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The process of Technology Leapfrogging: Case analysis of the national ICT infrastructure development journey of Azerbaijan

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ABSTRACT

Technology Leapfrogging is one of the most cost efficient and effective ways for developing countries to attain an advanced state of ICT development and connectivity. And yet, despite its numerous benefits, there is currently little research on the process of Technology Leapfrogging. To address this knowledge gap, we conducted a case study of the national ICT infrastructure development journey of Azerbaijan, one of the top developing countries 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 process model of Technology Leapfrogging was then inductively derived. More specifically, our study reveals that ICT development in Azerbaijan unfolded as a "stage-skipping" variant of Technology Leapfrogging that consists of four stages: (1) Psyching, (2) Planting, (3) Propelling and (4) Perpetuating. Analogous to the mechanics of a physical leapfrog, traversing the four stages enabled Azerbaijan to achieve an advanced state of ICT connectivity quickly and cost effectively in spite of its limited resources, which served to generate a variety of economic and social benefits for the country.

1. Technology Leapfrogging

Information and Communications Technology (ICT) development and connectivity are crucial to developing countries because they enable the communications, interactions and transactions that will allow developing countries to engage more effectively with world markets (Ojha, 2013). This, in turn, 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 developing countries to overcome potential 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 developing countries 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).

Technology Leapfrogging, 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, Vogel, Harris, & Jones, 2000), is one of the most cost efficient and effective ways for developing countries to attain an advanced state of ICT development and connectivity (Liu & Yuan, 2015). This is because Technology Leapfrogging enables developing countries to learn from the experience and expertise of developed countries, avoiding the risks associated with Research and Development (R&D) as well as experimentation (Gray & Sanzogni, 2004). In addition, because Technology Leapfrogging voids the need to invest in successive generations of ICT (Alzouma, 2005), developing countries would be able to avoid the inertia that could stem from legacy ICT infrastructures (Kleine & Unwin, 2009). And yet, despite its numerous benefits, there is currently little research on the process of Technology Leapfrogging. Addressing this knowledge gap is important because developing countries tend to have

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limited resources, and this knowledge could provide indications to government officials, policy makers and public servants in these countries on the enactment and management of the process, so that they would be able to make the most of the resources at hand.

The purpose of this case study is to address this knowledge gap by conducting a case study of Technology Leapfrogging in Azerbaijan, a country that has attained one of the highest levels of ICT connectivity among developing countries (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 stages of Technology Leapfrogging will be constructed and presented in this case study. In doing so, not only will this study contribute an empirically-grounded, developing country-specific process model of Technology Leapfrogging to the ICT for International Development (ICT4D) literature, but the framework can serve as a blueprint for officials and policy makers in developing countries to direct their ICT development efforts as well. Accordingly, this study seeks to address the following research question: How was Technology Leapfrogging enacted in Azerbaijan?

2. Case background: national ICT development in Azerbaijan

Azerbaijan is a developing country 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, but 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, 2017). 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), the 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 developing countries in the world, making the country a revelatory case (Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012) for the purpose of our study.

3. Case analysis: the process of Technology Leapfrogging

Based on the findings from our case study, the process of ICT development in Azerbaijan is clearly aligned with the concept of Technology Leapfrogging. 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. 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 theproject 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."*

Table 1
Core Indicators of ICT Connectivity in Azerbaijan.
Source: Azerbaijan State Agency for Public Service and Social Innovations (2017).

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 h per month), USD	0.77
Internet access tariff per capita income (monthly), in percentage	0.3
Mobile cellular tariff (100 min of use per month), USD	4.07
Relation of mobile cellular tariff to per capita income (monthly), in percentage	1.5

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 Fig. 1). More specifically, our case data reveal 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.

3.1. 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. The Chief Advisor for Science, Technology and Information Society Development at the Azerbaijan Ministry of Communications and High Technology explained the role of the current National ICT Strategy in driving ICT development: