakhstan (2010), the Program for Development of Information and Communication Technologies in the Republic of Kazakhstan 2010-2014.

Calculations of LC in procurement can be seen in Table 5.5 below.

To implement an integrated state policy in ICT and state management of information and communication infrastructure, a joint stock company called *National ICT Holding Zerde* was established in 2008. According to the information at *Holding Zerde* website, the implementation of the State Program *Digital Kazakhstan* will be in four key areas:

- creating a *Digital Silk Road* including the development of reliable, affordable, high-speed, secure digital infrastructure;
- shaping a *creative society*, including the development of competencies and skills for the digital economy, an upgrading of digital literacy, and training of ICT specialists for industries;

- digital transformation in the economy assuming the widespread introduction of digital technology to enhance the competitiveness of various branches of the economy;
- the formation of *proactive digital government*, including improvement of electronic and mobile government platforms, with optimization of the public services supply sphere.

Table 5.5. Plan of IT procurement for NOC KMG.

Year	Goods, Thousands Tenge	LC, %	Services[17], Thousands Tenge	LC, %	IT programs, Thousands Tenge	LC, %
2015	309,906	1	1,581,034	96	117,354	0
2014	2,189,805	0	1,904,774	93	575,960	0
2013	157,314	0	963,468	84	314,730	0
2012	103,679	1	1,668,169	83	2,260,453	12

Source: Heim (2019)

However, launching all these programs does not in any way guarantee the success of development; time has to pass for results to be visible.

The program requires enhancing skills through the public-private partnership in information technologies (OECD, 2013). As of December 2017, the list of investment programs of the Holding Zerde (2017b) accounted for eight projects including:

- central provision of the IT services for state bodies;
- data processing centers (data centers) in 14 regional centers and in Almaty to provide a set of information services for all government agencies;
- unified notary information system;

[17] Prices are not available for all positions.

- unified service monitoring system;
- a consolidated computing platform for civil defense;
- an information system for technical inspection of motor vehicles;
- single contact center of state bodies of Kazakhstan;
- unified e-mail system of state bodies of Kazakhstan.

The list of public-private partnerships the Holding Zerde has taken part as of December 2017 (Zerde, 2017) includes five projects:

- automation of crop production traceability;
- automation of monitoring of fish and fish products turnover;
- intelligent transport system;
- automation of traceability of farm animals and livestock products;
- smart city.

In September 2017, the Government of Kazakhstan presented the State-initiated Program *Digital Kazakhstan*, and in December 2017 the government developed and presented a detailed plan of the program to the President of Kazakhstan (KazInform, 2017a; 2017b).

ICT procurement also comprises a part of procurement in the O&G industry and therefore is the subject of local LC regulation in the O&G sector. However, these two policies are not synchronized, as LCP in the ICT industry is focused on this sector only, and investments and public-private projects target mostly ICT in the public services domain. However, according to Adewuyi and Oyejide (2012), knowledge-intensive sub-sectors control systems and the ICT sector, feeding into the O&G industry, can also serve other sectors and neighboring countries, creating backward linkages and providing a potential for spillovers. Backward linkages between a company and its suppliers, including the ICT supplier, are generally relatively labor intensive, and thus an attractive source of diversification for governments. These linkages may also increase

GDP, and therefore governments may actively target linkages in their IP in the hope that complementary development of the national system of innovation may result in a competitive, diversified economy in the future (Morris, Kaplinsky & Kaplan, 2011).

Conclusion and Future Research

The New Silk Road concept was recently mentioned by the Chairman of the Security Council of Kazakhstan and former president Nazarbayev in his speech as one of the historical advancements of the country and a platform for the future development of the global exchange of goods and intellectual cooperation between nations (Nazarbayev, 2018; Nabayev, 2019). Kassym-Jomart Tokayev took office as President of Kazakhstan in March 2019, succeeding Nursultan Nazarbayev, who resigned on 19 March 2019 after 29 years in office. The new President admits that the modern technologies play an important role in the world economy and development of Kazakhstan. In September 2019 he met the founder of the Alibaba Group in China. According to Akorda (2019), the official site of the President of Kazakhstan, he said the following: “I appreciate your desire to support Kazakhstan. We have a strategic agreement that cooperation between China and Kazakhstan in the digital economy will be developing further, and we are interested in your engagement”.

The digital economy is a key driver of growth and development; it can boost competitiveness across all sectors, new opportunities for business and entrepreneurial activity, and new avenues for accessing overseas markets and participating in global e-value chains. NDE also provides new tools for tackling persistent development problems. Yet, NDE comes with a host of challenges for policymakers, including the need to bridge the digital divide, minimize potential negative social and development impacts, and deal with complex internet-specific regulatory issues (UNCTAD, 2017). Thus, the role of economic policies in information-based economies will

by no means become less critical in terms of NDE. It is “even more urgently pressing scholars to study all aspects of the way and method people apply to handle information dedicated to improving information systems” (Li & Liu, 2018). For academia it raises the question: do current management conceptual frameworks hold true in the new economy and what needs to be researched? How are the combined effects of digital technologies transform organizations, industries, and institutions? From the strategic perspective how do firms achieve and sustain a competitive advantage in new market conditions? How does the use of digital technology as strategy or complementary resources change the way value is created and extracted?

From the innovation perspective, will digital technologies depend more on open-sourced innovations? While innovations become more global, regulation and institutions still remain local. This also raises the question of how different digital institutions will affect new business models? What will be the role of institutions such as regulations, antitrust and the local legal frameworks in a digital world? Do institutions face new challenges due to the spread of digital technologies? What are the consequences of digitalization for organizational knowledge and learning taking into consideration increasing connectivity and sharing of information and knowledge? How do employees adapt to the new digital business processes? In relation to Central Asia, digitalization comes to the New Silk Road and considering Kazakhstan’s development rate and endowment factors, investments in a Digital Kazakhstan have the potential to become as attractive as the development of the natural resources sector of the economy.

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