

PART III

SUSTAINABLE URBAN DEVELOPMENT AND SMART CITIES: ACHIEVEMENTS, OPPORTUNITIES AND CHALLENGES FOR ASTANA TO BECOME A MODEL OF SMART AND SUSTAINABLE CITY

The ECE and the International Telecommunication Union (ITU) define a smart sustainable city (SSC) as an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental and cultural aspects.¹³⁸ A *smart city*, therefore, can be understood to be an agglomeration that enables each of its residents to access all services (public and private) in a way best suited to his or her needs. It implies the building of adequate hard infrastructure, human capital and skills, community institutions and (digital) technologies that fuel sustainable development and provide an attractive environment to foster innovation and human well-being. In other words, smart cities can be described as a process by which urban centres become more sustainable, inclusive, safe, resilient to climate change, and able to respond more quickly to development challenges. In addition to fostering local innovation, the embeddedness of smart cities in world networks of knowledge and technology has also been emphasized. Thus, smart cities are also cities which have successfully built experience in attracting foreign direct investment (FDI) from global sources, which have become socially and economically open to the rest of the world¹³⁹ as well as environmentally sustainable.

With the global urban population forecast to reach 5 billion by 2030, the need for *smart* and *sustainable* cities has become more urgent. The United Nations Sustainable Development Goals (SDGs) under 2030 Agenda for Sustainable Development (2030 Agenda) call for improved policy calibration in order to achieve improvements in each of these two areas (smart cities and sustainable urban development). Whereas the “urban” SDG 11 includes targets to “make cities and human settlements inclusive, safe, resilient and sustainable”, the “infrastructure” SDG 9 calls for Member States to work together to “build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”¹⁴⁰.

Moreover, innovation activities, which are fundamental for achieving each of these objectives, are recognized as a significant pillar for the implementation of the entire 2030 Agenda.

In this context, the implications for countries seeking to promote SSCs are multifaceted. For example, improving ICTs is crucial to achieve the urban climate targets of lowering energy use and GHG emissions while boosting socio-economic growth. Although some cities in various geographies claim to have already become “smart and sustainable”, their levels of achievements are uneven. Countries with economies in transition face additional constraints.

¹³⁸ United Nations Economic Commission for Europe, “United for Smart Sustainable Cities (U4SSC)”. Available from <http://www.unece.org/housing-and-land-management/united-4-smart-sustainable-cities-u4ssc.html>

¹³⁹ United Kingdom, Department for Business, Innovation and Skills, *Smart Cities: Background Paper* (London, 2013). Available from <https://www.gov.uk/government/publications/smarter-cities-background-paper> (accessed 15 December 2016); R. S. Wall & S. Stavropoulos, “Smart cities within world city networks”, *Applied Economics Letters*, vol. 23, Issue 12 (Online: 20 January 2016), 875-879, p. 878.

¹⁴⁰ Innovation policies are also implicit in the targets specified for SDG 8 on decent jobs, and in achieving SDG 12 on sustainable consumption and production.

UNECE research on innovation policies has identified these barriers to often include low levels of entrepreneurship, insufficient access to stable sources of funding, human capital deficits, and insufficient access to cutting edge technologies and knowledge, among others¹⁴¹.

Another challenge is that, at present, there are no universally agreed standards and indicators that could be used to measure “smart sustainability”. Although innovations in the use of digital technologies can help create life improvements, such as intelligent transport, smart energy systems, resource efficiency, and transparent and open societies, at present there are still no established standards and benchmarks that could generate a more predictable transition towards climate neutrality through the use of novel products, processes, and technologies.

Box 1
Measuring “smart sustainability”

Recently, the UNECE has initiated activities to help Governments and local authorities to tackle these constraints. In cooperation with ITU, it has launched the United for Smart Sustainable Cities (U4SSC) global initiative, which now includes 16 UN agencies and programmes as well as several cities and relevant stakeholders. In 2013, the two organisations started to build indicators to evaluate smart sustainable cities. ITU worked under the framework of the Focus Group on Smart Sustainable Cities and UNECE under the framework of the Committee on Housing and Land Management and its project “United Smart Cities.” The three-year multi-stakeholder negotiations concluded in December 2015 with the endorsement by the ITU and the UNECE Committee on Housing and Land Management of the UNECE-ITU Smart Sustainable Cities Indicators. These indicators formed the basis for the ITU-T Recommendation on Key Performance Indicators (KPIs) on smart sustainable cities to address the achievement of SDGs.

The United for Smart Sustainable Cities (U4SSC) global initiative was launched at the ITU-UNECE Forum “Shaping smarter and more sustainable cities: striving for sustainable development goals”, which took place in Rome in May 2016. By providing a platform that is open to all UN agencies and other relevant stakeholders, U4SSC will advocate public policy projects to encourage the use of ICTs to facilitate and ease the transition to smart sustainable cities. The initiative will produce policy guidance for the integration of ICTs in urban operations based on existing international standards.

A. THE SMART CITIES AGENDA IN KAZAKHSTAN: THE CASE OF ASTANA

The “Smart Astana” concept, support institutions, and activities

Since becoming the capital of Kazakhstan in 1998, Astana is regarded as a modern, innovative city. In order to revamp its sustainable development agenda, the Government has also undertaken reforms to promote sustainable city principles. *Smart Astana* as a brand has been advertised to represent the capital’s smart and sustainable development aspirations. This goal became an official policy initiative after a Road Map was set up by order of the President (Order No. 01-7.6 of 22 April 2013 “On the need of developing an action plan for including Astana in the list of 50 “smart cities” of the world”). The goal is to improve quality of life and to speed up the modernization of the infrastructure in Astana, as well as to enhance its level of public safety. Since Astana has a population of near 700,000 inhabitants, and a GDP of nearly 1 billion US dollars, the Astana Smart City Roadmap was inspired by other successful cities of relatively

¹⁴¹ For more information, see <https://www.unece.org/index.php?id=41402#/> (accessed 15 December 2016).

medium size (e.g. Amsterdam in the Netherlands, Boston in the USA, and Oulu in Finland). For instance, the Government has considered the history and institutional framework of these cities for the establishment of innovative business-hubs¹⁴².

One key objective of the Astana Smart City Roadmap, which is in line with the national Programme of Progressive Industrial-Innovative Development, is to assist Astana authorities in the introduction of innovations that could create spillovers all over Kazakhstan and contribute to economic diversification¹⁴³. The basis of the Roadmap relies on the enhancement of a combination of six characteristics that make for a “smart city”: smart economy, smart management, smart life, smart mobility, smart people and smart environment; and it includes policy actions aimed at the complex modernization of the city infrastructure. As a result of the application of the six smart city characteristics, the Government expects to achieve a more centralized, but also more agile and responsive, administration of city infrastructure. Furthermore, progress will also occur in terms of higher quality of life, better housing and utility services, renewed utilities network and increased urban security. Finally, new types of social programmes are envisioned, including more affordable and higher quality education, healthcare and social protection. The project will rely significantly on the establishment of a modern ICT network. This network will serve as the basis for all expected innovations, services and products. Since this is also the most expensive part of the project, it is expected to be undertaken through the attraction of both public and private investments.

One of the key actors involved in the implementation of the Roadmap is a smart city development agency, Astana Innovations JSC, which has been operating since 2011 (Decree of the Akimat of Astana No. 30-48 of 31 May 2011). The company is fully owned by the municipality (or “Akimat”) of Astana, and plays a significant role in coordinating all state mechanisms of support for innovations. Other important players in the field of innovation are the National Academy of Sciences, Nazarbayev University, JSC National Scientific and Technological Holding “Parasat”, and JSC “National Innovation Fund”¹⁴⁴.

Since its establishment, Astana Innovations became an engine and catalysing element of the innovative development of the city. According to its management, the work of the agency aims to improve the quality of life of the urban population by increasing the energy efficiency of city services, as well as by developing the innovation potential of small and medium businesses. The main service provided by Astana Innovations is to act as a one-stop-shop for all support mechanisms that exist at the national level (e.g. investment promotion, innovation grants) to help deepen industry-science linkages. Key initiatives that have been undertaken include developing the *Smart Astana* and *Safe City* concepts, as well as providing technological business incubation and development, and enhancing the potential of 3D technologies in the capital (see smart Astana projects below).

According to government plans, the process of the development of *Smart Astana* has three components. The first one took around three years to implement, and focused mainly on improving city management. Actions included strengthening the rationalization of consumption, and using more flexible tariffs for public utilities to encourage savings. The second component is currently being rolled out. It involves adopting new management technologies for selected

¹⁴² We build a Smart City, an interview with Yerlan Kozhagapanov, Deputy Mayor of Astana”, *Infopanorama*, Issue 1(01) (2011), pp.75-77.

¹⁴³ Furthermore, the Government sector is also undertaking reforms under the “100 Specific Steps National Plan” of 2015, which assigns the objective to make Astana a business, cultural and scientific centre of Eurasia, attracting researchers, students, entrepreneurs and tourists from all over the region.

¹⁴⁴ Interview with Mr. Nuraly Bekturganov, Chairman of the Board of Parasat”, *Astana Innovations*, vol. 1 No. 2 (2012), pp. 68-71; UNECE (2012).

infrastructure development projects (e.g. water and heating supply systems, energy, street lightning and transport). The most difficult and long-lasting stage is the third component. It includes the involvement of city residents as active participants of the smart city. In particular, it means that citizens will become active decision makers on issues such as determining the quantities of heat and electricity they use and the quantity of waste they produce. Overall, it means they will become more conscious of the dangers to the environment of their everyday actions and behaviour¹⁴⁵.

In the context of *Smart Astana*, all kinds of research and development (R&D) activities, including marketing, will be supported by “Damu”, the Government Fund for the Development of Entrepreneurship¹⁴⁶. The Development Bank of Kazakhstan will also be involved, providing part of the finance. The private sector will be involved through investments in the Special Economic Zone (SEZ) of “Astana New City” (see Box 1). The first industrial park in the SEZ was developed in a rather rapid fashion: as of 2016, it nearly exhausted its resident capacity, counting already 62 resident firms, out of its maximum capacity of 70 firms. One key challenge has been that registration in the Zone was done without much planning and it soon exceeded its capacity to accommodate new firms. The development of another Zone was expected to start in 2017 to accommodate increased demand.

International cooperation on innovation will also be significant. An agreement has been signed with the Fraunhofer Institute of Germany, which will promote the development of high-technology projects. The initiative was launched in 2012 and will help transfer new technologies that could bolster the public infrastructure, such as 3D engineering. This type of cooperation will be instrumental in encouraging more intramural applied research in the business sector of Astana, and Kazakhstan more generally, which is underdeveloped¹⁴⁷.

FDI will also play a crucial role. There are significant advantages for foreign investment in innovative activities in Astana. These include a dynamic financial sector, an expanding IT, knowledge intensive activities, the availability of adequate infrastructure to introduce smart technologies at the city level, the emergence of some clusters in the medical, scientific and educational sectors, and a favourable tax and investment environment. The division on Investment Promotion of Astana Innovations foresees that, thanks to a series of measures to be undertaken to improve the investment climate, it is expected that the city will attract FDI worth USD 200 billion within a 10-year period¹⁴⁸.

In addition to Expo 2017, which will focus on sustainable energy solutions, other significant investment promotion initiatives will also encourage innovation. These include plans to establish an international financial centre “Astana”, which has the potential to become a financial hub for Central Asia, the Caucasus, Eurasian Economic Union, the Middle East, West China, Mongolia and Europe¹⁴⁹; the deepening of aftercare services with firms in the SEZ “Astana New City”; and the development of further service support for investors.

¹⁴⁵ “Astana Smart City”, *Infopanorama*, vol. 1, No. 1 (2011), pp 80-81.

¹⁴⁶ The Damu Entrepreneurship Development Fund JSC, established by Government Order No 665 “On Establishment of Small Entrepreneurship Development Fund” of 26 April 1997.

¹⁴⁷ United Nations Economic Commission for Europe, *Innovation Performance Review: Kazakhstan*, (United Nations: New York and Geneva, 2012), pp. 51-68. Available from <http://www.unece.org/fileadmin/DAM/ceci/publications/icp5.pdf>

¹⁴⁸ Recent measures include the provision of incentives for large projects, simplification of the process of hiring foreign personnel, tax exemptions from corporate income, land and property tax for up to 10 years in some cases, subsidies for up to 30 per cent of the actual costs of construction and assembly works and purchase of equipment; new guarantees for investors with regards to tax stability and employment legislation; and the introduction of the figure of the Investment Ombudsman, amongst others. (Source: Kairat Karmanov, “Investment Attractiveness of Astana: Components”, *Smart Astana*, No.3 (December 2015), pp. 54-60.

¹⁴⁹ For more information, see website of Astana International Financial Centre. Available from <http://www.aifc.kz/>

Box 2

Industrial parks in the Astana New City SEZ

The industrial park of Astana New City is located in an area of 598.1 hectares (ha) within the Astana city district. Its public infrastructure was built up through government funded investments. As of 2015, 62 projects worth USD 1.124 billion have been implemented. Amongst these, 11 projects are foreign owned. Since its inception in 2006, a total of 96 firms have been registered, of which 21 are already operational. The total value of manufactured products amounted to about USD 1.9 billion in 2015.

Municipal authorities are interested in further attracting leading transnational corporations and other investors in order to foster the transfer of technology and knowledge spillovers. Major global transnational corporations (TNCS) that have been involved through investments, both in infrastructure and in priority economic sectors, undertook activities in the production of electric locomotives (Alstom, France), train coaches (Talgo, Spain), diesel locomotives (General Electric, USA) and helicopters (Eurocopter, Germany and France: through a joint venture with domestic partner Kazakhstan engineering).

Companies located in the territory of the Astana New City SEZ are exempt from the following taxation: income tax, land tax and value added tax (VAT). An additional benefit is that tariffs for public utilities are lower compared to other regions: examples include water (water and sewerage rate is \$1.3 per cubic meter), electricity (USD 0.09 per kW), and heating (USD 7.9 per Gcal). These benefits apply both to local and foreign investors.

Because of the rapid growth and continued interest of industrial enterprises, the city administration decided to build a new industrial park in an area of 433.1 ha, adjacent to the territory of the existing industrial park. Jurong Consultants, a subsidiary company of Singaporean Jurong International, has been involved into the development of the second industrial park master plan.

Source: Astana Innovations and Astana Invest Forum 2015

Finally, it should be highlighted that the further enhancement of infrastructure in Astana and the deployment of smart city technologies and services will require large financial investments. In a context where the Kazakhstani economy has been negatively affected by a number of external factors (i.e. economic crises in trade partners in the Eurasian Economic Union (EAEU), the decline of world commodity prices), it is unlikely that national and municipal budgets for such investments could keep up with demand. Authorities have highlighted mechanisms such as public-private partnerships (PPP) to make up for shortfalls in public spending that may occur. PPPs are an alternative to public procurement for both building new and upgrading existing infrastructure. Their success depends on finding the right balance of responsibilities and risks to be borne between government and private actors. In order for such initiatives to succeed, it is also necessary to work out sectorial legal and other measures to encourage private investments in priority sectors of the economy.

With this goal in mind, a new Law on PPPs was enacted in 2015, which is based on international best practice experiences, including new concepts and mechanisms for various PPP implementation schemes. These mechanisms could provide for the private capital with an opportunity for stable revenue from infrastructure investments with low risk as compared to commercial projects, including smart projects. For instance, investments in modern roads that include highly intelligent systems integrating the modern technology of flow control and traffic

safety could involve funding through PPPs. Similar systems could be implemented in the urban environment (e.g. smart traffic lights, intelligent security systems).

B. INNOVATIVE PRODUCTS AND SERVICES OF SELECTED SMART ASTANA PROJECTS

Pilot projects

As of 2016, Astana Innovations has implemented four Smart City pilot projects, with support of the municipality of Astana, which totalled public investments of about USD 10 million. These are the following: Smart Polyclinic, Smart School, Smart Street Lighting and Smart Payments. It is expected that each of these projects will be replicated upon their completion in other city locations.

Smart Healthcare

The Smart Polyclinic project has been launched with the goal of modernizing the healthcare facilities of Astana and improving the quality of medical services in the city. The project is currently being implemented in pilot mode in City Polyclinic No. 4. In the long term, the objective is to improve the operation of the healthcare industry across the board by means of enhancing the automation of internal and external processes.

One of the problems with health facilities in Astana is that they involve long waiting times and queues for doctor visits. Finding a solution to this challenge has been one of the main objectives of the project. For instance, innovative solutions have allowed for doctor appointments to be arranged either through a terminal or else online at the polyclinic's website, which helped minimize queuing times by 10 per cent. In addition, the system also offers the opportunity to save time through the digitalization of health information, thus reducing time needed for the entry of patient records. Finally, it is expected that the introduction of analytical systems will help improve the coordination and performance of all departments of the polyclinic. Such systems will support medical, accounting, financial and laboratory activities in the institution.

Another constraint that has been tackled by the “Smart Polyclinic” project was diagnostics. Since the project was introduced, it has enabled the more efficient work of doctors by providing them with medical instruments that contain all the necessary elements for making right diagnostics decisions. In the future, it is expected that productivity of the clinics' laboratories will increase significantly after a unified database of research results is created. This will imply integrating all medical laboratory information records into the earlier existing informational systems of medical and preventive treatment facilities, which will provide access to test results for all doctors treating the same patient. For this purpose, a Medicine Information System (MIS) has been set up that is closely linked to the register of the Ministry of Health and Social Development. The system allows the automatic checking of a patient's registration at a particular polyclinic. In addition, the system reduces the use of paper-based patient records that need to be filled in by hand. In total, over 600 standard forms of medical examination protocols have been introduced so far.

As of 2015, 8,735 patients were provided with services through the MIS in the City Polyclinic No.4; more than 700 people have used the new terminal and online appointment service; and 363 employees of the Polyclinic have been trained to work in the system. According to preliminary estimates, a successful scaling up of this project could save about KZT 600 million

of the city budget¹⁵⁰. In the autumn of 2015, the project was presented to the delegates of the VI International Investment Forum “Astana Invest 2015” at the *Smart Astana* exhibition hall. It is expected that the further development of the project will significantly improve interaction between healthcare organizations and Astana citizens. In particular, significant results can be expected in the form of shorter queues and waiting lists; the reduction of medical prescription errors; and the improvement of accuracy, efficiency and informational content of diagnostic research.

Smart schools

The goal of this project is to increase the automation of education-related processes in two Astana schools (No. 3 and No. 5). Paramount among its objectives is the prevention of access of unauthorized persons to the schools’ buildings; the prevention of emergency situations; improved student welfare by enhancing the efficiency of the service in school canteens; and the better monitoring of student expenditure by parents. The project will also make the use of the library more attractive, as well as increase safety and security with the use of video surveillance and access control systems. In each of these spheres, the project involves the introduction of innovative technologies in the everyday management of schools, including the following:

- *ACMS (Access Control and Management System)*: enhances the control of access to the school building through the use of SMS notifications to parents’ cell-phones that register student attendance;
- *video surveillance*: includes certain functions to enhance security in the classroom, including monitoring in real time, manual/automatic recording, and playback and storage of video information;
- *e-canteen*: introduction of electronic payment in canteen. Allows parents and students to better monitor spending by registering transactions in a personal account;
- *e-library*: involves the rolling out of an electronic database of books and software for quick searches of entries in the library collection. In addition, the project involves the distribution of electronic reader cards, which will allow for faster processing of book requests.
- *personal account*: the setting up of students’ personal accounts will allow parents to oversee statistics on attendance and compliance with class schedules, as well as setting a tracking system for monitoring the use of library resources and expenditure statistics in the school canteen.

Smart street lighting

The goal of this project is to reduce energy consumption and street lighting operating expenses. Among its objectives, it is expected to obtain energy savings of up to 48 per cent because of the improved use of technology; an additional energy saving of 13.6 per cent due to automatic dimming; and a significant reduction in expenses regarding maintenance and inspections. The latter is achieved given that the system will allow for the transfer of light usage and lamps’ condition information, through IT, to a central managing and monitoring unit, where an operator will be able to visualize information displayed on the monitor of his or her office computer. Statistical data have already proved the project’s effectiveness. As of 27 November

¹⁵⁰ “Smart Polyclinic: comfort, high quality, promptness”, *Smart Astana*, No.3 (December 2015), p. 62.

2015, since the beginning of the project implementation, electricity consumption has reduced from 22,950.8 kW (KZT 390,852) in 2014 to 10,229.5 kW (KZT 174,208). Thus, the project has saved 12,721.3 kW or KZT 216,644.¹⁵¹

A pilot street was selected to begin the project implementation (Enbekshiller, located in the Yessil district of Astana). The system of lighting in this street has been refurbished, providing for a more flexible configuration of operating modes that increased energy efficiency. The manager is able to set the schedule of turning on/off lighting (which can also be programmed to occur automatically). The operator can thus determine the schedules for lamp usage according to the availability of natural light. Notably, the dimming function provides control over light consumption and ensures a better management of lighting equipment¹⁵². Communication is provided by means of both wireless (radio, GSM) and wired technologies (PLC). It is expected that the “Smart street lighting” will be one of the key projects of the EXPO-2017 international specialized exhibition¹⁵³.

This project also builds on Kazakhstan’s national strategy on efficient lighting, which has been set up to implement Law 541-IV of 2012 on Energy Saving and Energy Efficiency. The strategy promotes the use of light-emitting diode (LED) lamps by introducing a phase-in ban on the use of incandescent lamps¹⁵⁴. Some specific measures include the following: (i) upgrade of indoor lighting in public buildings; (ii) upgrade of street lighting in towns and settlements; (iii) proposals for energy-efficient labelling for lighting products; (iv) demonstration projects on energy-efficient lighting; (v) proposals for amending construction standards for lighting; (vi) a proposal for setting limits on production and sale of mercury containing lamps; (vii) upgrade of electric lighting and power supply systems in multi-apartment buildings; and (viii) utilization of mercury containing lamps¹⁵⁵.

Smart payments

This project involves the provision of payment of utility services in electronic format. The system allows for payments in electronic format of bills for water supply, water disposal, gas supply, municipal waste disposal, residential expenses, and electricity, heating and telecommunication services. The system of personal accounts also keeps records of the payment history of residents in line with Law No. 94-V of 21 May 2013 on Personal Data and Its Protection. In order to input payments, an “electronic wallet” can be replenished via payment terminals and bankcards.

The project’s goal is the creation of a single account for all consumer utility payments. In the long term, the rolling out of all stages of this project will contribute to a “one-stop-window” that provides an opportunity to efficiently perform all city payments at one place, avoiding the need to visit several organizations. The project relies on an Internet portal that allows users to create an account and pay for city expenditures, such as administrative fines, taxes, electronic tickets for public transport, parking tickets, and polyclinic services, as well as to make contributions for school lunches of children.

¹⁵¹ “Smart Potential of Astana”, *Smart Astana*, No.3 (December 2015), p. 45.

¹⁵² The software provides the opportunity to dim each lamp separately or as a selected group of lamps.

¹⁵³ The project will also benefit from innovative development at the industrial park, where “Parasat” Holding established a joint venture with LLP “Led System” through a PPP mechanism for the manufacturing of LED products.

¹⁵⁴ Because favourable price changes for LED lamps have made such a strategy cost efficient, and given challenges related to disposal of mercury containing lamps, the Government has put in place Program 2020, which proposes to replace incandescent lamps with LED lamps.

¹⁵⁵ United Nations Development Programme, Project Document 2010-2015: Nationally Appropriate Mitigation Actions for Low-carbon Urban Development, (Astana, 2010), p. 13.

Other projects

In addition to the four pilot projects, a series of other initiatives have been envisioned that will be rolled out in the future through partnerships between the municipality and private investors, including the following:

- *Enhancing the ICT Infrastructure*

Astana Innovations will implement a series of projects aimed at strengthening the city's ICT infrastructure for the benefit of residents and the business sector. With the accelerated growth in the use of smartphones and tablets, urban residents have a real need for high-speed mobile Internet anywhere. Thus, one key initiative concerns expanding the coverage of free wi-fi urban locations. The "Open Wi-Fi" project was first designed in 2011. Its components involved strengthening the ICT infrastructure of Astana by creating a city network of hotspots that provide open access to the Internet. The project has been undertaken with the cooperation of "The One Capital" company, a partner of Astana Innovations. As of 2016, the project has provided free wi-fi access in 24 public places in Astana, including public monuments, parks, public transportation terminals, restaurants and shopping malls¹⁵⁶.

One outcome of this project has been that over 15,000 people a day now use free Internet in public places during working days, according to city authorities. In addition, the initiative has had an impact on the attitude of local entrepreneurs, who felt encouraged to extend the free provision of wi-fi services to their clients¹⁵⁷. Results of monitoring by Astana Innovations show that, as of 2016, all major public institutions of Astana (shopping centres, hotels, restaurants, cafes, sports facilities, libraries) provide clients with free Internet because they consider it a tool to increase their competitiveness.

- *Intelligent Contact Centre Astana*

Intelligent Contact Centre is a unit of the larger Complex Life Support System of Astana (CLSS). The goal of this project is to provide residents with efficient communication between the administrators of city services and related institutions. The Centre will perform professional processing of incoming requests received by the city services providers (e.g. Akimat units, emergency and dispatching services, among others). Once fully implemented, the system will allow for the centralization of all service requests from citizens; expand methods of informing the population about city services; provide receipt of requests through different channels (i.e. phone, email, website and social network); provide high-quality and fast processing of all types of requests; and keep a record of statistics on the provision of city services.

- *Unified Resident Card*

This project will enable the full coordination of all *Smart Astana* projects. Among other objectives, it will allow citizens to pay for bus tickets electronically; request appointments and access waiting lists at polyclinics; and enable students to use plastic cards to carry out such activities as entering school facilities through turnstiles and pay for lunches in the canteen. The goal is that, after full-scale implementation of each of the *Smart Astana* projects discussed, residents and visitors of the city will be able to request and receive a plastic card for the payment of all smart services. The "Unified Resident Card" will contain personal information of the card holder (e.g. full name, unique identification number, current monetary balance of electronic wallet). Replenishment of the electronic wallet will be possible through the Internet portal or payment terminals.

¹⁵⁶ Smart Astana, "Open Wi-Fi/Wi-Fi Bus". Available from <http://smart.astana.kz/en/projects-open-wi-fi.html> (accessed 15 November 2016).

¹⁵⁷ Ibid.

The introduction of the Card will be gradual. Initially, they will be granted to representatives of vulnerable social groups, schoolchildren and university students. In the longer term, they will be available for all residents and guests of the capital.

C. SMART CITIES AND THE SUSTAINABLE DEVELOPMENT AGENDA: IMPLICATIONS FOR ASTANA CITY AUTHORITIES

The potential for cities to become smarter and more sustainable will likely increase over time. The number of innovation activities by resident start-up companies has been increasing in many cities around the world, regardless of their population and size. During recent years, cloud computing, open software and hardware, social networks, and global payment platforms, among other things, have made it easier to create start-ups with fewer physical resources and personnel. The availability of new technologies lowers the cost of innovation and permits entrepreneurs to take scale and other advantages from agglomerations. Thus, these trends have let businesses take advantage of city agglomeration effects to a greater extent than only a few years ago.¹⁵⁸

A research programme by the Economist Intelligence Unit (EIU) has shed light on some of the key agendas for the future of smart cities, which include both aspects of improving the use of technologies in city planning and enhancing transparency and public participation. The programme brings together the views of citizens, businesses, government leaders and experts. In May 2016, the EIU conducted a survey of 1,950 citizens and 615 business executives in 12 cities: Barcelona, Berlin, Buenos Aires, Chicago, London, Los Angeles, Mexico City, New York City, Rio de Janeiro, Shanghai, Singapore and Toronto, the findings of which have provided useful feedback to policy makers.¹⁵⁹

For instance, survey information has provided a list where future avenues for smart innovations are more promising, which include the following¹⁶⁰:

- the improvement to quality and affordability of social services (e.g. education and healthcare);
- reduced traffic congestion;
- faster access to city services and more transparency (e.g. e-government);
- crime reduction and improved emergency services;
- improved commuter networks;
- improved delivery of utilities such as water and electricity;
- improved waste management services, reduced pollution, energy consumption and other improvements in environmental sustainability;
- vibrant city life and leisure activities (commerce, festivals, public spaces).

¹⁵⁸ Victor Mulas, Michael Minges, Hallie Applebaum, “Boosting Tech Innovation: Ecosystems in Cities: A Framework for Growth and Sustainability of Urban Tech Innovation Ecosystems”, Discussion Paper, No. 100899 (Washington, D.C., World Bank, 2015). Available from <http://documents.worldbank.org/curated/en/623971467998460024/pdf/100899-REVISED-WP-PUBLIC-Box393259B-Tech-Innovation-Ecosystems.pdf>.

¹⁵⁹ *Empowering cities* is a research programme developed by the EIU, on behalf of Philips Lighting. The goal of the project is to assess the progress of cities toward adopting smart technologies. Between 150 and 185 respondents were interviewed from each city; of these, about half were aged 18-34 and the other half were aged over 35. In terms of gender, they were evenly split. Business respondents were drawn from various industries, functions and company sizes. See footnote 161.

¹⁶⁰ Economist Intelligence Unit, *Empowering cities: The real story of how citizens and businesses are driving smart cities* (2016), p. 14. Available from <http://empoweringcities.eiu.com/wp-content/uploads/sites/26/2016/09/Empowering-Cities.pdf>

With regards to the functional areas where digital technologies have impacted city life, survey information shows that both citizens and business representatives point to telecommunication services (36 per cent) as the most important area that was transformed through recent innovations. It is followed in ranking by transportation; emergency and crime prevention; e-government; and social services. Other areas that were not highlighted by recent experiences but were still deemed promising for transformation in the near future include pollution reduction and environmental sustainability. Overall, the EIU analysis highlights that the surveyed cities are facing similar challenges regardless of the different levels of economic development, which points to the fact that application of digital technologies can generate significant improvements for the welfare of urban dwellers anywhere.

When contrasting the experience of Astana with that of cities in other countries reflected in the EIU study, it can be suggested that much of what has been taking place in Kazakhstan's capital city is in line with global trends. Looking forward, there is still much potential for Astana to develop further applications that rely on data provided by citizens. Whereas the pilot and other projects promoted by Astana Innovations seem to constitute a solid base to build new projects, the experiences of other cities also point to alternative policy paths that could further strengthen both private sector involvement and public engagement.

With regards to the incorporation of sustainable development priorities in the agendas of municipal authorities in line with the adoption of Agenda 2030, there is much room for government action, as well as private led investment, to undertake new projects that could ensure both increasing economic returns and the achievement of public objectives. Recent examples of smart uses of new technologies – IT in particular – point to the importance of innovations that help gather, store and manage data on aspects of urban life, in areas ranging from traffic and land-use planning to pollution and crime. Also, the innovative use of digital technology can improve city safety structures at times of natural disasters (see Box 3).

Box 3

Success stories regarding the smart use of digital technologies that foster sustainable development

USA: In Boston, dwellers can use smartphones to record road defects through the “Street Bump” application. The GPS location is uploaded to a server for analysis, and this data helps municipal authorities to monitor potholes and other road issues. It also helps set priorities regarding decisions about investments in the road network. The application was developed by the Mayor’s Office of New Urban Mechanics. In Pittsburgh, the Myburgh application allows citizens to log service requests through cell phones and consult government press releases, including through social media interaction.

Spain: IT applications have been used to monitor the performance of procurement for the maintenance of public assets (e.g. parks and roads). In Madrid, work has been undertaken with IBM to develop a platform that aggregates data from invoices and other sources, including reviews by citizens, to assess the performance of suppliers. Pay rates for contracts have been tied to performance in order to enhance efficiency. In Barcelona, wireless sensors have been utilized to collect data on environmentally significant variables (e.g. temperature, air quality, pedestrian traffic, waste recycling), with information accessible to citizens through smartphone applications.

Poland: Until recently, Warsaw had no motorway system and just one metro line, and the relatively dense railway network was underused. During the last decade, the development of the city's transport network, including intensive expansion of the metro, has stimulated urban development and promoted wiser use of urban spaces. As part of this process, the city authorities have explored low-emission technologies (e.g. alternative fuel power was used in the entire urban bus fleet). Other innovations included the implementation of a single ticket system for all modes of transport, and an intelligent traffic management system.

Indonesia: In 2015, PetaJakarta, an online open-source platform, was developed. The application allows collecting information about flooding in the country's capital city, Jakarta. The software crowdsources information on flooding inputted by residents, so that city emergency authorities can promptly react. The application works through geo-location technology, which gathers users' reports posted on Twitter, and adds each report to an open-source map.

Source: Astana Innovations and Astana Invest Forum 2015.

Conclusions on the Achievements, Opportunities and Challenges for Astana to Become a Model of Smart and Sustainable City

Over recent years, a dichotomy can be observed among municipalities promoting smart innovations between those who are investing in IT infrastructure and data collection devices on the one hand, and those who have emphasized the development of human capital resources of residents through investments in knowledge generation and opportunities for public participation. Each of the two groups have been interpreted as representing, respectively, a "hard" versus "soft" approach to developing smart cities. Whereas the hard approach focuses on infrastructure refurbishing and setting-up selected urban sensors that gather information, the second group focuses on the level of education of the people and identifying incentives and other determinants that encourage them to participate and innovate.¹⁶¹ It should be highlighted that both types of interventions can benefit from proper planning, inter-ministerial coordination, and PPPs.

In the case of Astana, although existing projects put an emphasis on the "hard" approach, the need to increase public engagement has already been acknowledged as a priority for one of the components of the *Smart Astana* initiative. The two types of intervention may face significant constraints; therefore, a list of policy challenges needs to be considered by national and local authorities of aspiring cities that wish to embrace smart innovations concerning policy implementation. Regarding the short to medium term, the following is a summary of the crucial subject areas:

- The need for improved coordination between national and municipal innovation policies.

If city administrations are provided more resources to tackle the most pressing sustainable development challenges, there will be more need for coordination between existing capacities at the local level, and policies and strategies of national governments addressing the same areas. Firstly, support by national authorities is crucial with regards to the setting up of technology standards and best practices. Higher levels of government are also relevant to sanction legislation that promotes a transparent business environment. Whereas national authorities play

161 Francis Pisani, *A Journey through Smart Cities: Between Datopolis and Participopolis* (Paris, UNESCO Publishing, 2015). Available from <http://unesdoc.unesco.org/images/0023/002344/234422m.pdf>

crucial coordinating roles, these need to be complemented by the need for more practical and locally customized solutions that directly affect people's needs at the city level. Thus, further collaborations between city and national authorities in the design of "smart" development strategies should be encouraged. This collaboration should be based on the clear distribution of roles and responsibilities of different authorities (i.e. avoiding overlaps and improving communication). Such closer collaboration between different authorities will create synergies, and enable funding of integrative initiatives by local and national authorities.

- The need for improved transparency in legal frameworks and privacy protection.

It is likely that, progressively, smart applications will involve the generation, storage and use of newly generated information that may affect citizens' rights. Thus, it is important that municipal authorities in Astana engage the national Government in creating a suitable legislative environment that promotes the disclosure of data while guaranteeing appropriate levels of privacy. Crucial examples of what needs to be legislated include how cities may obtain energy use data from utilities, or how medical records may be shared to create more effective, systemic health-care solutions that involve emergency responders, social support of civic organizations, hospitals, health insurers, and other actors.¹⁶²

- The need to enhance citizen participation.

Social media and other forms of crowdsourcing have increasingly given stakeholders the opportunity to provide feedback on city services and infrastructure. Thus, there is a potential for digital technologies to offer ample opportunities to democratize decision making at the city level. For instance, technology has the potential to channel increased citizen participation and to enable elected officials to solicit far greater input on decisions than would be possible by scheduling public hearings or other traditional means. If government officials accompany these trends with policy reforms, this will add another layer of grassroots participation in a city's innovation ecosystem.¹⁶³ Astana authorities could learn from examples of successful participatory experiences both online (e.g. applications and platforms) and offline (e.g. laboratories and innovation spaces) gathered by the European Innovation Partnership on Smart Cities and Communities (EIP-SCC).¹⁶⁴

- The need to engage in national and international networks of learning.

Enriching local innovation ecosystems by linking to global networks of academia, businesses and civil society organizations is critical to ensuring continuous learning and the transfer of technology. Such networks may also be of help in recruiting and retaining a workforce that shares common values about improving urban life, and thus boost a city's scarce technical skills. Examples of peer-to-peer collaborative models between cities and other institutions that have addressed significant sustainable development challenges (e.g. monitoring GHG emissions and combatting climate change, promoting innovation amongst disadvantaged

¹⁶² Luís M. A. Bettencourt and Javier Gonzales, "Science and Practice for Thriving Cities Free Access", *Innovations: Technology, Governance, Globalization*, vol. 11, Issue 1-2 (Winter-Spring 2016), pp. 20-30.

¹⁶³ The results of the EIU survey in some large cities reveal there is certain room for improvement. Few respondents say they feel able to have an impact on smart city projects (15%) or improvements in energy and water services (9%), while one in four executives (the largest group) feel that their company cannot participate effectively in urban improvements. See Economist Intelligence Unit (2016). *Empowering cities: The real story of how citizens and businesses are driving smart cities*.

¹⁶⁴ European Innovation Partnership on Smart Cities and Communities, Citizen Focus Action Cluster, Principles and enablers for citizen engagement: the experience from the European Innovation Partnership on Smart Cities and Communities (n.p., 2015). Available from [https://eu-smartcities.eu/sites/all/files/CitizenFocus%20FINAL%20DOC%20\(2\)_0.pdf](https://eu-smartcities.eu/sites/all/files/CitizenFocus%20FINAL%20DOC%20(2)_0.pdf) (accessed 15 December 2016).

groups, matchmaking between research centres and city authorities) already exist¹⁶⁵. Astana authorities could consider engaging in such types of initiatives. To increase the chances of success, it would also be important for them to create technological platforms that promote network effects between cities and other regions of the country.

- The need for smart calibration in the building of new infrastructure through the involvement of private and public actors.

The transition towards smart cities creates both challenges and opportunities for interaction between public and private interests, including through PPPs. Successful PPPs have already been undertaken to promote smart and sustainable projects. For instance, in Australia, PwC (a business management consultancy) recently assisted the transportation authority in Sydney in the creation of a community of smartphone application developers.¹⁶⁶ In the future, Astana authorities can expect both local and foreign investors to become interested in partnering with them to develop its smart infrastructure. In this regard, the recent launching of the *Astainable* initiative, in cooperation with the Government of France, will offer numerous opportunities for French firms to undertake smart and sustainable development friendly projects in infrastructure, including eco-mobility, energy expertise, responsible water and waste management, sustainable construction, digital and information technologies, and farming and nature in urban environments.¹⁶⁷

Concerning the undertaking of PPPs, the UNECE has been at the forefront of discussions on how to best adopt best practices in the creation of infrastructure, that could bolster innovation and sustainability at the urban level. Notably, in 2015, a Centre of Excellence was established in Barcelona, Spain, that was sponsored by the local City Hall (see Box 3). Considering the variety of projects envisioned in the Astana Smart Concept, engaging with the programme of activities of the Centre could offer significant learning opportunities to Astana authorities in the future.

¹⁶⁵ Global initiatives such as “C40 Cities” and the “Compact of Mayors” have helped standardize the accounting of GHG emissions in cities; and promote innovations and collaborations to combat climate change. In the United States, the “My Brother’s Keeper” initiative by the White House seeks to create a network of cities that addresses issues related to disadvantaged youth. The MetroLab network, launched in 2015 as part of the White House’s Smart Cities Initiative, helps form partnerships between research institutions and city governments to develop practical solutions using ideas and technologies from scientific practice. See Bettencourt, Luis M.A. and Gonzales, Javier (2016).

¹⁶⁶ Top software application developers participated in a competition to present applications for city bus passengers, and winning teams were offered access to geo-location data of buses and support in advertising through the Transportation for NSW. This initiative allowed software firms to assist in the development of smart infrastructure, improving the welfare of passengers who can now better plan their trips. See Nartaev, A. (2015).

¹⁶⁷ A contract by the French Government was awarded to a consortium led by Eiffage in partnership with EGIS, ENGIE, Poma, Suez Environnement, Enodo and PGA. The consortium’s role is to promote French excellence in the various “bricks” that make up a sustainable city. For more information, see website of Eiffage - <http://www.eiffage.com/en/home/developpement-durable/astainable.html> (accessed 10 December 2016).