Chapter 14
What Can the South Learn from the North Regarding the Implementation of IoT Solutions in Cities? The Case of Seoul-Born Smart Transportation Card Implementation in Bogota

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14.1 Introduction

Over the past decade, the urban population of the Global South has been growing at an average rate of 1.2 million people per week (UN Habitat 2013), bringing developing countries to center stage on issues relating to urban development. Due to continuous urbanization and growth, cities have become increasingly complex environments (McHale and al. 2015; Hillier 2009), calling for the development of innovative solutions to ensure service delivery and well-being of their citizens. Collecting and processing the data produced by the operation of urban infrastructure systems, such as transportation, telecommunication, water, waste, or energy, can actually be seen as one of those solutions. Creating an interconnected network (Internet) of physical components from urban infrastructure systems (Things), that is to say the Internet of Things (IoT) (Dijkman and al. 2015), is indeed viewed as an efficient way to deal with much of the complexity associated with urban systems (Zanella et al. 2014), and for enhancing development. As a matter of fact, IoT solutions appear as having the potential to support the development of solutions contributing to make cities more resilient, sustainable, safe, and inclusive (SDG 11) and more generally to environmental sustainability (MDG 7).

However, most of IoT solutions usually originate from developed countries, part of what is often referred to as the "Global-North", and one might wonder their degree of transferability to the "Global-South". This chapter thus seeks to explore the conditions required to reproduce IoT "success stories" from the North to the South by answering the following question: **what can the South learn from the North regarding the implementation of successful Internet of Things (IoT) solutions?**

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To answer this question, we present the cases of development of the same IoT solution, being a smart transportation card, in Seoul (North) and Bogota (South), based on archival data and data collected from semi-structured interviews with stakeholders involved in the projects. We then conduct a comparative analysis of the two cases using a conceptual framework building on co-evolution between technology and institutions theory, to understand the extent to which technological innovation can be a driver for institutional changes in urban transportation systems, and vice versa.

14.2 Seoul Case

Seoul, the economic and political capital of the Republic of Korea, is one of the most populated urban areas in the world. In 1960, the Greater Seoul metropolitan area was home to 5.2 million of inhabitants (Bae and Richardson 2011); it is estimated that nowadays, about 23 million people live in Seoul Metropolitan Area, accounting for approximately half of the South-Korean population (Cervero and Kang 2011).

Consequent transportation problems resulted from the exponential growth Seoul experienced. Driven by strong industrial development, Seoul's demographic growth was followed by an impressive economic growth. The per capita income (in 2004 US Dollars), that was about US$ 311 in 1970, rose to US$ 7378 in 1990, and finished 2002 at US$ 12,531 (Allen 2013). Automotive manufacturing became an especially powerful sector (Samsung Motors, Hyundai, Kia Motors), and because of the rising household economic power, more and more citizens started to buy private cars, eventually leading vehicle ownership to rise from 2 cars per 1000 persons in 1970 to 215 per 1000 persons in 2003 (Pucher et al. 2005). Unfortunately, Seoul's road infrastructure did not adapt to this impressive increase in car ownership. As a result, congestion became significant, leading to lower travel speeds and increased travel times for all road vehicles, ultimately becoming synonymous of decreased efficiency of the bus system, on which Seoul was heavily dependent at that time.

To tackle the congestion problem, Seoul Metropolitan Government (SMG) undertook the construction of an urban rail system, which was finally inaugurated in 1980. The new Seoul metro system constituted an alternative mode of transportation for Seoul citizens, who graciously welcomed its development. Unfortunately, this new solution did not act in favor of the Seoul bus system (Pucher et al. 2005). Indeed, due to the convenience and reliability of the new metro system, as well as the affordability of private cars, bus quickly became the less preferred means of transportation in Seoul, leading to a rapid decline in bus usage. Because of the decreasing number of passengers on buses having shifted to rail or private cars, bus companies operating under a license from SMG, also motivated by a lack of control from Seoul's authorities, started to do whatever was most profitable for them. Hence, it was not unusual at that time to see bus-operating companies cancel their non-lucrative routes without notice, or bus drivers drive recklessly to put as many passengers as possible onboard in order to generate more revenues, flouting the safety and comfort of their

passengers (Allen 2013). As a direct consequence, 31 bus companies went bankrupt from 1995 to 2002 (Pucher et al. 2005).

Due to the urban sprawl of the Korean capital, resulting from its exponential growth after the post-Korean War, most of Seoul urban dwellers experienced long commutes, made of a combination of multiple trips, being synonymous of multiple transfers between different transport modes available, or within the same transport mode but between different operators. Because of the inexistence of an integrated fare system at that time, public transport users in Seoul were spending tremendous amounts of money on public transportation fare payments. Indeed, each time a user had to transfer, he had to pay an additional fare. Evidently, there was an urgent need for fare integration across the whole metropolitan area, and across all bus and metro operators. Consequently, this became one of the main campaign promises of Mr. Lee Myung-Bak, who was elected as Mayor of Seoul in the 2002 municipal elections. To support this integration, a new fare scheme was devised by SMG, as part of a broader public transportation reform, which would be supported by an integrated smart card ticket system (Park and Kim 2013). The first step of the creation of an integrated transport system was to change the ownership of the bus operation system in order to create a semi-public bus system.

To do so, SMG first created the Public Transport Promotion Task Force, led by the head of Seoul's transportation sector, which was composed of Seoul city officials and researchers from the Seoul Development Institute, who were to conduct the transportation reform from an expert point of view. Following the Institute's urban transportation research division head guidelines and based on the advice from the Public Transport Promotion Task Force, the Seoul Bureau of Transportation and the Transportation Policy Advisory Committee then created the Bus System Reform Citizen Committee (Kim et al. 2011), composed of 20 professionals from public authorities, industry and civil society, which aimed at solving conflicts between the different involved stakeholders (Kim and Dickey 2006). After a long series of formal and informal meetings between the CEOs of bus companies and SMG, the newly elected Mayor Lee Myung-Bak and the Chief of the Seoul Bus Transport Association, representing the 57 remaining bus-operating companies in Seoul, signed an agreement approving the bus reform and stating the change of the operational content of the companies' operating licenses. Once signed, it was just a matter of time to have the IoT technological vector (smart card) implemented, that would support the creation of a new integrated distance-based Automatic Fare Collection (AFC) system, allowing users to freely transfer across and between modes (Kim and Shon 2011).

The device, named T-money, was implemented and operated by a Special Purpose Company, called Korea Smart Card Corporation (KSCC) led by LG CNS, a subsidiary of the LG Group, and finally inaugurated on July 1, 2004 (Audouin et al. 2015). As part of the Public–Private Partnership (PPP) concluded between SMG and KSCC, the whole investment was performed by the private sector. The card itself is a plastic card embedded with a Central Processing Unit (CPU) that can store and transmit data when in contact with dedicated card readers, using Radio-Frequency Identification (RFID) technology (Blythe 2004). When implemented, the T-money card was a

prepaid card, so users needed to top-up cash on their card at dedicated machines to be able to travel. Users would need to tap-in their card on card readers when entering a bus or metro station, and tap-out when exiting, so the AFC system would calculate the total distance traveled and deduce the corresponding fare from their T-money balance. Ultimately, the T-money sought to streamline human traffic flows at metro gates, to reduce bus delays caused by cash transactions for fare payments at vehicle gates, and as an IoT device, to ensure complete transparency of bus drivers operations, and obtain data about public transportation use by the citizens (Park and Kim 2013). The card was widely embraced by the population, as in 2013 it is estimated that it was used for 97.1% of the 32 million trips processed daily on Seoul public transportation system (SMG 2014).

14.3 Bogota Case

With almost 10 million inhabitants, Colombia's capital is the most populated city in the country (Munoz-Raskin 2010). The economic situation in Colombia, specifically in Bogotá, is significantly less developed than Korea and can be characterized as belonging to the Global South (Cervero 2013). Prior to 2000, the Metropolitan Area of Bogotá was characterized by a fairly complex transportation system. Bus services were provided by 64 different companies operating around 21,000 vehicles citywide. Private bus operators were often leasing their routes (previously obtained on concessions-based contracts) to third-party bus owners, creating a complex structure for bus operations (Cain et al. 2006). At that time, most of the bus-operating companies used obsolete vehicles, and showed very little concern for public safety. Bus stops were actually depending on the willingness of the bus drivers to stop, resulting in an anarchic bus system. As the income of bus drivers was directly linked to the number of passengers they carried, Bogota's bus system was synonymous of chaotic competition between operating companies, also known as the "penny war" (Ramos 2015), resulting in serious safety issues for pedestrians and other road users (World Bank 2010).

To address the poor condition of public transport in Bogota, the 1998 newly elected Mayor, Mr. Enrique Peñalosa, proposed a Bus Rapid Transit (BRT) system, called TransMilenio (Ardila 2004), in cohesion with the Bogota Mass Transport System plan of the Colombian National Development plan (Lara and Gutierrez 2012). TransMilenio was a citywide, city-owned system that was supposed to offer speed and convenience to its users. Buses were to run in dedicated corridors to avoid traffic flows, and riders were to purchase their tickets at the entrance of bus stations instead of upon entering buses. The project started in 1998 and was inaugurated in December 2000. Additional corridors opened every year until 2006 (Heres et al. 2013). Old buses were progressively taken out of these main corridors ensuring a smooth transition so that eventually TransMilenio was the only public transportation remaining on the main routes. Through concessions, TransMilenio outsourced the operation of the BRT and feeder line buses. Tendering processes were implemented

where pre-TransMilenio era companies could bid if they had previously demonstrated experience operating the city transportation system. This process motivated the birth of new entities, composed of former bus companies partnering with firms from other industries responsible for cash investments, and high competition between them.

Because it improved the efficiency of the overall transportation system, reduced travel times and afforded significant cost saving for citizens (Bocarejo et al. 2014), TransMilenio was first considered a success for the city of Bogota. However, Bogota's public authorities failed in using the development of TransMilenio to create a city-wide integrated transportation system. While TransMilenio ran in a regulated manner on dedicated bus lines, pre-Transmilenio collective public transport, still completely unregulated, actually continued running in parallel on streets (Ramos 2015), creating competition between the BRT and pre-TransMilenio collective transport. Public authorities did not also use TransMilenio to create a citywide integrated fare system. Indeed, a dedicated fare system, the blue and red smart cards operated by Angelcom (El Espectador 2014), was specifically created for TransMilenio, that did not allow users to transfer freely to and from non-TransMilenio buses. To address the cruel lack of integration that was characterizing Bogotà public transport system at that time, the city of Bogotá proposed in 2009, as part of the Bogotá Mobility Master Plan, the development of the SITP (Integrated Public Transport System of Bogota). At the core of the SITP lied the development of an integrated fare system, which was to be supported by a unique payment method, aimed at improving local traveling conditions (SDP 2009). In July 2011, the city of Bogotá awarded Recaudo Bogotá, a concession composed of three different shareholders, namely Citymovil (60%), Land Developer (20%), and LG CNS (20%), for the operation of the fare collection and user information of SITP. LG CNS was in charge of providing an automatic fare collection system (AFC), aiming at integrating the TransMilenio routes with the new feeder routes, that were going to be developed later to replace the old unregulated feeder bus lines, dating from the pre-TransMilenio era.

The funding of Recaudo Bogotá was secured through a $176 million financing package loan by the World Bank, HSBC and Korean Banks (Shinhan and Woori Bank). The loan aimed at enabling Recaudo Bogotá to develop and introduce an easy-to-use electronic-payment mechanism supported by a smart card named "Tu Llave" card (standing for "Your key" in Spanish), which would eventually eliminate cash from the system, and enable free transfer between SITP bus routes, resulting ultimately in increased efficiency of the system, and security for users (IFC 2012). From a technological point of view the "Tu Llave" card works exactly as the T-money card as they both use Infineon's Security Microcontroller SLE66 with 4K Memory.

As part of the SITP, an important part of the city bus system was also redesigned, forcing most of the pre-TransMilenio bus companies operating in parallel to the BRT to stop operations, and to conform to the same competitive concession arrangements and regulations devised under TransMilenio (World Bank 2014). Those newly regulated bus-operating companies, who for many started to operate as TransMilenio feeder lines, combined with TransMilenio, formed the SITP network, on which the only mode of payment accepted was the "Tu Llave" card. As part of SITP, bus

drivers also got a fixed salary, independent of the number of passengers transported, announcing the end of the "penny war" on the SITP network.

However, the implementation of the "Tu Llave" card did not happen as smoothly as planned. Indeed Recaudo Bogota and Angelcom, for which the blue and red smart cards were still in place on the TransMilenio network, had not reached any agreement. Hence, while the "Tu Llave" card was accepted on all newly regulated bus routes, it remained unaccepted at most TransMilenio bus stations. Recaudo and Angelcom finally reached an agreement in 2013 where Recaudo was to pay for the upgrade of all the TransMilenio card readers to make them "Tu Llave" compatible (El Espectador 2014). Since September 2015, both cards provided by Recaudo and Angelcom are accepted on the whole TransMilenio network. "Tu Llave" card users are thus able to access SITP buses (including TransMilenio) and Bogotá Metro, as well as to freely transfer between those. Currently, the "Tu Llave" card is used (and has to be used, as it is the only mean of payment) in all SITP buses and BRT system. The average numbers of daily transactions, including validations, recharge and transfer, processed by the "Tu Llave" card is around 7 million. In 2015, during the Korea–Colombia business forum, the Colombian President, Juan Manuel Santos, recognized the significant role LG CNS played in the development of the Bogotá transportation system (Business Korea 2015). However, it was estimated at the time this paper was written that approximately 2500 buses in Bogota were still operating as unregulated, thus outside of the SITP, and that Bogota's City Hall was continuously fighting to regulate them, to ultimately have the SITP cover the entire Bogota public transport system.

14.4 Analysis

Because these two cases deal with the introduction of the same technological innovation (smart transportation card) by the same technological actor (LG CNS), they can provide a good basis for comparative analysis. The following analysis is based on the alignment (sometimes referred to as coherence) framework from the co-evolution between institutions and technology literature (Finger et al. 2015). The framework acknowledges that infrastructure systems are "co-evolving" as a result of evolution in technologies on the one hand and in institutions on the other hand (Finger et al. 2010), where institutions must be understood as "*the rules of the game*" (North 1993: 12), and not as organizations. Specifically, innovations are acknowledged to happen as a result of interaction between institutional, technological and market actors, when institutions and technology are "misaligned". A graphical representation of the framework is available in Fig. 14.1.

When using this framework to look at the Seoul and Bogota cases, it seems that the development and implementation of the T-money and "Tu Llave" cards have taken completely opposite paths. In Seoul, the card was basically implemented to support a wide institutional bus reform (the Seoul Bus Reform) that aimed, among other things, at changing ownership of bus routes and implementing a citywide-

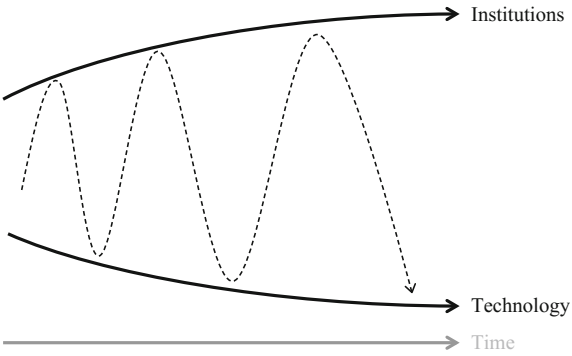

Fig. 14.1 The alignment framework (inspired from Finger et al. 2010)

integrated fare system. Thus, for the Seoul case, one can see the change having first happened on the institution axis of our framework, and then on the technology axis, because the Seoul bus reform created a misalignment that could only be tackled by the introduction of a technological innovation. The T-money card must thus be understood as a mean for public authorities to "catch-up" on institutional changes introduced, or at least as a way to support those. Although the card was actually developed by LG CNS prior to the bus reform, and even prior to the election of Mr. Lee Myung-Bak as the Mayor of Seoul (Lee and Lee 2013), its introduction was only made possible because of the introduction of institutional changes, known as the Seoul bus reform. In Bogota, things seem to have happened the other way around. The introduction of the smart card actually predated a wider institutional change in the transportation sector. Indeed, the "Tu Llave" card was introduced not as a mean to support a system-wide institutional reform (as it was the case in Seoul), but as a vector for the development of the SITP, which was being incrementally implemented as Bogota city hall was struggling to integrate pre-TransMilenio bus-operating companies into its new transportation network. Consequently, one can say that the introduction of the smart card in Bogota, that is to say, the technological change, might have happened a little bit too early, and not as a mean to catch-up on institutional change, thus perhaps making the institutional change (development of the SITP) more laborious to accomplish.

14.5 Conclusion

From this chapter, it seems that an IoT solution originally developed in the North can also produce positive outcomes when implemented in the South. Indeed, the implementation of an integrated smart ticketing system seems to have contributed to improving the experience of public transport users and the efficiency of the public transport system both for Seoul and Bogota. However, it also seems that, in order for southern cities to fully benefit from the technological innovation implemented,

those must be implemented ex-post system-wide institutional reforms, and not preceding those. By implementing a technological solution "hastily", public authorities might indeed take the risk of delaying institutional changes at a system level, and consequently not fully harvest the potential of the technological solution. Building on Wright (2011), we thus think that for the case of Bogota, institutional changes (regulation of pre-TransMilenio operating companies) should have been introduced during the implementation of TransMilenio, and only after, the "Tu Llave" card should have been introduced, to consolidate the whole and back-up the institutional change introduced.

While we have seen in this paper that southern cities have some things to learn from northern cities regarding the implementation of IoT solutions, it also seems that southern cities might soon have some things to teach to northern cities. Indeed, over the last decade, the Information and Communication Technologies (ICTs) have enabled, as much in the South than in the North, the development, mainly by the private sector, of new mobility solutions, such as ride-booking, car-sharing, or car-pooling, that might enable to reduce private car use, and ultimately tackle congestion in urban areas (ITF 2017). Those new ICT-supported mobility solutions call for the development of new rules and regulations and some southern cities have actually been quite good at it. For example, innovative regulatory solutions developed towards ride-booking in Sao Paulo (Audouin and Neves 2017), might well become quickly inspirational for northern cities. Given those recent developments in urban mobility, it seems entirely relevant to look at transferability of solutions not only from a North to South perspective, but also from a South to North angle.

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