Exploring connectivity in landlocked developing countries

The Azerbaijan model of technology leapfrogging

ABOUT THIS REPORT

This report comprises one of three interrelated research projects on ***Exploring Connectivity in Landlocked Developing Countries***, undertaken by the University of Sydney and funded by the International Think Tank for Landlocked Developing Countries (ITT LLDC).

The United Nations Convention on the Law of the Sea (1982) defines a "land-locked State" as one that has "no sea-coast". In line with this, early research into landlocked countries mainly focused on the transport infrastructure required by landlocked countries to gain sea access. More recent studies, however, have highlighted the other complexities associated with landlockedness, including vulnerability to neighboring countries' political and regulatory systems, infrastructure, and peace and order. These can serve as impediments to the ability of landlocked developing countries to establish relevant connections required to foster sustainable economic growth and development.

The business and economic context of landlocked countries continues to remain an underexplored area both in the scholarly and policy literature, and the aim of these three exploratory projects is to investigate different aspects of the connectivity challenges faced by landlocked developing countries.

The ***industry and trade connectivity*** component of the project (led by Dr Sandra Seno-Alday and Dr Yayoi Lagerqvist) raises questions on the relationship between industrial development, domestic economic diversification (driven by foreign direct investment in mining), and the international business and trade activities of Laos. The project explores preliminary insights into how significant foreign direct investment in primary industries is correlated with the diversification of economic activity, the growth of international business, and the integration of a landlocked country into the regional economy.

The ***information and communications technology (ICT) connectivity*** component of the project (led by Dr Barney Tan) explores the role of digital connectivity in supporting business activity, and in promoting regional and international business expansion in one of the most digitally connected landlocked countries, Azerbaijan. The project thus offers preliminary insights into best practices in establishing digital connectivity in a landlocked context, which can be used to aid other landlocked countries in developing more robust digital connectivity networks to support regional and international business activity.

The ***transport connectivity*** component of the project (led by Dr Xiaowen Fu) explores the challenges faced by air transport companies operating in landlocked Central Asia, where businesses incur high operating costs due to severe geographic constraints and barriers within small markets. The project offers insights into the business model innovation required by transport companies to operate effectively and profitably within the landlocked business context. The project further provides guidance on how alternative government policies could promote the growth of the aviation industry. This is an important issue that goes beyond the aviation sector as allowing transport companies to operate profitably and efficiently within landlocked contexts gives other businesses access to robust and cost-effective transport services, which supports regional and international business activity.

The three individual projects correspond to the critical challenges for international business development in landlocked countries: that is, (1) the development of a robust digital infrastructure that allows businesses in landlocked countries access to the international online marketplace; (2) the development of a high quality transport infrastructure (operated by profitable private enterprises) that allows businesses physical access to international markets at competitive cost levels; and (3) the development of strong and diversified domestic industry base that allows businesses to engage in the regional and global economy.

These reports represent outputs of the first research collaboration made possible by the Memorandum of Understanding (MOU) between the University of Sydney and the ITT LLDC, signed in 2015.

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Abbreviations

ASAN	Azerbaijan Service and Assessment Network
GDP	Gross Domestic Product
ICT	Information and Communications Technology
ICT4D	ICT for International Development
ITT LLDC	International Think Tank for Landlocked Developing Countries
ITU	International Telecommunication Union
LLDC	Landlocked Developing Country
NCSC	National Certificate Service Center
TASIM	Trans-Eurasian Information Super Highway
UN-OHRLLS	United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
USAID	US Agency for International Development

Executive Summary

To understand how Information and Communication Technology (ICT) development should be enacted and managed at a Landlocked Developing Country (LLDC), we conducted a case study of Azerbaijan, one of the top LLDCs in the world in terms of ICT connectivity and development. With an in-depth exploration of how Azerbaijan charted the overall direction of ICT development, as well as the specific initiatives implemented in the areas of infrastructure development, e-government, information management and security, business and entrepreneurship and research and education, a framework of Azerbaijan's model of ICT development was then inductively derived. The framework reveals that ICT development in Azerbaijan unfolded as a "stage-skipping" (Lee & Lim, 2001, p. 464) variant of Technology Leapfrogging (Davison, Vogel, Harris, & Jones, 2000). The process of Technology Leapfrogging, in turn, consists of four stages: (1) Psyching, (2) Planting, (3) Propelling and (4) Perpetuating.

The focus, underlying mechanisms and outcomes of each of the four stages are different. **Psyching** is centered on formulating a blueprint for ICT development and is underpinned by the mechanisms of specifying a high-level strategy, and translating the strategy into a concrete action plan. Through these mechanisms, the outcomes of the Psyching stage include providing an indication of the vision and commitment of the government as well as the effective coordination of the various agencies that are participating in ICT development.

Planting, on the other hand, is centered on establishing the foundation of ICT development, which consists of the mechanisms of seeking foreign expertise and taking stock of the existing ICT capabilities that are already available within the country. These mechanisms will lead to the attainment of legitimacy and knowledge transfer, which are crucial to the subsequent implementation of specific ICT initiatives, as well as the identification of capability gaps and existing entities whose capabilities can be repurposed to support a more advanced state of ICT development.

Moving forward, **Propelling** is when the initiatives of ICT development are enacted. This stage is underpinned by the mechanisms of the development of new ICT capabilities, as well as the bricolage of existing ICT capabilities. Both of these mechanisms will address the capability gaps identified in the prior stage, but the latter, in particular, could lead to novel applications of existing ICT capabilities so that potential waste and the costs of ICT development are kept to the minimum.

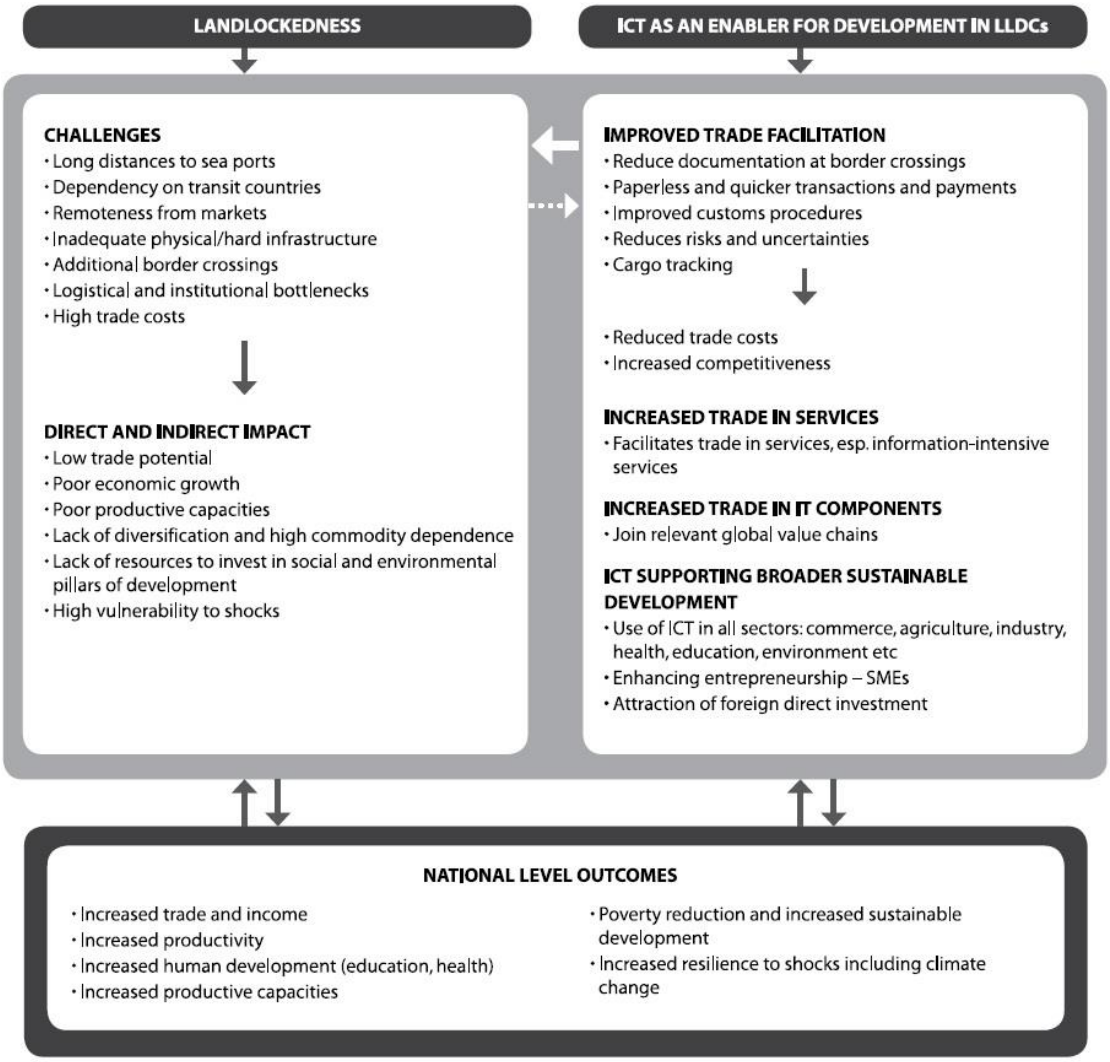
Finally, the focus of **Perpetuating** lies in maintaining the trajectory of ICT development by demonstrating and showcasing ICT achievements, as well as generating returns on investments. Through these mechanisms, a key outcome of the Perpetuating stage is the generation of buy-in and goodwill for future ICT initiatives among the participating agencies. But more importantly, the returns on investment in ICT development can be reinvested in other areas of national priority, so as to achieve a variety of economic and social benefits.

1.0 Background

1.1 ICT Connectivity and Landlockedness

Landlocked Developing Countries (LLDCs) lack territorial access to the sea, which increases transit and transportation costs for goods to limit their ability to participate in global trade, exacerbating their remoteness and isolation from the rest of the world (UN-OHRLLS, 2014). To overcome this challenge, Information and Communications Technology (ICT) development and connectivity are crucial because they enable the communications, interactions and transactions that will allow LLDCs to engage more effectively with world markets (Ojha, 2013). This, in turn, translates to a number of important economic and social benefits (see Figure 1 - ITU, 2014).

Figure 1: The Role of ICT in Enabling Development in LLDCs



Source: ITU (2014)

More specifically, ICT development is especially crucial to LLDCs because it generates economic and social benefits on two levels. Domestically, the local development of ICT infrastructure will drive the growth of the ICT and ICT-related industries to facilitate economic diversification and restructuring (Mbuli, 2003). On the international front, ICT connectivity can enable LLDCs to overcome geographical (i.e. in terms of physical distance) and bureaucratic (i.e. in terms of information transfer) barriers that impair their integration in the global trading system for

products (Arvis, Carruthers, Smith, & Willoughby, 2011). In addition, ICT can generate new opportunities for LLDCs to participate in, and benefit from, international trade through the service sector. For instance, ScanCafe, a leading United States (US) image processing firm is taking advantage of ICT development in Bhutan to establish its base within Bhutan's Thimphu TechPark, creating hundreds of new jobs, including for women, within the country (see Mehta, 2015). These new economic and trade opportunities, in turn, will promote social development through their positive impact on employment, poverty reduction and inclusive development (ITU, 2014).

And yet, the state of ICT development and connectivity across LLDCs is highly varied (Internet Live Stats, 2016). Some LLDCs have a level of connectivity that approaches that of developed countries (e.g. Macedonia & Azerbaijan – estimated Internet penetration rates of 69.2% and 61.1% respectively), while others have a level of connectivity that ranks them among the least developed of all countries (see Figure 2 – Five of the 15 countries with the lowest levels of ICT connectivity, as measured by Internet penetration, are LLDCs).

Figure 2: The 15 Least Developed Countries in terms of ICT Connectivity

#	Country	Internet Users (2016)	Penetration (% of Pop)	Population (2016)	Non-Users (internetless)	Users 1 Year Change (%)	Internet Users 1 Year Change	Population 1 Y Change
185	Eritrea	56,728	1.1 %	5,351,680	5,294,952	4.8 %	2,583	2.37 %
200	Timor-Leste	14,030	1.2 %	1,211,245	1,197,215	3.1 %	416	2.24 %
169	Burundi	167,512	1.5 %	11,552,561	11,385,049	5.1 %	8,133	3.34 %
164	Somalia	192,775	1.7 %	11,079,013	10,886,238	4.6 %	8,519	2.71 %
158	Guinea	236,932	1.8 %	12,947,122	12,710,190	4.7 %	10,688	2.68 %
142	Niger	439,164	2.1 %	20,715,285	20,276,121	6.7 %	27,514	4.1 %
171	Sierra Leone	160,188	2.4 %	6,592,102	6,431,914	6.6 %	9,921	2.15 %
120	Myanmar	1,353,649	2.5 %	54,363,426	53,009,777	6.1 %	77,334	0.87 %
148	Chad	387,063	2.7 %	14,496,739	14,109,676	5.5 %	20,083	3.27 %
178	Guinea-Bissau	66,284	3.5 %	1,888,429	1,822,145	4.1 %	2,586	2.39 %
92	DR Congo	3,101,210	3.9 %	79,722,624	76,621,414	11 %	306,376	3.18 %
79	Ethiopia	4,288,023	4.2 %	101,853,268	97,565,245	13.4 %	506,738	2.48 %
130	Madagascar	1,066,397	4.3 %	24,915,822	23,849,425	7.3 %	72,746	2.81 %
161	Central African Republic	224,432	4.5 %	4,998,493	4,774,061	5.3 %	11,270	2 %
95	Tanzania	2,895,662	5.3 %	55,155,473	52,259,811	5.6 %	153,394	3.15 %

Source: Internet Live Stats (2016)

The large variance in terms of the state of ICT connectivity, as well as the disproportionate number of LLDCs among the least developed nations in terms of ICT connectivity are indicative of a lack of knowledge on the development of ICT infrastructure at LLDCs. This knowledge is important because billions of dollars are cumulatively invested by LLDCs in the development of ICT infrastructure each year (ITU, 2014) and an understanding of how ICT infrastructure should be developed and managed could enable the governments and ICT development authorities of LLDCs to maximize the returns from, while minimizing the risks of, their investments. However, most of the existing ICT development frameworks and theories in the literature tend to be based on research conducted in developed or non-landlocked countries (e.g. Heeks, 2008; Ngwenyama & Morawczynski, 2009), and may be inappropriate or plainly irrelevant given that they do not account for the unique constraints and challenges that confront LLDCs (Lin, Kuo, & Myers, 2015).

The purpose of this project is to address this knowledge gap by conducting a case study of the national ICT infrastructure development journey of Azerbaijan, a country that has attained one of the highest levels of ICT connectivity among LLDCs (Internet Live Stats, 2016). By tracing Azerbaijan's journey from the formulation of its national ICT strategy to the implementation of specific ICT development initiatives, a framework that reveals the nature and drivers of ICT infrastructure development in Azerbaijan will be constructed and presented in this report. In doing so, not only will the project contribute an empirically-grounded, LLDC-specific process

theory of ICT infrastructure development to the ICT for International Development (ICT4D) literature, but the framework can serve as a blueprint for practitioners and policy makers to direct their ICT development efforts as well.

Accordingly, this project seeks to address the following research questions:

- How was ICT development enacted and managed in Azerbaijan?
- How does ICT development bring about economic and social benefits in Azerbaijan?

1.2 The Case of Azerbaijan

Based on the objectives of the project, two conditions formed the basis of case selection. First, the country studied must be a LLDC so that we are able to explore the constraints and challenges presented by this unique context and how they have been overcome. Second, the country selected must have achieved some measure of economic and social development as a result of the impact of ICT. The case of Azerbaijan is particularly appropriate for our study because not only is it the one of the most developed LLDCs in terms of ICT connectivity, but its ICT development initiatives have also led to a number of widely publicized stories of economic success and social inclusion (see Alguliyev & Aliyev, 2015) as well.

Azerbaijan is a LLDC situated in the South Caucasus region, bounded by Russia to the north, the Caspian Sea to the east, Georgia and Armenia to the West and Iran to the south. With a population of approximately 9.8 million and a GDP per capita of US$17,500, Azerbaijan's primary export is oil and ICT development is seen as a primary means of diversifying its economy so as to reduce its dependence on natural resources. As a result of ICT development, it is estimated that the local ICT industry has a current size of US$972 million, and accounts for approximately 2% of its current GDP (Azerbaijan Ministry of Communications and High Technology, 2017a). Azerbaijan is ranked 58th in the world according to the ICT Development Index of the International Telecommunications Union (ITU) in 2016 (ITU, 2016), and 53rd globally according to the Network Readiness Index of the World Economic Forum (World Economic Forum, 2016), which places them ahead of countries such as China, Thailand and Brazil.

ICT Development in Azerbaijan is guided by a national-level ICT strategy formulated by the Office of the President of the Republic of Azerbaijan. The strategy would be translated into a formal state program, and jointly put into action by Azerbaijan's Ministry of Communications and High Technology (**http://www.mincom.gov.az/home**), State Agency for Public Service and Social Innovations (**http://vxsida.gov.az/**), as well as the Special Communication and Information Security State Agency (**http://cert.gov.az/en/index.html**). The national-level ICT strategy and state program of Azerbaijan over the years have led to major infrastructural projects such as the Trans-Eurasian Information (TASIM) Super Highway, the Azerspace Communications Satellite program and the Azerbaijan High Tech Park. These ICT development initiatives have led to a level of connectivity (refer to Table 1) that ranks Azerbaijan among the most advanced LLDCs in the world, making the country a revelatory case (Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012) for the purpose of our study.

1.3 Data Collection and Analysis

Access for data collection was negotiated and granted in September 2016. For this particular study, data collection was staged in two main phases – a preparatory phase and a fieldwork phase. The focus of the preparatory phase was to collect and analyze data from a variety of secondary sources so as to gain an overview of ICT development in Azerbaijan, while the emphasis of the fieldwork phase was to collect data that were specific to our research questions

and explore in depth the various stages of ICT Development that emerged (Pan & Tan, 2011). Interviews formed the primary means of data collection during the fieldwork phase (Myers & Newman, 2007) and a total of 18 informants were identified via chain referral sampling (Biernacki & Waldorf, 1981). The informants consist of key executives and officials from the Ministry of Transport, the Ministry of Communications and High Technology, as well as a number of ICT-enabled organizations and research institutions (refer to Table 2).

Table 1: Core Indicators of ICT Connectivity in Azerbaijan

Core Indicator	2015
Fixed main telephone lines per 100 inhabitants	16
Mobile cellular subscribers per 100 inhabitants	112
Internet users per 100 inhabitants	77
Percentage of population living in areas covered by mobile cellular telephony	100
Use of Next Generation Network technology as a percentage of all communications	40
Internet access tariff (20 hours per month), USD	0.77
Internet access tariff per capita income (monthly), in percentage	0.3
Mobile cellular tariff (100 minutes of use per month), USD	4.07
Relation of mobile cellular tariff to per capita income (monthly), in percentage	1.5

Source: Azerbaijan State Agency for Public Service and Social Innovations (2017)

Table 2: Interviews Conducted

Organization	Interviewees	Topics Discussed
Azerbaijan High Tech Park	3	History of organization, role of organization within the ICT sector, development of organization, resources provided for tech startups
Azerbaijan National Academy of Sciences	2	Role of organization within the ICT sector, ICT research in Azerbaijan, development of ICT capabilities
Azercosmos	1	Role of organization within the ICT sector, history of organization, infrastructural projects developed by organization
Center for Strategic Studies	1	Role of organization within the ICT Sector, ICT research in Azerbaijan
Data Processing Center	3	Role of organization within the ICT sector, History of organization, data security issues, challenges of ICT integration
Ministry of Communications and High Technology	3	Role of Ministry, national ICT strategy of Azerbaijan, infrastructural projects spearheaded by the Ministry, overview of the ICT sector
Ministry of Transport	1	ICT related challenges due to landlockedness, role of Ministry, ICT-enabled projects planned by Ministry
R&D Center for High Technologies	2	ICT research in Azerbaijan, development of ICT capabilities, research priorities of the center
State Agency for Public Service and Social Innovations	2	National ICT strategy of Azerbaijan, development of e-government, development of ICT capabilities, learning from developed countries

Each interview was conducted with the help of a semi-structured interview guide (Myers & Newman, 2007) that had a set of standard questions with respect to ICT development in Azerbaijan, the interactions and initiatives of the various entities within the ICT sector, as well as the economic and social outcomes that resulted from the initiatives. There were also specific questions for each informant that were tailored based on the specific events, activities, or decisions in which the informant directly participated in (Pan & Tan, 2011). Each interview took an average of about 60 minutes, was digitally recorded and subsequently transcribed for data analysis.

Data analysis was performed concurrently with data collection to take full advantage of the flexibility that the case research method affords (Eisenhardt, 1989). From our review of the secondary data sources and the ICT4D literature, we arrived at a set of themes and subthemes that served as an initial theoretical lens to guide data collection during interviews (Strauss & Corbin, 1998). These themes and subthemes included the drivers and challenges of ICT development, the initiatives and capabilities that are typically developed in the context of developing countries, as well as the economic and social impact of ICT. The data collected was then coded using a combination of open (to identify new, and validate existing, themes), axial (to identify new, and validate existing, subthemes), and selective coding (i.e., to assign case evidence to themes and subthemes – see Strauss & Corbin, 1998).

The visual mapping and narrative strategies (see Langley, 1999) were also used to organize our data. The visual mapping strategy entailed documenting the key milestones in ICT development in Azerbaijan for our period of study in a diagram, while the narrative strategy involved creating a summary of the key events, activities and decisions that transpired. Both the visual map and narrative were subsequently verified with some of our informants to validate our interpretation of what happened. This process of iterating between data, analysis and theory development (Eisenhardt, 1989) continued until the state of theoretical saturation is reached, where it was possible to explain our findings comprehensively and any additional data collected yielded no further insights, and merely overlapped with the findings that have already been uncovered (Glaser & Strauss, 1967).

2.0 ICT Development in Azerbaijan

2.1 Charting the Overall Direction

ICT Development in Azerbaijan begins with the formulation of a **National ICT Strategy** by the Office of the President of the Republic of Azerbaijan. The current strategy is named the "National Strategy for Information Society Development in Azerbaijan" that will be in place for the period between 2014 and 2020. It was preceded by Azerbaijan's inaugural National ICT Strategy that spanned the period between 2003-2012. The Chief Advisor for Science, Technology and Information Society Development at the Azerbaijan Ministry of Communications and High Technology explained the role of the National ICT Strategy in driving ICT development:

"The main purpose of the Strategy is (in) forming innovative, competitive and export-directed ICT potential, to make Azerbaijan the center of regional information services. The strategy focuses on the development of the space industry, the exploitation of satellite technologies, creating opportunities for people to benefit from available products and services and increasing their knowledge and skills in ICT… The development of "e-government" and organized usage of e-services at all levels of state management (are also an integral part of the strategy)."

The need for a National ICT Strategy is driven by a number of factors, including the growing potential of ICT in generating economic and social benefits, satisfying the increasing demand for ICT products and services, and bridging the digital divide. The National ICT Strategy, in turn, consists of a wide-ranging array of objectives, such as the modernization of the national ICT

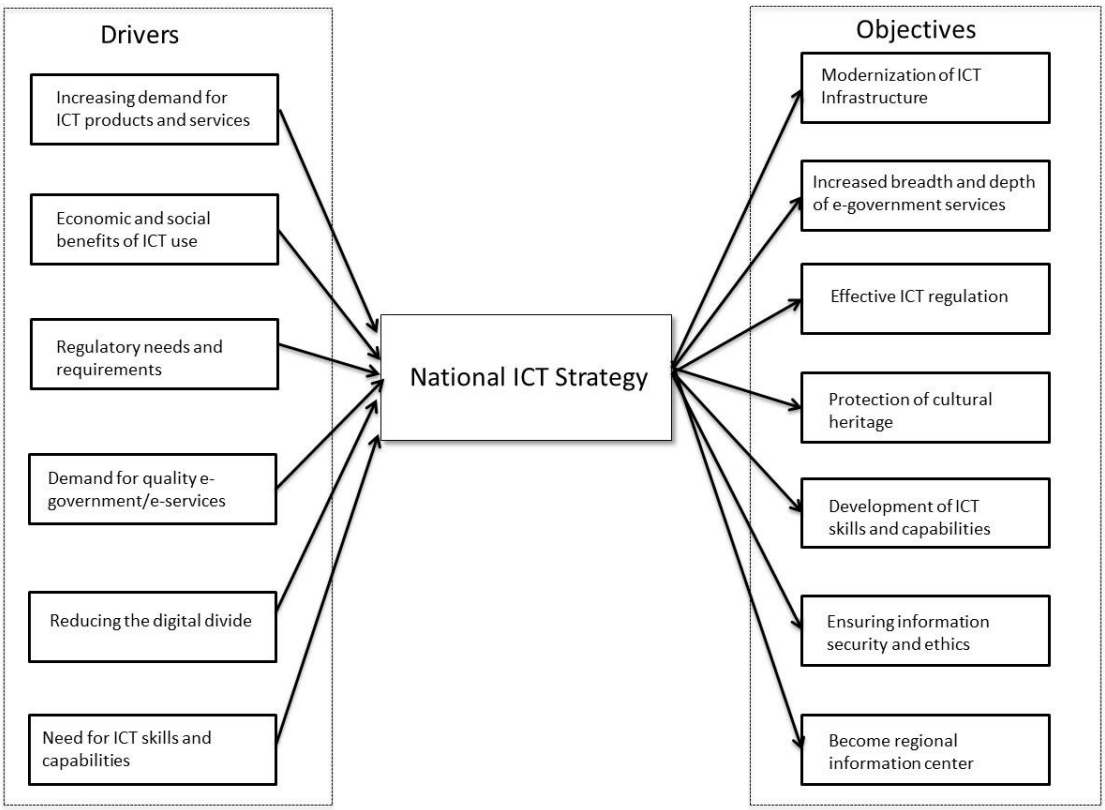
infrastructure, the expansion of e-government services, the protection of Azerbaijan's cultural heritage, as well as the development of skills and capabilities within the ICT sector (refer to Figure 3).

The National ICT Strategy of Azerbaijan are associated with a number of traits that enhances its effectiveness. First, as the strategy is approved personally by the President in his capacity as the Head of State and Government, the strategy is not only a blueprint, but a directive for all the ministries and public agencies that signals the commitment and will of the Azerbaijani government.

Second, it encompasses strategic priorities that correspond with a full spectrum of ICT-related developmental areas, including e-government, infrastructure development, as well as education and training. This ensures that the ICT development efforts of the Azerbaijani government are expansive and holistic in nature, and the various aspects of ICT development that tend to be connected and interdependent (e.g. ICT infrastructure will influence the quality of e-government services - see West, 2004) are systematically accounted for.

Third, the National ICT Strategy is aligned with the broader developmental aims of the country, so that ICT development is not enacted for its own sake, but to facilitate the attainment of a number of higher-order socioeconomic objectives. In Azerbaijan, these aims are manifested in the in the "Azerbaijan 2020 – Vision of the Future" concept, which was confirmed by the decree of the President of Azerbaijan in 2012, two years before the formulation of the National ICT strategy.

Figure 3: The Drivers and Objectives of Azerbaijan's National ICT Strategy



Source: Azerbaijan Ministry of Communications and High Technology (2014)

And yet, while the National ICT Strategy is intended for charting the broader direction for ICT development, it is inherently an abstract vision that cannot provide concrete guidance for action. Consequently, in order to carry the National ICT Strategy to fruition, the strategy is translated into a series of **State Programs** that are spearheaded by the Azerbaijan Ministry of

Communications and High Technology and led by a Coordination Council consisting of representatives of the relevant public agencies that have oversight of the various ICT developmental areas (e.g. e-government development is under the purview of the Azerbaijan State Agency for Public Service and Social Innovations). One of the State Programs that have been confirmed for the implementation of the current National ICT Strategy will be effective from 2016 to 2020. The Chief Advisor for Science, Technology and Information Society Development at the Azerbaijan Ministry of Communications and High Technology described this State Program:

"The State Program on Implementation of National Strategy for Development of Information Society in the Republic of Azerbaijan was adopted on September 20, 2016 by the decree of the President of Azerbaijan Republic. (The program will) implement specific activities on 7 directions, out of the 8 determined by the National ICT Strategy."

The State Program is described in a detailed plan that consists of specific action items in the form of activities, outcomes and deliverables, as well as the agency responsible for implementation and expected duration of each item. The plan would also provide details on how the various action items would be funded and resourced. By systematically specifying the initiatives to be implemented, the scope of ICT development is made clear, and by delegating responsibility for the initiatives, the plan provides the basis for coordinating the efforts of the relevant public agencies to achieve the objectives laid out in the National ICT Strategy in a collective and synergistic manner.

National ICT Development in Azerbaijan is particularly centered on five areas: (1) Infrastructure Development, (2) e-Government, (3) Information Management and Security, (4) Business and Entrepreneurship, and (5) Research and Education. The following stream of reporting will describe the achievements and specific initiatives implemented by the Azerbaijan government in relation to each of these areas.

2.2 Infrastructure Development

The government of Azerbaijan is keenly aware that the attainment of the objectives of its National ICT Strategy is contingent on the development of a state-of-the-art, reliable and effective ICT infrastructure. As such, Infrastructure Development has always been one of the government's key strategic priorities that would provide the foundation for the other initiatives of the National ICT Strategy.

Historically, Azerbaijan was the first country among the Commonwealth of Independent States (CIS) with a fully electronized fixed telephone network that extends to all households (Azerbaijan Ministry of Communications and High Technology, 2014). Three mobile operators currently provide 3G/4G services across the country and mobile coverage has reached 100% of population with an estimated 112 mobile subscribers per 100 people (Azerbaijan Ministry of Communications and High Technology, 2017a). Internet penetration is reported at 77% (61.1% according to Internet Live Stats, 2016), of which 72% are Broadband Internet users. The rate of Infrastructure Development is particularly evident from the growth in capacity of international Internet channels, which increased eight-fold over the last 4 years to reach 500 Gb/s.

One of the defining milestones in the development of ICT infrastructure in Azerbaijan, in particular, stems from the State Program on Establishment and Development of **Space Industry** in the Republic of Azerbaijan that was approved in 2009, which led to the launch of Azerspace-1, the country's first communications satellite, in February 2013. Built by Orbital Sciences Corporation from the US, and launched by Arianespace from France, the satellite is currently operated by Azercosmos (refer to Figure 4), a local state-run firm and currently carries over carries 13 and 128 mostly free-to-air radio stations and television channels respectively, in addition to the services it provides to the Azerbaijani government (de Selding, 2014). Since the

launch of Azerspace-1, Azercosmos has also taken over the operations of a high resolution optical Earth observation satellite named Azersky in 2014, incorporating earth observation and geo-information services into its suite of offerings. The Director of Satellite and Ground-Based Systems at Azercosmos described the capabilities of its satellite fleet:

Another initiative that provides a clear indication of the scale and ambition of ICT infrastructure development in Azerbaijan is the ongoing **TASIM project** (Azerbaijan Ministry of Communications and High Technology, 2017b). The TASIM project, aimed at establishing technology leadership across Central Asia, is a mega project aimed at improving connectivity in the region by establishing new fiber-optic telecommunications transit routes between Asia (i.e. Hong Kong) and Europe (i.e. Frankfurt). The planned transit route will pass through China, Kazakhstan, Azerbaijan, Georgia, Turkey, before reaching Germany via the countries of Eastern Europe. An alternative northern route that passes through Poland, Ukraine and Russia is also currently being considered (refer to Figure 5). An Adviser at the Department of International Cooperation of the Azerbaijan Ministry of Communications and High Technology described the objectives and expected benefits of the TASIM project:

"The main objective of the project is to establish a new fiber optics (pipeline) to Europe and Asia, and the route will start from Frankfurt, which is the major transit center in Europe, and will connect with Hong Kong, which is one of the major transit centers in Asia. What we are expecting from this project is to improve the regional connectivity, reducing digital divide, contribution to network technologies, and contribution to the digital innovation."

Figure 4: Operations at the Azercosmos Ground Control Station

Source: http://azercosmos.az/

The TASIM project will be operated by the multi-national TASIM Future Consortium that consists of AzInTelecom from Azerbaijan, China Telecom from China, Kaztranscom from Kazakhstan, Rostelecom from Russia and Turk Telekom (represented by PanTel). The members of the consortium were selected on the basis of their interest, the resources owned, and the support they enjoy from their respective governments (Azerbaijan Ministry of Communications and High Technology, 2017b).

Prior to the commencement of the project, the US management consulting firm Booz Allen Hamilton was engaged to conduct two rounds of feasibility studies – the first round centered on

establishing a business case for the TASIM project for the Azerbaijan government, while the second was focused on building a business case for potential consortium partners. Subsequently, the TASIM project is planned to unfold across two stages – the first stage will entail the construction of the Transit Backbone by the TASIM Consortium, while the second will be centered on the implementation of a number of linked regional connectivity development projects. When completed, the TASIM project is expected to generate a number of economic and social benefits, such as improving regional and global connectivity, enhancing disaster resiliency, bridging the digital divide (particularly among the Central Asian and Easter European countries that will be hosting the TASIM infrastructure), and most importantly, promote regional innovation and modernization.

Figure 5: Planned Network Routes of the TASIM Project

Source: Azerbaijan Ministry of Communications and High Technology (2017b)

2.3 e-Government

A second strategic priority of the current National ICT Strategy of Azerbaijan lies in the area of e-government, with the overall objective of achieving an *"increase of efficiency, provision of accountability and transparency, increase of quality and use of e-services by application of modern ICT in public administration, as well as creation for suitable conditions for participation of citizens…"* (Azerbaijan Ministry of Communications and High Technology, 2014, p. 51).

The e-Government journey of Azerbaijan began over 10 years ago, initiated by the inaugural National ICT Strategy that was in place from 2003 to 2012, which resulted in the launch of the **E-Azerbaijan** state program in 2005. There have been three successive iterations of the E-Azerbaijan program since its inception, with the first in place till 2008, the second from 2008 to 2010, and third from 2010 to 2012. The E-Azerbaijan program was eventually superseded by the State Program for the Expansion of Electronic Services in Public Administration and Development of e-Government that was launched in response to the current National ICT Strategy. This new state program will be in place from 2016 to 2018.

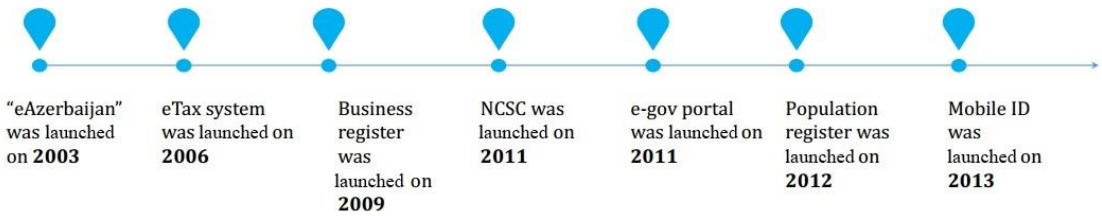
The major e-government initiatives that were launched as a result of the successive state programs over the years include an eTax system, the National Certificate Service Center (NCSC – which issues and manages a registry of electronic signatures for public authorities, citizens and business entities), an integrated online portal and a population register (refer to Figure 6). The timing of the launch of these initiatives was dependent on the availability of supporting ICT infrastructure and services (e.g. a mobile portal was developed with the needs of younger citizens in mind but this was only possible after 2013 with increasing smartphone penetration). According to a survey sponsored by the US Agency for International Development (USAID)

conducted in 2016, there are currently 122 electronic services offered by 18 different public agencies over the various service channels in Azerbaijan (Muradov, 2016).

But moving forward, the State Agency for Public Service and Social Innovations, which oversees e-government initiatives in Azerbaijan, has a clear trajectory for e-government development in mind. This is because they have modelled their developmental efforts after those of the government of Estonia, and have even actively consulted with their Estonian counterparts to leverage their knowledge and experience. A Senior Advisor from the State Agency for Public Service and Social Innovations explained:

"We learn from Estonia… (Learning from) The Estonian model (with its emphasis on integration and one-stop convenience) is especially useful in helping us think about integrating our existing databases… They (Estonian e-government practitioners) are usually happy to share what they know"

Figure 6: Major e-Government Initiatives in Azerbaijan



Source: Azerbaijan State Agency for Public Service and Social Innovations (2017)

To complement e-government development, the State Agency for Public Service and Social Innovations has also established a number of Azerbaijan Service and Assessment Network (ASAN – which means "easy in Azerbaijani) Service Centers (refer to Figure 7) all across the country. The service centers are based on a "single space" philosophy that provides one-stop convenience for Azerbaijani citizens. Around 10 government agencies and 30 private organizations (including banks, travel agencies, and insurance companies) would offer over 230 services in a Public-Private Partnership arrangement at a single ASAN service center. The services provided include the issuance and renewal of passports, driver licenses and identity cards; birth, death marriage and military registration, as well as notary and customs services (Azerbaijan State Agency for Public Service and Social Innovations, 2016).

Figure 7: ASAN Service Center

2.4 Information Management and Security

Related to its emphasis on e-government development, a third strategic priority of ICT development in Azerbaijan is centered on Information Management and Security. Tasked with ensuring the security of the country's information environment, increasing confidence in the use of ICT, and developing a normative legal basis to regulate the ICT sector (Azerbaijan Ministry of Communications and High Technology, 2014), there are two public organizations in Azerbaijan, in particular, that play a key role in this area. The first is the Special Communication and Information Security State Agency, whose primary responsibilities include managing network connections between government organizations and interagency electronic document circulation (Azerbaijan State Agency for Public Service and Social Innovations, 2017). The second is the **Data Processing Center**, which is under the purview of the Azerbaijan Ministry of Communications and High Technology.

The Data Processing Center was first established as the "Republican Information Computing Center" in 1973 and has an operational history of over 40 years. Renamed as the Data Processing Center in 1999, the organization was initially only responsible for managing a number of simple billing systems as well as the personal data of the citizens of Azerbaijan, but its role has expanded gradually with ICT Development over the years to the extent that it is today the main technology arm of the Azerbaijan Ministry of Communications and High Technology. Its current role includes managing AzDataCom, a data transfer network that spans the entire country, managing the NCSC and maintaining the public key infrastructure, as well as administering the nationwide e-Signature (i.e. electronic identification and authentication) program (Data Processing Center, 2017). The Head of the NCSC described the evolving role of the Data Processing Center:

"In 1973, the Center began its work with computer technology, which was primitive at the time and the equipment was imported from the Soviet Union… Our role evolved over the years and today we are the main technology department of the Ministry of Communications and High Technology… The transformation did not happen all at once. We have (acquired) the technology specialists and our obligations (to the Ministry) grew over time"

Under the first National ICT Strategy from 2003 and 2013, the primary responsibility of the Data Processing Center was on establishing the ICT infrastructure to support the operations of the various government agencies. With a modern ICT infrastructure now in place, the focus of the Data Processing Center has shifted to leveraging the infrastructure to develop cutting edge applications with the aim of enhancing operational effectiveness across the Azerbaijani public sector. Some of the latest projects of the Data Processing Center, for example, include the provision of electronic notary services, developing and managing systems that support Azerbaijan's next generation Identity Cards, as well as expanding its role in identification and authentication to assume the role of the National Crypto-Provider.

2.5 Business and Entrepreneurship

A fourth strategic priority of ICT development in Azerbaijan lies in the area of fostering ICT-related businesses and entrepreneurship, which the government sees as key to becoming a technology leader within the region, unlocking the economic potential of ICT and diversifying from its oil-based economy. Toward this goal, one of the key initiatives implemented was the establishment of the **Azerbaijan High Tech Park**, which is meant as a hub for high tech firms, Research and Development (R&D) centers, and clean production facilities that will eventually foster the transition of Azerbaijan from an oil-based economy to a knowledge-based economy.

In support of the High Tech Park, the Azerbaijan government has granted 50 hectares of land for its use at Pirallahi Island, a site that is conveniently located just next to Baku, the capital of Azerbaijan (refer to Figure 8). Within the High Tech Park, there would be facilities such as office and commercial spaces, conference and exhibition centers, and even a three-star hotel to create an atmosphere of a vibrant township. One of the main features of the High Tech Park, in

particular, is its incubation center which will provide resources and training for aspiring entrepreneurs to foster the emergence and growth of high-tech startups (Azerbaijan High Tech Park, 2017). The Deputy CEO of the Azerbaijan High Tech Park described the resources that are made available to startups and businesses:

"We provide plenty of resources to our applicants. First, we provide offices and open spaces. Second, we offer them networking opportunities. Since we have a lot of investors, our start-ups applicants can participate in business conferences and exhibitions, which are organized by the Ministry or our park, to network with the investors. Furthermore, we invite mentors and business trainers from overseas to provide training to applicants. More importantly, seed funding will be provided as well, but the amount varies, depending on the availability of government funding. Lastly, we provide concessional loans to big businesses"

The High Tech Park is an important means for the Azerbaijan government to generate returns from its investments in ICT. Leveraging its advanced state of ICT development, there are already over 75 startups housed at its incubation center whose businesses range from online food ordering, social media monitoring, bonus and cashback schemes, and online payment. Beyond attracting high potential businesses as tenants, the High Tech Park is looking to target investors, venture capitalists and real estate developers as well. The park is aiming to gradually reduce its dependency on government funding to become profitable and self-sustaining in the long term.

Figure 8: Facilities and Services of the Azerbaijan High Tech Park

Source: Azerbaijan High Tech Park (2017)

2.6 Research and Education

A fifth strategic priority of the current National ICT Strategy of Azerbaijan is ICT Research and Education, which aims to train ICT professionals to meet the growing and changing demands of the industry and strengthen the relationship between academia and industry to foster the generation and dissemination of new ICT knowledge and applications (Azerbaijan Ministry of Communications and High Technology, 2014). To this end, the Azerbaijan government has established a number of research and academic institutions such as the Center of Strategic Studies, ADA University and the Research and Development Center for High Technologies. Established institutions, such as the **Information Technology Institute** of the Azerbaijan National

Academy of Sciences, are also leveraged for an expanded role in the national development of ICT skills and capabilities as well.

These institutions have varying roles in fostering ICT research and education. Some institutions would serve as the focal point for scientific ICT research (e.g. Center of Strategic Studies and the Information Technology Institute). Others would provide degree programs to equip students with the skills and knowledge that are required for the ICT industry (e.g. ADA University), or provide a conducive environment for applied research that translates technology know-how into real world applications (e.g. Research and Development Center for High Technologies). But collectively, these institutions are key to channeling the resources invested by the Azerbaijan government into generating innovations and unlocking the business and social potential of ICT. The Director of the Information Technology Institute within the Azerbaijan National Academy of Sciences explained:

"All innovations are based on think tanks like our institution! The support we receive from the state will drive our ideology of information globalization within the next two years… As they say, it is all about turning 'black gold' into 'human gold' (using the resources generated by Azerbaijan's oil sector to promote the development of the services sector)"

The development of ICT knowledge and skills through research and education is especially important to overall ICT development in the context of Azerbaijan. This is because even though many ICT initiatives in the country tend to be implemented with the help of foreign experts (e.g. e-government development and the TASIM project), it is generally the local ICT professionals who would be responsible for the management and use of the systems and applications that have been established due to factors such as the challenges of retaining foreign talent or security concerns. The Head of the New Technologies Department of the Data Processing Center provided an illustration:

"Foreign consulting firms have been hired in the past to help or provide recommendations for systems implementation… We also have our Information Security audited by SGS, a Swiss firm. But the operations of our systems are never outsourced… Foreign experts will never come into direct contact with our data"

3.0 Technology "Leapfrogging"

3.1 A Framework for Technology Leapfrogging

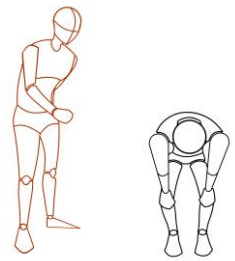
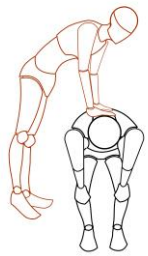
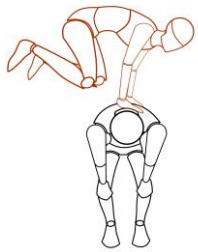
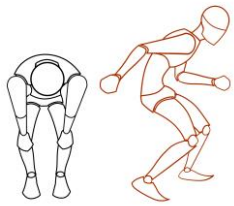
Based on the findings from our case study, the process of ICT development in Azerbaijan appears to be aligned with the concept of Technology Leapfrogging, which is defined as the implementation of a new and up-to-date technology in an application area in which at least the previous version of that technology has not been deployed (Davison et al., 2000). More specifically, patterns of "stage-skipping" (Lee & Lim, 2001, p. 464) are evident over many aspects of Azerbaijan's national ICT implementation journey. One example in relation to Infrastructure Development is the TASIM project, which is based on cutting edge fiber optic technology. The scale and sophistication of the TASIM project appear to be more in line with the needs of a developed country and at least a generation ahead of Azerbaijan's current state, as well as many of the countries it will affect and benefit.

Another example lies in the trajectory of its e-government development. The classic conceptualization of e-government development sees the process as one that consists of four sequential stages (see Layne & Lee, 2001): (1) Catalogue – delivering static or basic information, (2) Transaction – enabling simple online transactions, (3) Vertical Integration – Integrating government functions at different levels, and (4) Horizontal Integration – Integrating different

functions from different agencies. However, by learning from the Estonian model of e-government, it is clear that Azerbaijan has already achieved Horizontal Integration before the Transaction stage has been fully completed (see Muradov, 2016).

By integrating the findings from our study of the various ICT initiatives developed, a framework that depicts the process of Technology Leapfrogging in Azerbaijan can be inductively derived (refer to Figure 9). More specifically, our case data reveals that the process of Technology Leapfrogging is analogous to the mechanics of a physical leapfrog, and traverses across four stages: (1) Psyching, (2) Planting, (3) Propelling, and (4) Perpetuating. In the following subsections, we will delve into the specifics of our framework to explain the underlying mechanisms, as well as the outcomes achieved, in each of the four stages.

Figure 9: The Four Ps Framework of Technology Leapfrogging

Stage 1: Psyching	Stage 2: Planting	Stage 3: Propelling	Stage 4: Perpetuating
			
Focus: Formulating a blueprint for ICT development	**Focus:** Establishing the foundation for ICT development	**Focus:** Enacting the initiatives of ICT development	**Focus:** Maintaining the trajectory of ICT development
Mechanisms: - Specifying a high-level strategy - Translating the strategy into a concrete action plan	**Mechanisms:** - Seeking foreign expertise - Taking stock of existing ICT capabilities	**Mechanisms:** - Developing new ICT capabilities - Bricolage of existing ICT capabilities	**Mechanisms:** - Demonstrating and showcasing ICT achievements - Generating returns on investments
Outcomes: - Indication of vision and commitment - Effective coordination of the participating agencies	**Outcomes:** - Achieving legitimacy and knowledge transfer - Identifying capability gaps and existing entities whose capabilities can be repurposed	**Outcomes:** - Addressing capability gaps - Reducing the costs and minimizing waste through novel applications of existing capabilities	**Outcomes:** - Generating buy-in and goodwill for future ICT initiatives - Leveraging ICT development for socioeconomic benefits

3.2 Stage 1: Psyching

Our findings suggest that Technology Leapfrogging, as it unfolded in Azerbaijan, begins with a Psyching stage that is centered on formulating a **blueprint** for ICT development. Moreover, the Psyching stage is underpinned by two underlying mechanisms: (1) Specifying a high-level strategy that delineates the scope, objectives, strategic priorities and expected outcomes of ICT development, and (2) the development of an action plan to translate the strategy into specific activities, outcomes and deliverables.

In Azerbaijan, the high-level strategy is manifested in its National ICT Strategy, while the action plan takes the form of its various State Programs. Formulating a blueprint on two levels is a common practice in national ICT development, even at developed countries. Singapore, for instance, also develops a high-level strategy in the form of its "National Infocomm Plans" and action plans in the form of its "Government Infocomm Plans" (see Tan, Pan, & Cha, 2013).

In addition, it should be noted that there is a span of time between the formulation of the National ICT Strategy and the various State Programs in the case of Azerbaijan. This is because the process of breaking down the high-level strategy to more concrete action plans require careful planning and mapping. This serves to minimize risks and reduce potential waste, which would be especially important for LLDCs and other developing countries due to resource constraints, but will inevitably take time (Gichoya, 2005).

The Psyching stage is the crucial first step of Technology Leapfrogging and National ICT Development because its underlying mechanisms leads to two important outcomes that will pave the way for the stages to come. The first outcome is that the development of the high-level strategy and action plans provides a clear indication of the government's vision and commitment, which previous scholars have described as a fundamental principle of ICT4D (see Unwin, 2009). The second outcome is the effective coordination of government agencies that are participating in ICT development. This is because the high-level strategy will define the government's collective goals, and by delegating responsibility through the action plans, it will ensure that the disparate public agencies would be able to effectively pool their resources and capabilities to fulfill those goals (Gil-Garcia, 2012).

3.3 Stage 2: Planting

Following the Psyching stage, our framework suggests that the process of Technology Leapfrogging moves into the Planting stage. Akin to planting one's hands firmly on the back of a partner to create a firm base for leapfrogging, the focus of the Planting stage is on establishing a **foundation** for ICT development, which manifests through the workings of two underlying mechanisms: (1) Seeking foreign expertise, particularly from developed countries, to leverage the knowledge and experience of those who are more advanced in ICT development, and (2) identifying capability gaps that must be addressed, as well as existing agencies whose capabilities can be repurposed subsequently.

In our case study, instances of seeking of foreign expertise were evident across a variety of ICT initiatives. Among others, these include the construction and launch of Azerspace-1, the conduct of feasibility studies as part of the TASIM project, as well as the development of electronic public services based on the Estonian model of e-government. It should be noted, however, that the involvement of foreign experts in all of these instances tended to be only in the earlier stages of implementation. This could be due to the fact that it may prove difficult to retain foreign talent for an extended period of time, especially for a resource constrained LLDC (Kuptsch, 2006). Another reason is the potential security concerns surrounding public ICT initiatives. The heightened risk exposure may be deemed to be unacceptable to the implementing organization, particularly if it relates to critical infrastructure or sensitive information (Khalfan, 2004).

Taking stock of existing ICT capabilities is another mechanism that is crucial to the Planting stage in Azerbaijan. The evolving role of the Data Processing Center, in particular, is an illustration of the workings of this underlying mechanism. When the Azerbaijan government was developing its e-signature project, it understood that new authentication protocols had to be put in place (i.e. a capability gap). As the Data Processing Center was historically the agency that manages the personal data of Azerbaijani citizens, and as an organization that was already technology-centric, it was identified as the ideal agency to lead the e-signature initiative. This underlying mechanism is important to the Planting stage because it generates an understanding of the ICT capabilities that are already available, which enables the "*planned reconfiguration of existing*

operational capabilities" (Pavlou & El Sawy, 2010, p. 443) for subsequent innovation and development.

The Planting stage should immediately follow the Psyching stage because its underlying mechanisms would generate two important outcomes that will serve as the foundation for the actual implementation of ICT initiatives. The first outcome is the attainment of legitimacy and knowledge transfer through the seeking of foreign expertise, which will increase the confidence in, as well as the likelihood of success of, the ICT implementation process (Ko, Kirsch, & King, 2005). The second outcome is the identification of capability gaps and existing entities whose capabilities can be repurposed through taking stock of its current ICT capabilities. This may be especially crucial to a resource constraint LLDC because it will reveal if investments are required for the acquisition of new resources and capabilities, or if it is possible to simply "make do" with the existing resources at hand (Baker & Nelson, 2005).

3.4 Stage 3: Propelling

From the Planting stage, the process of Technology Leapfrogging enters the Propelling stage, which is analogous to making the actual leap in leapfrogging. The Propelling stage is when the **initiatives** of ICT development are enacted, and as with any other form of innovation, it can manifest in the form of two mechanisms: (1) The development of new ICT capabilities, or the (2) bricolage of existing ICT capabilities (Fisher, 2012).

With the identification of capability gaps in the Planting stage, there may be some gaps that cannot be filled even with the reconfiguration of existing resources and capabilities. For example, in our case study, the high speed connectivity envisioned as part of the TASIM project requires a new fiber optic network to be put in place and cannot simply leverage the existing ICT infrastructure. As such, new ICT capabilities will have to be acquired or developed through a mechanism that some have termed "resource-seeking" (Baker & Nelson, 2005, p. 331). The main advantage of the development of new ICT capabilities is that the capabilities developed would be tailored to purpose and would likely fulfil the requirements of ICT development more fully. A key disadvantage, however, would be the time and costs that would have to be expended in order to develop those capabilities (Andrews, Pritchett, & Woolcock, 2013).

Conversely, if entities who already possess capabilities that can be repurposed to address the identified capability gaps can be found, then the enactment of the initiatives of ICT development can occur through a mechanism called bricolage, defined as the act of "making do" by applying combinations of the resources at hand to new problems and opportunities (Baker, Miner, & Eesley, 2003). Many instances of bricolage can be found in the case of Azerbaijan, including the expanded role of the Information Technology Institute in ICT research and education, the evolving role of the Data Processing Center, as well as the repurposing of land on Pirallahi Island for the establishment of the Azerbaijan High Tech Park. Bricolage tends to be a quicker and less costly means of ICT development (Ciborra, 1996), which may be especially attractive for resource constrained LLDCs. However, some researchers have warned that habitually turning to bricolage to solve new problems could isolate the implementing organization from new environmental opportunities and inhibit learning. It may also discourage the creation of new objectives and routines that provide fresh opportunities for development and growth (Baker & Nelson, 2005; Miner, Bassoff, & Moorman, 2001).

Through the development of new, or the bricolage of existing, ICT capabilities, two outcomes will eventuate from the Planting phase. The first outcome is that the capability gaps identified in the prior phase would be addressed by either the new or the repurposed ICT capabilities. The second outcome is that if bricolage is applied in a judicious and selective manner, the costs of ICT development as well as potential wastage would be kept to a minimum through the novel applications of the existing ICT capabilities (Andrews et al., 2013; Baker & Nelson, 2005).

3.5 Stage 4: Perpetuating

Finally, the findings from our case study suggest that last stage of Technology Leapfrogging is a Perpetuating stage that is centered on maintaining the **trajectory** of ICT development. Like the previous stages, the Perpetuating stage is underpinned by two underlying mechanisms: (1) Demonstrating and showcasing ICT achievements, and (2) Generating returns from the investments in ICT development.

Demonstrating and showcasing ICT achievements is about creating awareness of the results and positive outcomes of ICT development. In Azerbaijan, this mechanism is manifested in the information circulated to its citizens and public servants, as well as the marketing materials of a number of public organizations (e.g. Azerbaijan High Tech Park). For example, as a LLDC, being ranked 53rd (World Economic Forum, 2016) and 56th (Azerbaijan Ministry of Communications and High Technology, 2017a) globally in terms of network readiness and e-government development respectively are significant achievements that have been made widely known across the entire public sector. Likewise, the operational benefits and efficiency gains of e-government development have been widely publicized as well (see Muradov, 2016).

Generating returns from investments in ICT development is about extracting value from the ICT initiatives implemented, which could be in the form of revenue. This mechanism is manifested in a number of ways in our case study. For example, Azercosmos offers capacity leases, as well as broadcasting, teleporting and telecommunications services through the Azerspace-1 satellite (de Selding, 2014). Similarly, the land, facilities and infrastructure granted to the Azerbaijan High Tech Park can be leased to businesses to generate revenue as well (Azerbaijan High Tech Park, 2017).

As national ICT development is not a one-off megaproject, but a continuous process that progressively unfolds over a number of iterations (Tan et al., 2013), the Perpetuating stage is the crucial final step of Technology Leapfrogging because the two underlying mechanisms will generate outcomes that will set the stage for future iterations of ICT development. The first outcome is that publicizing the results and benefits of ICT development, particularly to the stakeholders of participating agencies, will generate buy-in and goodwill for future iterations of ICT development to come. Each iteration of national ICT development can entail significant undertakings that may take a long time to yield results. Consequently, the ability to demonstrate "quick wins" and benefits that can be derived from the deployment of ICT will help participating agencies to not lose sight of the bigger picture, sustaining their motivation and commitment to support the longer term objectives (Hanna, 2008).

The second outcome is the leverage of the ICT initiatives developed for socioeconomic benefits. The revenue that can be generated from monetizing the ICT initiatives developed, the convenience of enhanced e-government services, the opportunities for employment in an expanded ICT sector, as well as the extension of networks to the more remote regions of the country are all examples of benefits that were evident in the case of Azerbaijan. The socioeconomic benefits achieved will strengthen the overall motivation for the government to invest further in national ICT development, triggering the next iteration.

4.0 Conclusions and Recommendations

LLDCs tend to be less developed in terms of ICT infrastructure development (ITU, 2014). And due their resource constraints, it is even more important that there are no missteps when investing in ICT (Ojha, 2013). A crucial advantage that they possess due to their less developed state, however, is the ability to "leapfrog" by learning from the best practices of others (Davison et al., 2000). This form of strategic imitation can allow a LLDC to attain achieve the state of the art in ICT infrastructure development rapidly and cost effectively (Gray & Sanzogni, 2004). An

example of a LLDC that has made this leap is Azerbaijan, which currently has an Internet penetration rate that approaches the level of developed countries (Internet Live Stats, 2016).

Through a case study of the national ICT development journey of Azerbaijan, from the formulation of its national ICT strategy to the implementation of various ICT initiatives, we have generated insights into how technology leapfrogging can be achieved. More specifically, the findings from our study suggest that technology leapfrogging is a process consisting of four stages that are analogous to the mechanics of an actual leapfrog. The four stages are Psyching, Planting, Propelling, and Perpetuating. In our report, we have not only discussed the specific decisions and activities undertaken by the Azerbaijani government in relation to each of these steps, but the outcomes of those decisions and activities as well.

The Technology Leapfrogging framework developed and presented in this report, in particular, provides a number of useful recommendations and can be used as a step-by-step guide for informing ICT Development in LLDCs.

The first recommendation is that **it is crucial to first develop a blueprint for ICT development**. The blueprint should contain two elements on different levels of abstraction. A strategy that delineates the overall scope, objectives, strategic priorities and expected outcomes of ICT development, and an action plan to translate the strategy into specific activities, outcomes and deliverables. The blueprint is important because not only will it chart the overall direction and define the boundaries of ICT development (Tan et al., 2013), it serves as a signal of the vision and commitment of the government as well (Gichoya, 2005).

A second recommendation is in relation to the use of foreign expertise, particularly from developed countries. **It may be both unfeasible and unrealistic to rely on foreign help to operate, manage and maintain the ICT initiatives that have been developed on an ongoing basis**. Like in the case of Azerbaijan, this could be due to resource constraints (Kuptsch, 2006) or security concerns (Khalfan, 2004). However, foreign expertise can be sought in the early stages of implementation to provide legitimacy and facilitate knowledge transfer. This will ensure that the ICT initiatives to be implemented are put on the right track at the earliest possible juncture to increase the likelihood of successful implementation.

A third recommendation is that **the use of bricolage can reduce the time and costs associated with ICT development, but it should be used judiciously and selectively**. "Making do" with existing ICT capabilities can help a LLDC overcome its inherent resource constraints but it cannot be the exclusive means of ICT development. Otherwise, it may result in a vicious cycle that inhibits learning and blinds a government to future developmental opportunities (Baker & Nelson, 2005). A thorough understanding of a country's ICT capability gaps and a careful, objective review of the business case for each ICT initiative to be implemented will reveal if the use of bricolage is appropriate.

A fourth recommendation is that **it is important to create awareness of the quick wins and achievements of ICT development**. National ICT development is a continuous process and happens over a number of iterations (Tan et al., 2013). Consequently, pursuing only long-term, high-impact projects could cause the public agencies that will be involved in the implementation of ICT initiatives to lose sight of the collective national objectives, or question the value of supporting the overarching national ICT strategy. Instead, it is important to also pursue a number of short-term "quick wins" projects: The ability to demonstrate results and benefits will serve to gain and sustain the buy-in and commitment of the participating agencies (Hanna, 2008).

A final, overarching recommendation is that **it is important to remember that ICT development is never enacted for its own sake**. As such, when planning for national ICT development, a government should not only consider the technological possibilities, but the local conditions (e.g. technology readiness and the availability of complementary capabilities) and ICT demands as well. The resource constraints of a LLDC usually mean that it can ill afford mistakes, and if ICT initiatives are developed but not well-utilized, it is not only a waste, but it will be impossible to fully unlock their potential for generating economic and social gains as well.

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