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CONTENT

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INNOVATIVE GOVERNANCE OF LARGE URBAN SYSTEMS

Today, urban development has begun to attract more attention than the development of individual countries. The impact of the development of the city on social life and the development of the cultural and technological environment in the region, as well as the emergence of new companies, is becoming important. We see that today large multinational companies appear in certain cities. For example, Salesforce, Fitbit, Square, and other big companies have sprung up in San Francisco; Shenzhen created conditions for the emergent development of Huawei, Tencent, Mindray, etc. In such cases, the task of the city administration is to create conditions not only for attracting talent, but also for their development in these cities.

After the reading the writings of major urbanists such as Frederick Olmsted on the development of Open Spaces in the early 20th century, André Duani on "New Urbanism" and Richard Florida on creating a creative class in cities, we understand that city management process is a creative process, and it is very important to understand social environment of the city and make the most of new technological opportunities in order to provide comfortable conditions for the development of residents.

In Almaty, we pay great attention to the development of the Smart City program and it is extremely important for us to focus on the needs of each citizen and create an environment for inspiration to everybody.

We are grateful to IGLUS for the opportunity to share the experience of the city of Almaty and are confident in the development of new high-quality joint projects

Bakytzhan Sagintayev
Akim (Mayor) of Almaty City

Almaty is the largest metropolis, scientific and educational, cultural and historical, economic and financial, banking and industrial center of Kazakhstan. The city is also considered the economic center of the Central Asia region. Almaty is in the South-East of Kazakhstan, at the foot of the Northern Tien Shan Ridge - Zaili Alatau. The urban territory of Almaty covers more than 782 km2 with about 2 million registered population. Since October 2020, Almaty City Government has initiated a 5-year Smart City strategy in collaboration with Innovative Governance of Large Urban Systems (IGLUS) action-research program. Almaty Smart City aims to create a technological architecture covering all the information systems and Information Technology (IT) infrastructure on the city level with the description of service, data and infrastructure layers. In this issue of IGLUS Quarterly, we will further investigate this technological architecture with the articles of the experts from Almaty City.

The issue starts with the article of Mr. Konirbayev and gives a deep discussion on the smart urban transportation infrastructure initiative of Almaty City as the city government has been developing a new complex urban transportation model by focusing on data integration and data collection system infrastructure aiming the cooperation of state bodies with private organizations and the scientific environment, in which new improved technological solutions will be iteratively developed on the basis of a list of current problems provided by the government representatives of Almaty.

The second article focuses on The Unified Communication Space (UCS) for the Smart City Concept of Almaty. Ms. Bakhytgul Zakirova's article presents an overview on the newly created platform of Almaty City Government: UCS. The platform unites all educational institutions, technological parks, accelerators, incubators, and IT companies into one platform and provides direct access and direct communication for each participant.

The third article is from Kazakh British Technical University (KBTU). Kultyshev Evgeniy's article briefly covers Urban Living Laboratory (ULL) evaluation framework designed for Almaty City. The article demonstrates the role of scoring system in better understanding the overall situation of smart city platform construction. His article also discusses the research activities aimed at creating a metric system for smart cities' productivity and stability monitoring and evaluation.

In the last article, Madi Saken explains the geo-analytical system of Almaty City for city activity analysis, based on telecom data. His article talks about the description of the system, its content and how city departments use analytics. He gives further discussion on its application for COVID pandemic with studies on finding correlations and building predictive models for morbidity rate. Furthermore, developmental plans and potential use cases are reviewed.

We sincerely hope that you can enjoy the articles on this special of IGLUS Quarterly for Almaty Smart City. We invite you to join the discussion at iglus.org. If you feel there are innovative practices underway in your city/region and you would like to contribute to an upcoming edition of IGLUS Quarterly, we encourage you to contact us at umut.tuncer@iglus.org. You may also contact the editors of this issue through numanyanar@hotmail.com and bkonirbay@gmail.com.

You may visit https://digital-almaty.kz/ for further information about Almaty Smart City.

Editors: Numan Yanar and Bayan Konirbayev

Smart Urban Transportation System in Almaty City, Kazakhstan: A Case Study

Bayan Konirbayev*

Abstract: *Every city with high population density faces the problem of providing convenient and comfortable service of public transportation for their citizens. It is very important to understand the certain steps of the development of public transportation system based on buses, Light Railway Transportation (LRT), Bus Rapid Transit (BRT) and subway stations. Almaty City public transportation strategy is focused on the integration of Vision Zero practices and the basic solution provided by the city administration should be arranged according to the standards of Vision Zero concept (Belin, 2011). This article describes the possibility of implementing of different solutions in order to create the basic ecosystem around the citizen and "one card methodology" with tracking activity of mobile transport.*

Keywords: *Public transportation, vision zero, smart city, urbanization, digital infrastructure, Almaty City*

Author's Profile

Bayan Konirbayev is a Chief Digital Officer at Almaty City. He is responsible for the development and the implementation of digitalization strategy in Almaty City with a smart city development perspective. Before his position in Almaty City government, Bayan also served as the director of the Business Transformation Department in Mining Industry in Kazakhstan, as the Deputy Director of International Business Development Department in HY/Tencent Artificial Intelligence Laboratory in China, and as a senior project sales supervisor at Global Business Investment Development Department of Bright Oceans Corporation in China. He has had more than 10 years of working experience in Asia-Pacific, Europe and Commonwealth of Independent States countries.

Introduction

Almaty is the biggest city in Republic of Kazakhstan with more than 1.9 million population. The city was founded in 1854, and due to rapid increase of population the pressure on the urban infrastructure has relatively increased in last 20 years. The city size is 683 km^2, and average age of the citizens is 33.5 years. From economical perspective, Almaty City provides 18.5% of country's Gross Domestic Product (GDP) or around 35 billion USD in 2018, where 5.1% is related to transportation industry.

Currently, public transportation has 2232 public buses, 3 BRT lines and a subway system with 9 stations. All public transportation vehicles are equipped with Geo-Position System (GPS) trackers. According to the year 2018, 86% of citizens used buses, 10% used trolleybuses and 4% used metro. The traffic situation is not standardized, there are 352 000 cars registered in Almaty City and more than 200 000 cars are entering the city every day (Almaty City Government, 2020). In addition, Almaty City runs 400 cars for sharing and 194 public bicycle stations

In December 2017, a state program named "Digital Kazakhstan", which aims at complex development of the country's economy and improving the quality of service for the citizens as well as creating a digital economy of the future, was approved. The program takes a role for the transition to a digital state by introducing the concept of "Smart city" (Almaty City Government, 2020). The main goal of the initiative is to create an urbanized area in which the resources of city services and private initiatives interact and collaborate to ensure a sustainable development of the city by creating favorable conditions for the residents and the visitors of the city through implement-

* Chief Digital Officer at Almaty City

ed technologies in real time.

As a part of Almaty Smart City, smart urban transportation system has also been introduced. This article is based on this system of Almaty City and revised on the basis of the need to update the lines of activity at the request of the population, business and the scientific environment.

The main format of interaction between the participants in the digitalization development initiative is the cooperation of state bodies with private organizations and the scientific environment, in which new improved technological solutions will be iteratively developed on the basis of a list of current problems provided by the government representatives of Almaty. Thanks to the integration of the systems on one solution, the city government collects real time data of activity inside the city and agglomeration.

Smart Urban Transportation System

Since 2016, Almaty City government has been developing a new complex urban transportation model with focus on data integration and data collection system infrastructure. The main format of interaction between the participants in the digitalization development initiative is the cooperation of state bodies with private organizations and the scientific environment, in which new improved technological solutions will be iteratively developed on the basis of a list of current problems provided by the government representatives of Almaty. For the development of smart urban transportation system, the city administration of Almaty has been focusing on the following points:

- Creation of an innovative technological ecosystem by providing conditions for the development of Information Technology entrepreneurship with strong links between business, science and the state;
- Development of a pilot zone for applying the Long Range Network Protocol (LoRa) protocol as a part of promoting the development of the application of the concept of the Internet of Things (IoT) in the urban transportation system (Wang, 2008).

While following of these goal, several challenges are confronted. These problems related to the public transportation system are:

- Decentralization and lack of coordination of bus operators
- Absence of a unified payment system
- Low level of efficiency
- High maintenance cost
- Automobile competition

Challenges related to the managerial level (Table 1) and public level (Table 2) should be determined clearly. The role and responsibility of the private company and government administration working with public transport operators will show better results if the whole challenges will be determined in

Table 1. Managerial challenges
Source: Author's own resources

Challenges	Infrastructure layer	Services layer	Data layer
Technological	Interconnection of transport modes of IoT sensors to the current infrastructure	Interoperation between new smart devices and traditional transport services	Managing data standards, data flow and protocols
Economic	Financial funding to the new projects	New disrupting business models	Data governance fee
Social	-	User acceptance	Security
Political	Cooperation with local governance in order to control long-term investments	Profit sharing and conditions of government funding	Calculation and presentation of the qualitative benefits
Jurisdictional	-	-	Data ownership coming from the private IoT sensors

Table 2. Policy challenges
Source: Author's own resources

Challenges	Infrastructure layer	Services layer	Data layer
Technological	Finding the most optimal technical solutions	-	-
Economic	Financial funding on traditional and digital infrastructure	Increasing the number of services with limitation to direct financial funding	Building the data warehouse and providing technical support
Social	-	-	Different rules for the part of specific data
Political	Infrastructure development and land use planning	-	Data policy and regulation
Jurisdictional	-	-	Data policy and regulation

advance (Lombardi, 2010).

The new concept of the development of urban transportation system is focused on the balance between the development of traditional infrastructure and digital infrastructure. According to the strategy of Almaty City 2050, urban transportation should be more adaptive to the citizens' services with three directions:

- Infrastructure layer
- Ecological layer
- Smart mobility layer

Smart mobility layer is the main direction and it is represented by digital Infrastructure. Digital infrastructure consists of data layer and IoT part.

Implementation of the Mechanism of Data Layer

From one side, data layer should develop informative side of the whole transportation industry in the city, from another side, it should have and interconnected structure. Intellectual Transportation System is based on the development whole transportation eco-system with Intellectual Traffic Lights (ITL), video monitoring system (Altshuler, 1980) and smart vehicles (vehicles with implemented IoT sensors, which should be able to share the current status with the Transportation Center).

Implementation of the mechanisms of the IoT

The concept of using the IoT was formulated in 1999 with the aim of ensuring, on the basis of radio frequency identification, the interaction of physical objects with respect to each other and external information systems. The spectrum of technology application applies to all physical devices, reporting the status of each object with a focus on inter-machine data processing. The level of autonomy of the sensors and the accuracy of measurement and range are fundamental. IoT technologies (data transmission through sensors at installed sites) are at the initial stage of development and in the future they will have very strong growth potential, and will be applied in all areas of the city life from utilities to healthcare.

IoT technologies for Almaty Smart Urban Transportation System were utilized throgh LoRa protocol. LoRa is and IoT protocol for low data rate, low power, low cost and long range sensors (Hong, 2018). LoRa protocol was created in January 2018. Because of its technological advantages, it is optimal for existing development. The creation of an applied educational laboratory in partnership with the main protocol developer will contribute to the development of the IoT technology, not excluding the possibility of using other types of protocols and will also create a new cluster in the city's economy with the necessary number of professional specialists namely according to the LoRa IoT protocol (Wang, 2008).

Practical Steps

To solve the problem of the development of IoT infrastructure, a number of the following actions are required:

1) Integration of new projects in road construction with Internet of things.

2) The signing of a strategic document of interaction with representatives of the LoRa Alliance to at-

tract projects for the application of this protocol to the city of Almaty.

3) Creating a list of protocol integrators with an individual development plan for new companies with the ability to work in applied projects.

4) Definition of pilot zones within the city for adaptation and subsequent application of transport solutions.

5) Adaptation of all of public transports the IoT protocols.

The next chapter will describe the certain solution based on the unified dispatch center created to monitor public transport on the basis of Almaty City Transport Holding.

Pathway

In order to develop the whole smart mobility concept, in 2016, smart public card "ONAY" was created for the whole public transport vehicles with functionality to use it even in bike sharing stations. The idea of gamification was applied to it as well, so when the person gained the certain number of miles used by public transportation he can apply for some certain discount in public entertainment centers, like museums, theatres etc. (Yelemessov, 2017). Moreover, each bus is equipped with GPS tracking sensor and IoT sensors to count every person coming inside, that helps to monitor the whole situation through the situational center located in Transportation holding.

In 2018, the city started to build new traffic lights system based on intellectual distribution, so that lights would be able to calculate the certain routes and according to the traffic situation in the city, based on video monitoring analysis, would be able to reduce or increase time green or red light in particular road sections.

Results

Even though various challenges have been confronted, Smart Urban Transportation System of Almasty has been showing successful results in terms of

- Adapted and modern regulations especially developed for public transport
- Environmental friendly policy of public transport
- Convenient service for passengers
- Integrated intelligent traffic management system
- Sustainable development of the public transport system

Conclusion

The highest priority in this case is to keep the balance between traditional transportation systems and create new digital infrastructure without losing already sustainable process. The rapid change in technology shows that the implementation of new protocols and sensors will bring more opportunities and threads. With integration of autonomous vehicles and artificial algorithms, it expected for the beginning 2030 that the whole concept of public transportation will be changed. Regarding this, certain steps should be taken with regulations.

- Responsibilities of the each stakeholder should be confirmed in advance with the following steps:
- Confirmation of the main stakeholders of the project which is Almaty City Transportation Holding
- Settlement of one ecosystem with unified payment instruments and unified monitoring system based on IoT sensors and GPS tracking system
- Early application of IT architecture so that there will be no problem with data integration in the future.

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The Unified Communication Space for the Smart City Concept and an Innovative Ecosystem

Bakhytgul Zakirova*

Abstract: *It has always been a big issue to provide an excellent educational platform which will be able to collect all the data from the students and map it with certain demand coming from the private companies. As part of the implementation of the strategic task for the development innovation ecosystem in Almaty, Almaty city government created a platform: Unified Communication Space (UCS) for the universities located in Almaty in order to create an ideal environment for IT community. The platform unites all educational institutions, technological parks, accelerators, incubators and IT companies into one platform and provides direct access and direct communication for each participant. Currently, more than 15 IT companies and about 500 IT talents are recorded on the platform. The city within a few years had a problem building the right ecosystem based on a point of attraction for IT talent, which will allow to nurture competent and adapted IT talents at the city level. Also, the city government is focused on increasing the resources in the city through the communication of the direct business and the educational cluster. To transform the communications between the different stakeholders in the innovative ecosystems, the local government of Almaty is implementing a public platform to bring about positive social and economic outcomes and developments in the IT sphere. This article reviews the main concept underpinning this platform, and examines its impact on different participants and the subsequent increase in their efficiency.*

Keywords: *Unified Communication Space, smart city, innovation ecosystem, talent development, smart education, IT community*

Author's Profile

Bakhytgul Zakirova has extensive experiences at both local and central levels of government. While working at the Ministry of Economy, she has also worked in the Government of Kazakhstan's central policy-making unit, which is responsible for the development of the public administration system in Kazakhstan and the conducting of administrative reforms. Her responsibilities have included undertaking a functional review of governmental organizations, as well as monitoring Kazakhstan's competitiveness and the improvement of its public services. Thus, she has been involved in a project related to designing a concept for the modernization of the public administration system. In 2013 and 2014, she was involved directly in reforming the public administration system. She also assisted to draft legislation that expanded the power of local authorities. The relevant draft laws were subsequently approved by the Parliament and the President of Kazakhstan. As part of these reforms, 5000 employees were transferred from the central level of public administration to local governance bodies. Pertinently, at the local governance level, Bakhytgul has worked on improving public service provision and processes

Introduction

The implementation of Information Technology (IT) projects brings various problems to deal with. These problems are mainly because of low-quality implementation, difficult adaptation of employees and misunderstanding of company processes, poor selection of employees, limited talent base (i.e. a pool of competent employees), and a lack of control over employee training. Moreover, a lack of a clear communication line with the public sector and updating disciplines at universities are also among the risks faced by the public management of the smart city concept.

As a tool for a transformation within the smart city concept, having the right communication platforms for IT development is imperative, albeit it is not always possible to implement the required measures in a short timeframe with desirable outcomes. This is because the approaches used in such implementation and the particular conditions might influence or hinder the process. Despite of certain achievements having been made regarding reforms in Kazakhstan,

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the fact that a number of remaining problems might lead the question of whether the approaches to implementing these administrative reforms is viable. In 2020, a platform named the Unified Communication Space was established, serving as an incentive in the implementation of the smart city concept in Almaty city. In this article, the preconditions to the successful implementation of this platform are considered. In addition, it is also suggested that the creation of such platforms would boost smart city development. Another aspect borne in mind is that the Unified Communication Space might turn out to be crucial as a means of value creation in an innovative ecosystem through punctual interaction with universities, IT businesses, and IT talents. A review of the possible social and economic effects of the platform is also undertaken.

According to the Strategy "Smart Almaty" for 2020-2025, one of the main tasks is the creation of a unified platform for the development of human resources in the field of IT. It was outlined in the Strategy, that "the development of human resources is the most important component of digitalization projects, and is seen as a long-term goal. Given the importance of the task, it is planned to create a platform on the basis of secondary and higher education institutions in order to improve the quality of training, accounting and development of specialists in the field of digitalization."

The main goals of the platform are creation of a qualified base for the preparation of theoretical and practical skills among the younger generation, stimulation of interests in the development of new technologies, identification of the most talented representatives of citizens interested in the development of the city through a digitalization program. Creation of the most optimal conditions for the functioning of active and competent human resources in the field of IT in the city of Almaty, mechanisms for coordinating and tracking the processes of training young specialists in a conducive environment in the course of the development of IT infrastructure, according to the specific IT needs within the city and a pool of successors and to profile them in order to provide targeted grants for education and development of needed competencies are also among the main directions of the platform.

The platform's other objectives are to distribute business tasks and cases for each direction and to identify the most advanced and capable personnel in the field to get involved in practical solutions throughout the city, to build common platforms for communication for all students through a single portal; and a map of occupations and professions corresponding to the relevant technical universities.

To implement the strategic task of developing an innovative ecosystem, work has already begun on establishing the Unified Communication Space for representatives of the IT community in Almaty, seeking to unite all educational institutions, technology parks, accelerators, incubators, and IT companies into one platform and providing direct communication for each participant. This entails creating a platform for developing and tracking IT talents, development of a unified communication space for IT, business, and educational clusters, making a creative space with a focus on IT development in Almaty, and organizing a convenient platform for all users.

The platform contains such options as the option for an employer (and business) to apply to find talents that would meet their IT skills requirements, the option for IT talents to find an internship, additional training, and jobs; and the option for a technical university, as a coordinator, to offer their specialized courses (paid or free).

Overall, the project intends to ensure development of IT talents, educational institutions, and businesses, to create an innovative ecosystem to nurture highly-qualified and competent talents, which will boost future business development, as well as for the city of Almay, and to build an IT talent pool.

The project's outcomes are directed to active IT

entrepreneurship in Almaty, especially among talented young specialists in IT, advanced training of IT specialists for specific IT business needs, to ensure employment for IT talents and IT freelancers, to increase the attractiveness of technical universities' specialized courses.

At the initial stage, three pilot partner universities (Kazakh-British Technical University, Kazakh Institute of Management and Economical Planning, and Suleyman Demirel University) prepared their own specialized courses to which IT talents could apply in order to advance their own skills to pursue career or other goals.

The budget has been determined and the technical specifications for the platform have been prepared.

Regarding the first stage users, a list of talented students in the field of IT was drafted of university students and specialized secondary education institutions, earmarked as potential practical problem-solvers in the development of the city with regard to digitalization projects, and a list of potential IT freelancers has been prepared from the registered unemployed (from the Employment Center – 1,900 people) and entrepreneurs (from the Koldau Atameken database – 195 people).

Expected Outcomes

The Unified Communication Space aims to create an economically stable ecosystem with a focus on citizen satisfaction and quality of life for IT talents, employers (businesses), and educational institutions (universities) in Almaty. Regarding the smart city concept, such communication platforms in their bottom-up implementation might have an effect on the relationships between city administration, businesses, universities, and researchers (Hall R., 2000).

The project promotes the formation of highly-qualified IT-talents for the Almaty market, as well as driving an improvement of business and educational institutions. By creating the Unified Communication Space, the city administration also aims to reduce the existing problems with respect to finding jobs for students in Kazakhstan through a wide range of learning courses and offering latest news on IT business developments and relevant educational and employment opportunities. Ultimately, this platform can be used for a broad range of education and employment areas.

Regarding educational impact, it was suggested that a concentration of highly-educated or skilled professionals in particular areas might have a positive effect on quality of life in the community and lead to the modernization of the local economy. In this regard, the Unified Communication Space provides an actual knowledge base connected with the actual business needs in its approach, and can provide such a concentration of educated professionals in different areas (i.e. creating a pool of smart people for a smart economy) (Avdeeva E., Davydova T., Skripnikova N., Kochetova L., 2019).

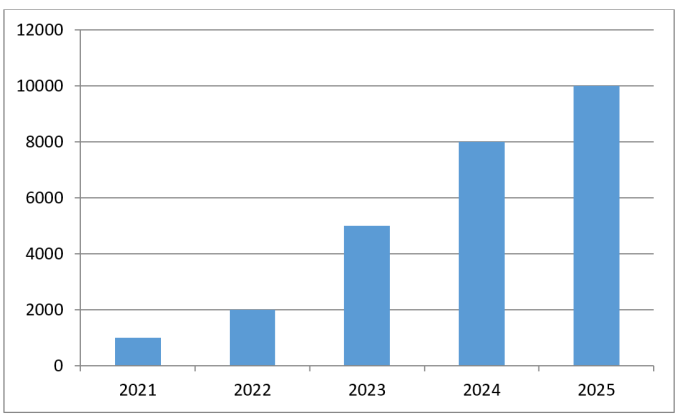

Figure 1. Active users of the system (2021-2025)
Source: Author's own resources

Another incentive behind the platform is tackling unemployment in the city. Projected number of Unified Communication Space users until 2025 is given at Figure 1.

According to this projection, it is expected that the

number of users or IT talents might positively affect value creation in IT network communication connected to the Smart City projects.

The Unified Communication Space is supposed to play a crucial role in the process of knowledge creation, and building relationships between universities, IT businesses, IT talents, and local government. It also serves to provide other opportunities with respect to reorganizing universities' traditional approaches to the provision of education to meet actual business needs in not only the IT sector but also in other socio-economic areas.

The Unified Communication Space as A Part of A Sectoral Innovative Ecosystem

As mentioned above, the Unified Communication Space tends to create sectoral interaction for IT talents, businesses, universities, and local government. In this case, there are exchange and learning opportunities for all participants of the Unified Communication Space in order to create new types of interaction, and knowledge- and experience-sharing. Furthermore, further learning and analysis is facilitated to ensure value creation in the course of the innovative interaction of participants from different sectors. For instance, for universities this is an innovative way of taking their educational perspectives into account and consequently modernizing their courses to be compatible with IT business and talent needs. At the same time, the universities might benefit from the scientific approaches undertaken through sectoral interaction and improvements to their taught courses. For IT talents, the platform better comprehends their actual demands when it comes to IT projects on the market and, consequently, enhancing their knowledge and competence in the process. Through sectoral systems of innovation, actors and networks are central elements of innovative activities (Malebra F. and Adams P., 2014).

There is another purpose of the Unified Communication Space to be noted in connection with value creation. Specifically, the Unified Communication Space has constructed explicit interconnections for each sectoral participant and clear coordination in the exchange processes. A positive element of this platform is that there are clear incentives for each ecosystem part to be interconnected, not only for IT purposes but for a wide range of economic areas. Encouragingly, there has been a considerable interest among financial institutions to be represented in the Unified Communication Space as taught course providers.

The certain literature review describes the meaning of innovation ecosystem. Innovative ecosystems might be defined as networks of interconnected organizations connected through a platform, and involves both production- and use-side participants, consequently creating new innovation value (Pellikka J. and Ali-Vehmas T., 2016).

It is recommended to increase interconnection in the ecosystem as doing so can lead to technological and business model changes that have a positive effect on the development or modernization of innovation (Pellikka J. and Ali-Vehmas T., 2016).

As mentioned above innovation ecosystem should be based on a common vision shared by all the users. In order to have that common vision all the subjects of ecosystem should be connected with setting goals and a conducive business environment for overall innovation. Moreover, the Unified Communication Space provides greater understanding of the needs of universities, IT businesses and IT talents. For IT talents, it represents an opportunity to implement urgent tasks to allow them to work in a team with experienced IT specialists, while for entrepreneurs and businesses there is a possibility to match project tasks with needed specifications (and deadlines), and for universities it enables them to keep up to speed with business needs and to amend courses accordingly. Ultimately, if the expectations of the participants in this communication network are met, the impact on innovation might indeed be positive.

Conclusion

As discussed above, the Unified Communication Space created by the local government in Almaty city has sought to implement strategic goals in connection with the smart city concept as part of an innovative ecosystem. On the other hand, having a correctly managed platform in place is vital as it is a new system and there is a need for proper understanding of all the benefits and motivations for all participants involved. As the Unified Communication Space is still only at the beginning of its implementation, further research and discussion over a longer timeframe and reviewing corresponding outcomes is necessary.

The efficacy of the Unified Communication Space depends on having appropriately targeted media coverage among the potential participants, along with a user-friendly platform, especially at the beginning of its implementation.

Looking ahead, further research into the results of the reform's implementation as well as the value created through interactions of participants as innovative ecosystems' subjects, and how this has affected the social, cultural, and economic outcomes, could be more productive.

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Smart City and Urban Living Laboratories (ULL) Evaluation: Smart Cities andULL Evaluation Frameworks with Metrics and Evaluation Systems

Kultyshev Yevgeniy*

Abstract: *This article aims to study the concept of formation, management and evaluation of such a phenomenon as smart cities and Urban Living Laboratories (ULL). Within the process of urbanization of cities and the constant influx of new urban residents in connection with the trend of population movement to cities, there is a need for a constant citizens life quality improvement and the life conditions enhancement, provided by the state. One of the most effective tools is the creation of smart cities, which in turn are formed from point experiments conducted at ULL. With reference to the above, this work's aim is to demonstrate scoring system's role for a better understanding of the general situation with the construction of the smart city platform. This paper discusses research activities aimed at creating a metric system for smart cities' productivity and stability monitoring and evaluating. The efficiency of a city is related to the performance of its infrastructure and urban systems. In this way, the performance of a smart sustainable city can be measured from a global perspective, taking into account performance indicators associated with various core and secondary dimensions.*

Keywords: *urban living laboratory, ULL, sustainable city, smart city evaluation, smart city, smart city performance*

Author's Profile

Yevgeniy Kultyshev is a Ph.D. program student at Kazakh British Technical University (KBTU). Currently, he is a participant in the program for the development of smart cities and urban living labs with the support of IGLUS and the government of Almaty. His research focuses on smart cities and Urban Living Labs (ULL) evaluation frameworks with metrics and evaluation systems. His goal is the development of an evaluation algorithm with a predictive component to improve the process of evaluating the effectiveness of potential laboratories.

Introduction

In the current conditions of rapid urbanization, technological progress growing and climate changes, solving the problems arising in the process is becoming one of the most important tasks for the governments and citizens. Every day, such issues as maintaining the environment, protecting the health of residents, traffic congestion, supporting and modernizing the city's infrastructure, increasing demand for energy, water and other resources necessary to maintain an acceptable quality of life are becoming more and more relevant. Today, urban living laboratories have become a common institution of urbanization to tackle this problem, facilitating the development and practical application of innovative experiments. However, urban life laboratories can help to improve the transition to sustainable development. It should be mentioned that the experts in the field of urban living laboratories note that in order to achieve positive results in these tasks, more research is needed on how to form and manage urban living laboratories. Accordingly, the development of adaptive methodologies and assessment systems plays an important role in the research of experts.

Today, more than 53 percent of the world's population lives in cities, and this is projected to rise to 70 percent by 2050 (Lierow, 2014.). Cities are becoming

more and more popular places to work and live. However, with each round of development, the cities face ever more acute problems: for example, difficulties with waste disposal, lack of resources, air pollution, public health, traffic congestion, maintenance and development of the city's infrastructure (Taewoo, 2011). In fact, economic actors, politicians and civil society organizations represent a new multidimensional reality that raises several issues related to the chosen criteria for selected areas effectiveness evaluating in the development of smart cities.

Literature Review

ULL Concept

The term "urban laboratory" refers to various local pilot projects involving local communities. It is often used synonymously with such terms as a test site, hatchery, incubator, space creation, test bench, hub, and etc. Despite the fact that there are some publications about ULL and urban laboratories, even in this context concept of an urban laboratory not clearly defined. In the literature discussing the "theory" of (urban) laboratories of life, Erickson is explained as a methodology (Eriksson,2005), Balun as a medium (Balun,2005).

Living labs mostly founded on the development of a specific innovations, focused on a specific problem solving. It also could see ULL defined by a geographic area that directly affects different living laboratories defined by specific problems. These specialized projects are better described as platforms for living labs. Such a platform aims are creating a ground for innovation, and not at the direct development of innovation. Managing a living laboratory platform involves setting up various living laboratory initiatives in a specific urban area and creating a supportive environment. Living labs are regularly formed about developing of a specific innovations concentrated on resolving a special obstacle. In practice, living labs that are defined by a region, form the multiple-labs arena focused on multiple issues. These specific projects could be called a living lab platform. Such a platform's aim is the creation of favorable conditions for innovation and research. The administration process of a living lab platform is complicated and has different methodologies and frameworks. However, the main idea is based on the creation of various initiatives in the field of living laboratories in a special urban area and supporting models creation, defined for each problem in this sphere. By their nature, each of the ULL united in the platform has a number of unique features and factors based on the specifics of the problem that is posed to these laboratories. However, at the same time, 7 main components can be distinguished that are necessary for the formation of such laboratories within the city (Mulder, 2009). The ULL key components are following:

- Management structure
- Business models
- Physical representation in the city context
- Innovation to experiment
- Partners and end users
- Multi-stakeholder engagement and data collection approaches
- Infrastructure

As mentioned earlier, there are several determinations of the living laboratory concept. It is accepted to define such ULL as a combination of several methodologies and a set of tools required to cooperate in the creation of innovative solutions applicable in real conditions with users who face similar problems on a daily basis (Mulder, I.J.2009). However, it's worth mentioning that the ULL concept derives from a concept, which aimed on innovative processes development, mainly in the corporate sector. The first living labs focused on how end users realize products and services at home conditions. Their goal was to make design centered on the user, not the product. Living labs emerged from the need for new methods, in addition new setups that

Table 1. Characteristics of ULL (Chroneer, D.2019)
Source: Author's own resources

Item	Urban living labs characteristics
Goal	*Innovations* • Development of new products to find new solutions to existing or new cases.
	Replications Knowledge Development • The production and exchange of knowledge about developed products and processes to achieve these products.
	Urban Sustainability • Sustainable development emphasizes local solutions supporting
Activities	*Innovation Development* • Living labs aims are innovation or product development, pre-developed solution testing or implementation.
	Co-creation • The participating actors together forms innovation process.
	Iteration between Activities • Feedback received from the use and evaluation of the product is used to further product development.
Participants	*Users, Private Actors, Public Actors, and Knowledge Institutes* • Four groups of participants actively contribute to the process of innovation and development that takes place in the living laboratory.
	Decision Power • All participants, including users, have the right to participate in decision making at various stages of the process.
Context	*Real-life Use Context* • The living lab activities are based on a real-life use cases.

allowed the long-term work integration with leaders in this industry (Puerari, E.,2018). According to Steen and van Bueren's research (Steen,2017), the main aim of urban life laboratories is innovations and training. The main activities are development of innovations, cooperative creation and iterational process development, based on the feedback from the previous steps. Based on the above, the characteristics of ULL with details can be seen at Table The simplified lifecycle of a living lab process is based on the eight stages outlined in the figure below. There are various pathways to get successful outcomes from ULL. Such a simplified way of working allow contributors to be involved in urban living labs planning and implementation processes towards the realization of results

Smart City Evaluation

In the process of forming smart cities and ULL frameworks. and methodologies for evaluating the effectiveness of implementations have evolved constantly. The research was mainly carried out in countries with well-developed infrastructure, a sufficient level of technological progress and economy. Similar studies were carried out by the World Organization of Smart Cities, the Center for International Development in St.Harvard University, international enterprises and corporations, universities and colleges.

Despite the fact that many organizations have developed their own methodologies and approaches to assessment, these solutions still need to be integrated with the general structures of the smart city. This is necessary that they can be used for complex and multi-criteria assessment of smart city projects (Yuan,2014). Thus, for the assessment to be truly objective, it must take into account a number of aspects for the assessment. Yuan, Y deduced the following principles to be considered: consistency, fundamentality, humanism, innovation, efficiency.

Later, Li et al. (Li.C, 2020) proposed the concept as a framework for creating smart cities. Structurally, it consists of seven main factors and 41 secondary assessment indicators for a wide analysis of the infrastruc-

ture of a smart city. Figure 1 illustrates the relationship between indicator selection and their meanings.

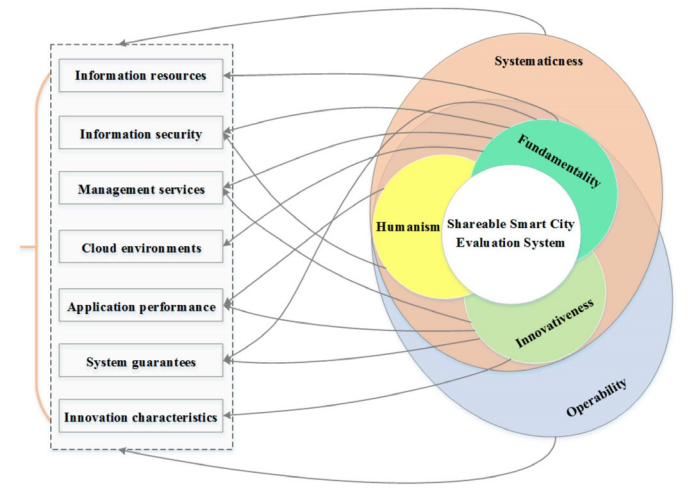

Figure 1. Smart city evaluation system and their correspondence relationships with assessment factors. *Source: Reproduced from an article published by MDPI) (Li.C,2020)*

Standardization and Smart Urban Metrics

Work is under way to endorse smart urban development standards and performance indicators (SSCC-CG 2015) via the International Organization for Standardization, the European Committee for Standardization and BSI. ISO has agreed on standards for the performance metrics of Smart Community Infrastructure. BSI in collaboration with ISO have developed some smart city standards and metrics to measure them[17][18].Moreover, one of the initiatives of the European Commission EUROCITIES called CITYkeys (citykeys-project.eu) is developing effective systems for measuring the effectiveness of Smart cities. They managed to derive key performance indicators (KPIs) and unify the procedure for collecting data on smart city solutions in different countries (Bosch.P.,2017).

Assessment factors are given as:

- Measurability: indicators must be measurable;
- Reliability: metrics should be able to be clearly defined
- Relevance: indicators should correlate with the measurement of the smart city for which they are used
- Intuitiveness: metrics should be easy understandable
- Exclusivity: Indicators should not measure a city metrics covered by another indicator.

Method of Evaluation

Once scores have been identified, their actual statuses need to be collected and processed in three ways: field surveys, questionnaires, and third-party collection. For field research, metrics are collected with the help of experts while validating the city's achievements of the smart city framework. For questionnaire studies, the metrics were obtained by self-assessment of each city via questionnaire. The third party collection mainly receives policies for smart building, residents awareness, and the attention level of smart city building through the network. Then via formula below, comprehensive score of smart city could be evaluated:

$$E = \sum_{i=1}^{41} w_i * s_i \qquad (1)$$

where i is the ordinal number of the secondary indicator. W i is the weight of the i^{th} secondary indicator, and S i is the percentage of the i^{th} indicator in. E ranges from 0 to 100 and can be used as a reference value for

comparing scores. When E 85, overall performance is outstanding. Good and acceptable performance ranges from 75 to 85 and 60 to 75 (LI.C., 2020).

Conclusion

In conclusion, ULLs demonstrate high performance to formulate urban city development strategy advice. All recommendations are based on knowledge gained and related learning processes developed through experimentation. In connection with this, such initiatives should definitely receive support and implementation in modern cities to improve residents' quality of life and resolve global issues arising in the process of city modernization. As a consequence, appropriate strategies and tools must be in place to support this implementation. The creation of an urban ULL portfolio will not only increase the impact and significance of each individual laboratory, but will also improve knowledge development processes and learning in other laboratories. The above may support small experiments designed to reach new stages through alternatives to current structures. Urban policymakers need to more strategically rethink ULL as mechanisms for systemic and institutional change to avoid sustainable and path-dependent practices for erratic urban development. At the moment, ULLs are mostly referred as locally fragmented initiatives, while incorporating ULLs into a more systemic transformation strategy would allow for adaptation of lessons learned. In the following step, they should be recognized as an efficient system tool for public support development , and reasonable indications for planned sustainability changes. From this point of view, ULLs can complement a broader range of tools and methods that support a more clear and comprehensive knowledge of experiments in planned urban development. Within the core of this work, it is planned to implement a methodology for the effectiveness of organizing ULLs on the territory of cities, methods for estimating work carried out in laboratories, as well as a strategy for the development and organization of laboratories within the city of Almaty. Among others, there is an aim for a construction of a comparative model to determine the correspondence and adaptation of the ULL's processes to the requirements and features of the city of Almaty and the Asian region as a whole.

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Telco Big Data Analytics in The Service of Urban Pandemic Combat

Madi Saken*, Bayan Konirbayev**

Abstract: *The regulation of quarantine regime and related measures, urges city administrations to seek and apply new analytical tools and data sources. In 2020, Almaty City Government launched a geo-analytical system for city activity analysis, based on telecom data. The project presents the potential of using telco data analytics and synergy between the IT market and municipal services, both for monitoring the pandemic and analyzing the city as a whole. The purpose of this article is to briefly describe a key component of the project and the use cases of the application of the obtained analytics. This paper first deals with the description of system, its content and how analytics have been used by city departments. In the following, it discusses experiments on finding correlations and building predictive models for morbidity rate. Finally, further development plans and potential use cases are reviewed.*

Keywords: *City analytics, COVID-19, quarantine regulation, big data analytics, geolocation mobile data, geo-analytics.*

Authors' Profile

Madi Saken is an executive director at Frontier KZ LLP, Kazakhstan-based IT-company specializing in big data analytics and telecom data processing. Having a legal background, he is specialized in the field of IT-regulation and data protection fields. He is also a member of Board of Directors at National Big Data Association in Kazakhstan, and a member of Almaty city mayor's IT-council, where he is responsible for the regulatory and IT sandbox development stream. Being a technology provider for Almaty city Digitalization Department in the field of city analytics, his team was responsible for execution of the project described in this article.

Introduction

During the state of emergency and quarantine in 2020, Almaty City Government faced an urgent need to use various analytical tools that would make it possible to quickly monitor the current situation in the city, without relying solely on official statistics, limited in resources and the scale of COVID-19 testing, and analyze the effectiveness of anti-epidemic and quarantine measures. One of such mechanisms was proposed by the telecom market: having united, Kazakhtelecom (the largest fixed telecom operator), all 3 mobile network operators (Kcell, Tele2/Altel and Beeline) and Frontier KZ (data integrator) created an analytical solution based on telco data analytics, which allows to analyze citizens mobility, epidemic situation, the effect quarantine restrictions and support city departments decision-making process in pandemic combat. The project called "Geo-analytical system for city activity analysis" represents an information system, which comprises storage, automated collection, transmission and processing of data on a daily basis from various sources, data visualization and interactive use of analytics via web-interface. This proposed approach, which includes data aggregation in a single repository and an interactive interface for presenting data in a single window format, expands the analysis and research capabilities of the city, allowing data to be analyzed by various city departments both independently and to explore new hypotheses together with the Supplier, integrating additional city data sources.

The main users of the system at the moment are: Department of Digitalization, Department of Sanitary and Epidemiological Control, Department of

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** Chief Digital Officer at Almaty City

Public Health, Police Department, Mayor's Office, Interdepartmental Commission for Combating Pandemic in Almaty (Covid-19 Operational Headquarters).

Implementation of the Project

Analytics and Use Cases

The system combines depersonalized data sources which is given Figure 1.

Within the framework of the project, together with the various departments of the City Government, the most active congestion places were analyzed. The main places of the biggest activity and congestion of residents outside the home areas or potential risk zones have been outdoor and indoor shopping markets, large shopping malls, central bus station and the areas around large hospitals. A possibility to identify the most popular congestion places was used in taking preventive or monitoring measures, allowing the most optimal distribution of human resources of city services. Moreover, analytics allowed the city administration and the Ministry of Health to determine changing of the situation in the city depending on the management decisions on quarantine regulations. In addition to mobile data analysis, a project team also analyzed quarantine regulation in other countries and cities, their statistics of morbidity and mobility trends and activity of their population, using Google Community Mobility Reports around the world. As a result, it has been possible to analyze the effectiveness of the adopted regulatory measures. However, there is still a great deal of work ahead for the state bodies to learn lessons from the entire period of the pandemic on the basis of various data.

An analysis of the dynamics and places of concentration of ringing activity showed the epidemiological significance of calls activity and a direct correlation between the high growth of calls to ambulance and the first wave of morbidity in June 2020, ahead of the labs statistics. Thus, the analysis of calls activity has become an important additional indicator of the forecast of the filling of medical institutions. It has provided an opportunity, together with geopositioning of call activity, to utilize this analytical tool for preventive preparation and deployment of beds in hospitals in the corresponding areas of the city. At the same time, given the limits of morbidity statistics due to its resources and labs testing scale, the use of additional indicators has allowed to objectively as-

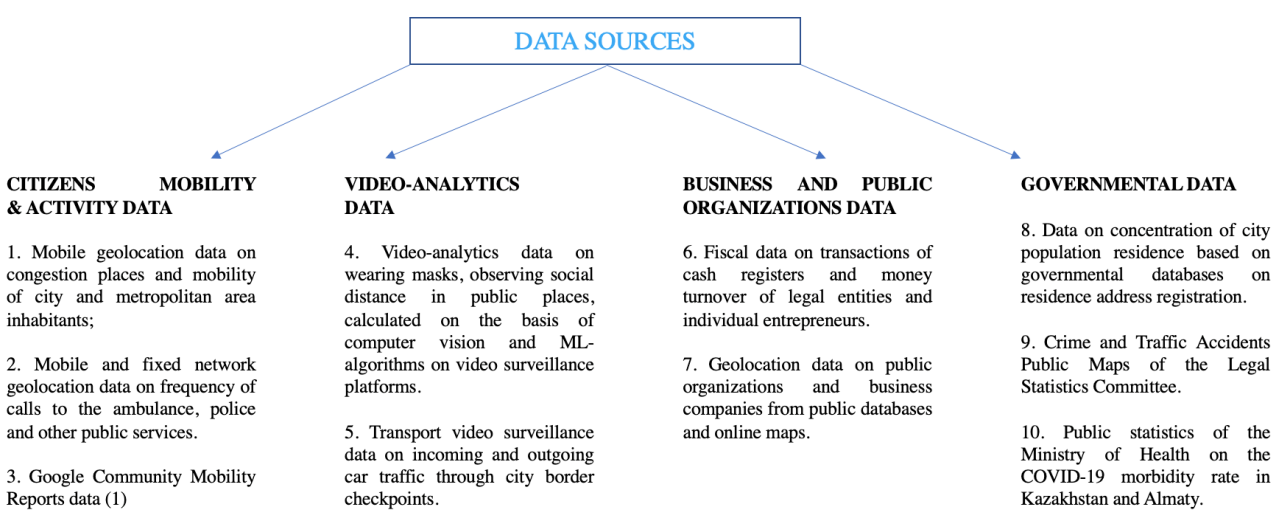

Figure 1. Data resources.
Source: Author's own resources

sess a real morbidity scale, and in some cases, to see warning trends.

Within the framework of the project, in addition to the execution of the technical task and the development of the system, research work was carried out to find correlations and patterns using machine learning algorithms and mathematical modeling in 3 directions: analysis of correlations, construction of predictive models for morbidity growth statistics, analysis of the impact of quarantine measures. Additionally, mathematical modeling experiments were carried out on searching for nonlinear correlations and building predictive models for morbidity rate.

The modeling process was formed taking into account two-week correlation ranges and city districts segmentation by specific types such as business concentration centers, residential areas, outskirts.

Correlation Research Results

- The number of calls to ambulance correlates well with the COVID morbidity dynamics. At the same time, there is a residual period of calls activity about 2 weeks after the decrease in the morbidity rate.
- There is a significant negative correlation between the number of infected and citizens mobility and activity. This is an indicator of the effect of restrictive measures taken, since the daily activity of citizens is effectively limited during the quarantine regime. Still this is not sufficient to assess the effectiveness of specific measures).
- Mortality rate does not show a significant correlation with other indicators, only with the morbidity rate 2 weeks before the increase in mortality rate. Thus, there is no direct connection between the epidemiological situation and mortality rate, but the third factor impacts the ratio of deaths to morbidity - the readiness of the healthcare system (hospital bed occupancy, availability of medicines and equipment, etc.), more data on healthcare has been needed.
- The demand for medicines (the fiscal cash registers data on the number of sales receipts in pharmacies) strongly correlates with the morbidity rate and calls to ambulance, with practically no delays or even slightly ahead of the morbidity rate.

Epidemic Predictive Modeling

In the process of predictive modeling both absolute and relative indicators were used. On stationary rows of morbidity rate, after calculating the morbidity growth pace with different time range, no clear patterns were identified. At the same time, the predictive accuracy of epidemiological forecast models based on hundreds of experiments (optimization of model parameters, a list of features) remained close to zero.

This means that the amount of data (amount of time period and types of data) is not enough to build a valid forecast of the epidemiological, even given the calls and citizens mobility data. In international practice, there are a large number of unsuccessful attempts to build an epidemical forecast, even taking into account the analysis of statistics around the world. In this regard, it is important to take into two problematic factors:

- Insufficient time period: in order to build an effective predictive model, it is necessary to take into account two basic factors - seasonality and trend. Only one-year time period (2020) were used, which suggests a possibility of further findings after passing several year seasons.
- Process controllability: it is extremely difficult to predict controlled processes, due to the regularly changing quarantine regulations. In the course of the analytics, negative correlation coefficients were identified between the mobility of citizens and the epidemiological indicators, which suggests that the epidemic situation has been effectively influenced by introducing or removing quarantine restrictions. On one hand, restrictive measures are always introduced when

epidemiological situation worsens, on the other hand, these measures, usually in combination with others, lead to an improvement in the situation. However, it was not possible to identify clear patterns for specific restrictive measure.

However, it is worth considering several other factors that might affect the quality of predictive models, such as in-depth information on laboratory testing of the population as well as detailed information on the operation of the medical system (e.g. bed capacity, load on hospitals, visits to private clinics etc.)

Further Development of the Project in 2021

The project is at the stage of active development and integration of new data sources, and already shows and provides vast opportunities for making optimal city management decisions in such areas as:

City agglomerations and pendulum migration

To achieve the development of a high-quality polycentric urban environment, reduction of forced mobility of citizens goals, it is planned to develop a system in the direction of analyzing such data as: analysis of outskirt districts and agglomerations in terms of deficit and surplus of various goods and services, concentration of social and business objects, for subsequent economic stimulation of the emergence of new, missing services in neighborhoods. In order to reduce the forced mobility of citizens, it is important to study both qualitative and quantitative indicators of pendulum migration of agglomerations residents, to determine the "real" boundaries of the urban system and the main directions of its spatial growth and development.

Small and Medium Enterprises

It is also planned to analyze economic portrait of the city in various segments for analysis of the most disadvantaged districts in terms of incomes of the population and business, analysis of the most affected segments of SME and their recovery potential by type of business activity, region, and other characteristics of business.

Public Safety

It is planned to improve the analytics in the following directions: identification the high-risk areas, repeat patterns of offenses and road accidents, research of dependencies with the economic portrait of the region, regional migration, infrastructure (concentration of objects, patrol routes) and formation of recommendations for the City Government or other authorized bodies.

Social Sphere

The development of a high-quality urban environment, creation and improvement of a favorable cultural environment in city districts can be achieved by analyzing the sufficiency and accessibility of objects of social significance for residents. Another potential use case of big data analysis application is an automated segmentation of public opinion regarding the main problems of the city based on algorithms for text analysis of social networks as well as public acceptance of projects of city administrations after the implementation of events (post-media monitoring).

Tourism

Development of a high-quality and favorable environment for domestic and foreign tourism is crucial area, where geo-analytics may be applied. The telco data analytics is planned to be directed at expanding the capabilities of the analysis of domestic tourism; profiling of foreign and domestic tourists for digital marketing strategies, analysis of hotel and tourist infrastructure, in-depth analysis of domestic migration and dynamics of recovery of domestic tourism.

Conclusion

The regulation of pandemic combatting measures, taking into account the continuing risk of disease spread, requires continuous collection and analysis of quantitative indicators, which may be based not

only on official statistics. Similarly, in order to plan long-term measures for the development of the regional economy, specific economically potential sectors such as tourism, development of the regional infrastructure, city administrations need new tools for more detailed and comprehensive analytics.

While the use of big data analytics to tackle the COVID-19 epidemic has been practically useful, it also provides lessons for continuous improvement of data ecosystem, filling existing gaps and advancing a new digital competencies of city administration. The development of such tools requires from governments further improvement of the accessibility and quality of data sources, in particular, governmental databases. At the same time, a practical effect of the implementation of such tools also requires each city department to quickly reshape their operational processes to become data-driven.

This stage of data analytics application is only the beginning of the development of urban analytics, which is aimed to provide answers to the city's problems, sustain continuous research process generating new hypotheses and motivating to search for new data sources for specific solutions. Eventually, the implementation of such tools in the future will provide the city with new approaches to diversified planning of the city development, taking into account the specifics of each district, social and economic segments, as well as the in-depth understanding of patterns of citizens and business activity.

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