

The Smart city vision: The internet-of-postal-things (iopt) approach

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Abstract

Nowadays the popular Smart city concept focuses on the quality improvement of a citizen's life by using the information and communication technology. Frequently Smart city projects are stalled at the initial stages due to insufficient data volume. Meanwhile, state Postal services remain outside the Smart cities concepts and models, despite the available resources to handle big data. This research is aimed to highlight the significance of Postal services involvement in effective data collection, storage and aggregation. The study refers to the international sources and considers a high-level Smart city architecture and data-driven approach; gives an analysis of researches results and case studies of international Postal services in the field of socially significant initiatives; describes the functions and assets of the Russian Post. The paper presents identified opportunities of Postal services participation in the processes of Smart city projects, describes an applicability of the approach to the Russian realities. It also provides the models of Postal services involvement in Smart city projects and meta-model of the data which collection is possible using the Russian Post assets. The main idea is to integrate urban information systems and the Postal services assets for more efficient and ubiquitous data collection, which entails additional quality in public services. The integration will improve the city authorities results, ensure the safety of information resources, i.e. will help all participants to achieve their goals. Such approaches are named Internet of Postal Things. The relevance of the work is further conditioned by increased government activity in Smart cities development in Russia, which is caused by "Russian Digital Economy" document release, where the Smart city direction is allocated. In accordance with the document city authorities, scientific and business communities started the mega-project "Smart city St. Petersburg" where the described research results will be used.

Keywords: IoT, data-driven city, postal assets, postal service, Smart city architecture, State information system.

1. INTRODUCTION

There is no central database of Smart cities generally in the world and particularly in Russia, but the most of the biggest cities support and initiate projects affecting Smart city concepts. Although many cities are experimenting with Smart city technologies, only some of them have advanced their projects to the prototypes and development phases, while many initiatives remain in the ideation stage of the process. There are several basic causes which complicate adoption of Smart city initiatives. It can be emphasized limited city budget, lack of technology expertise, an absence of understanding of the goals and real prospects of such projects and significant problems associated with the collection, storage, and analytics of the data. Currently, there is no recommended list of data sources,

fixed normatively or representing a set of best world practices. The sources identified in the scientific literature and regulatory documents are, as a rule, not equivalent in terms of composition, quality and quantity of data processed.

Traditional Smart city model includes separate subject areas or municipal government spheres: transport, healthcare, education, safety, municipal services, environment, the involvement of citizens (Narmeen & Jawwad, 2015, Robinson, 2012, PWH, 2016). The model is oriented on stakeholders – the great number of government agencies, state and business organizations. The city authority goal is to identify all the stakeholders, determine their roles, responsibilities and possibilities, but many stakeholders remain forgotten.

The Smart city gives exciting opportunities for the city environment development. A city area becomes Smart when city information and communication technologies (ICT) infrastructure can provide the functional needs of Smart city base domains. All city services require orchestrated coordination and resources. The Smart city model should be citizen needs-centric. The complexity of the city's systems embodied in the architecture and a large number of the city services realized to support life quality have to bring benefits to the citizens regardless of their ICT abilities. The primary goals of the Smart city include offering digital means for supporting social needs in all daily transactions. Above all, Smart city can give the way to implementation of a citizen-centered public administration, where corruption phenomena and time-consuming bureaucratic procedures are eliminated (Narmeen & Jawwad, 2015, Chourabi & Nam & Walker & Gil-Garcia & Mellouli, 2012, 5. Giffinger & Pichler-Milanović, 2007).

The State Postal services as rule as stand aside of involving in the Smart cities activities. Meanwhile, material assets of state Post agencies in any country are really significant. The Postal agency has permanent, steady, efficient consumer's post net that covers all country regions. The Post involvement in smart projects is absent for unclear reasons or occurs only in isolated cases despite a lot of opportunities to use obvious advantages of postal assets. This article is devoted to the consideration of the possibilities of Postal services participation in Smart city projects, the applicability of the allocated opportunities in the Russian realities, architectural approach and models for smart postal services realization.

2. THE POST IN A SMART CITY PROJECTS

2.1. WORLD EXPERIENCE OF THE POSTAL SERVICE'S INVOLVEMENT IN SOCIALLY SIGNIFICANT INITIATIVES

The key components of a data-driven city are directly data, data processing technologies, decision-making systems that use the results of data processing. A data-driven city is characterized by the ability of municipal authorities to use data collection, processing and analysis technologies to improve the social, economic, environmental situation and improve the living standards of residents (PWH). It is obvious that big data guarantees the good result from administrative decisions adoption. Data sources are

inequivalent and nowadays not the all data sources are revealed. For example, the possibilities of post services weren't considered at all until recently.

Postal operators around the world participate in the providing of public services to citizens or in the development of socially significant initiatives. Many posts provide local government services through windows at the post office (OIG, 2013). For example, Poste Italiane offers the "Sportello Amico" window where residents can conduct a variety of transactions, including different kind of local payments (Poste Italiane, 2017). The Russian Post also provides opportunities for receiving state and municipal services, making payments, issuing identifiers for accessing to electronic services in the post offices.

Furthermore, many posts helping cities promote efficient transportation by using fuel-efficient vehicles, such as electric vehicles or bicycle couriers (Post and Parcel, 2014-2015). Swiss Post is directly involved in improving mobility in cities through its PostBus service (public transportation system provided by Swiss Post that uses buses to carry passengers to and from different cities in Switzerland, France, and Liechtenstein), which is now even testing autonomous (driverless) buses (Postbus website, 2017). Swiss Post also offers a bikeshare program called PubliBike (Swiss Post, 2015).

Some of the Postal services are already beginning to explore sensor-based data collection. As early as 2014, Spanish post Correos was involved in developing air quality monitoring sensors for placement on postal vehicles (Grupo Correos, 2014). Finnish Postal service Posti is beginning to conduct experiments on how sensor-based collected data (for example, road conditions, traffic flow, and signal strength data) could be used (Posti, 2015). French postal operator La Poste, through its subsidiary Docapost, is taking a different tack, aiming to be a platform where sensor-based data from a variety sources can be housed together securely for easy access. Under this model, La Poste plays the of data broker, offering storage and analytics services (Docapost, 2016).

The US Postal Service is recognized as the best postal service in the top 20 largest economies in the world (Oxford Strategic Consulting Report, 2017). It can be considered as an isolated smart object that overcame certain limitations on the use of digital technologies and new postal services and achieved significant results (Kupriyanovsky & Martinov, 2014). It became 200% more efficient than the postal services of neighbouring countries, and 500% more efficient than the German Postal Service (№ 5 in the world). But nevertheless, even such a developed Postal Service as the USPS, like the most countries in the world, is only considered or is not studied at all the possibility of involving in a Smart city projects (U.S. Postal Service Office of Inspector General, 2016).

In contrast, the researchers (Oxford Strategic Consulting Report, 2017) note that the Russian Post supports a huge network of post offices and has a geographical coverage incomparable to any other universal postal services worldwide. At the same time, the Russian postal service inherited from the Soviet regime a worn out infrastructure and a problem of underinvestment. The age of most of the equipment is older than 20 years, and the number of deliveries per employee is in several times less than have the best posts in the rating, although this indicator is gradually improving.

Table 1 presents a general view of the world experience of the postal service’s involvement in socially significant initiatives. The data indicate a high level of involvement in the public and municipal services provision and in environmental initiatives of cities. The whole range of socially significant initiatives has not been implemented in the countries examined. It should be noted that less attention is paid to the collection, storage and analysis of data. Currently, the Russian Post pays sufficient attention only to the provision of state and municipal services. There are many opportunities for the enterprise to expand the range of its products and services that support socially significant initiatives following the example of the world practice.

Table 1.
World experience of the postal service’s involvement in socially significant initiatives

Service Initiative	The postal operator									
	Italy	Switz.	Spain	Finland	France	Norway	Germany	USA	Russia	
State and municipal services (SMS)	+	+	+	+	+	+	+	+	+	
Identification for SMS	+	+	+	+	+	+	+	+	+	
Acceptance of payments	+	+	+	+	+	+	+	+	+	
Promotion of an environmentally friendly transport		+		+	+	+	+			
Using sensors to collect data			+	+				+		
Storage and analysis of the collected data				+	+					

2.2. THE MODELS OF THE POSTAL SERVICE’S INVOLVEMENT IN THE SMART CITY PROJECTS

There are several possible levels of the postal service’s involvement in the Smart city processes regarding data management. Stakeholders should make an organizational decision on how the roles and responsibilities in the project will be distributed according to the chosen model. From the postal service’s side, the definition of a suitable business model depends on the business objectives, the level of readiness and what is legally permitted to do in accordance with the current legislation and collective agreements with trade unions.

In the framework of the current research, the models of the postal service’s involvement in the Smart city projects which represent data collection and processing approaches were identified and described.

The centrifugal model (Figure 1). A postal service infrastructure is a tool for collecting of the data which are transferred to the resource center for further storage, processing and analysis. It can be represented by two levels of involvement:

- Lessor. The lowest level of participation of the postal service lies in the fact that it leases its infrastructure for placing sensors to the third parties (city authorities or business) which are responsible for the installation and maintenance of sensors, data collection, data security. The postal service just passively collects data and does not invest in the project. Data collection will be a byproduct of the regular postal activity, rather than a separate service. This option does not imply creating additional workplaces and making changes to regular activities. The postal service may charge rent for the use of infrastructure, but in that case, it has no control over the collection of data;
- Data collector. The level is similar to the previous one in terms of using the infrastructure of the postal service as a data collection tool, when data ownership, storage and analysis are carried out by the city authorities or another partner. However, at this level of involvement, there are increased obligations and additional costs for staff training for the postal service, while it can set a higher rate for infrastructure maintenance and charge a variable fee, depending on the amount of data collected.

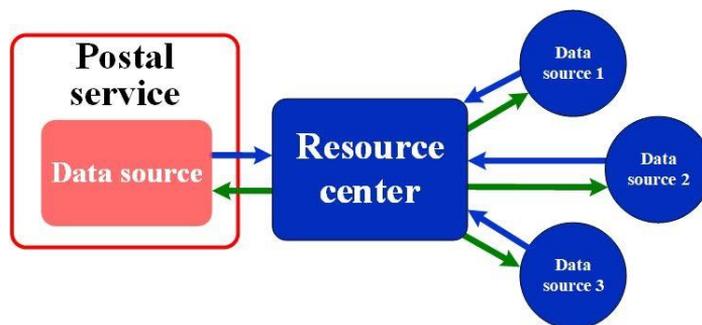


Fig. 1. The centrifugal model.

The centripetal model (Figure 2). The full range of services is provided by the postal service for the collection, storage, processing and analysis of the required data. If the postal service decides in the future to cover Smart city projects as a serious field of an activity, it can offer a number of related services: from storing data to creating dashboards and analytics in addition to data collection. The postal service can own equipment and/or software, store the collected data on its own servers, then sell either the original data or the results of their analysis for the city authorities. For these services may be charged a larger fee, taking into account the advance investment in infrastructure and technology.

Two existing approaches and, accordingly, two models of the data collection, transfer and processing organization by means of the postal services have viability since they imply access to data (with restrictions in accordance with the laws of a particular country) and do not violate information exchange between interested parties. The centripetal model implies the concentration of all functions for obtaining and processing data in the competence of the Post (U.S. Postal Service Office of Inspector General,

2016). The centrifugal model is distributed and leaves only a part of the functions behind the Post. Aggregation and processing of data from different sources are carried out in an independent unified or distributed city resource center. It is important to point out that the centrifugal model is more traditional in Russia for cities and urban management structures.

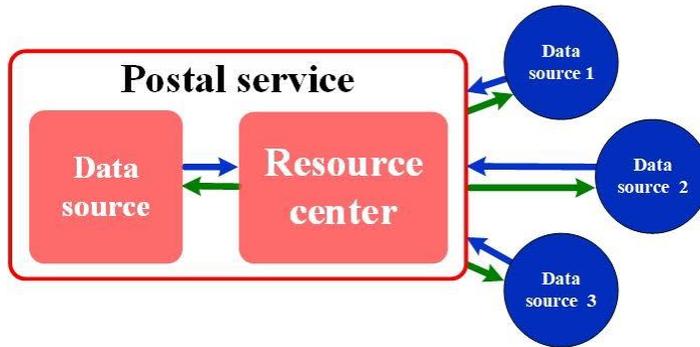


Fig. 2. The centripetal model.

The examples of the identified approaches application can be found in the reports of the American and French state postal services (U.S. Postal Service Office of Inspector General, 2016, Digital Hub and IOT, 2016). These models also could be applied in relation to any participants involved in the collection and processing of the data within the Smart city projects.

2.3. POSSIBILITIES OF THE POSTAL SERVICES ASSETS USAGE IN THE SMART CITY PROJECTS

There are many reasons why the Postal Service would become an equal partner in Smart city projects, including the groups of the reasons related to characteristics of the postal network and the circumstances of the nowadays.

The first postal network characteristic of great importance for Smart city projects is its omnipresence. However, not all postal administrations have their own network of postal offices. For example, post offices in Germany are not the property of Deutsche Post, in Italy, less than 20% of the offices belong to the postal service. In countries such as the United States, France and Russia the network opposite is owned by the postal service (The Russian Post, 2015).

The postal assets can be broadly divided into the three main categories: stationary assets, transport fleet and carriers. In Russia, the category of stationary objects includes post offices, collection boxes and home mailboxes which have been installed throughout the country. The transport fleet of the Russian Post presented by various vehicles including automobiles, trains, planes, etc. The total length of main and internode mail routes exceeds 2.8 million km. The structure of the Russian Post assets is shown in Table 2.

Table 2.
The Russian Post assets

Categories of the postal assets	Postal assets	Number of objects	
Stationary objects of the Russian Post	Post offices	42.000	
	Collection boxes	140.000	
	Home mailboxes in the residential sector	Moscow – 3.5 mln	
		St. Petersburg – 1.5 mln Nizhny Novgorod – 0.5 mln	
Transport fleet of the Russian Post	Automobiles	14.000	
	Other vehicles	3.000	
Couriers	Couriers and postmen	100.000	

The next important characteristics of the postal network in addition to comprehensive coverage are frequency and consistency which are more relevant for dynamic types of postal assets. Because of the Postal Service is considered as a universal service in most countries, post offices are situated in almost every community including remote and sparsely populated areas and its vehicles pass through almost every road, including roads that city or county vehicles and bus routes may not cover. Such wide coverage by one organization allows Smart city projects a degree of flexibility in setting their scope. Data could be collected and compared nationally, regionally, locally, or even just along specific areas if it is needed (Ravnitzky, 2011). Postal vehicles driving near-identical routes almost daily. Accordingly, the data collection potential of a large number of such vehicles overcoming significant distances is enormous and could create a powerful information network.

Postal Smart city projects would involve combining different types of assets with information and communication technologies to provide a service for the stakeholders. In most cases, the combination consisted of using postal assets equipped with sensors and other data collection devices as tools for gathering multiple types of data for local governments or any interested party.

By analogy with the Internet of things technology the described approach could be named the Internet of Postal Things (IoPT). IoPT – instrumenting the postal infrastructure with low-cost sensors to enable them to collect, communicate, and act upon a broad variety of data. It could help the Postal Service generate operational efficiencies, improve the customer experience, and develop new services and business models.

Postal vehicles are the asset most in demand by Smart cities, but Smart city projects could also leverage other postal assets, such as letter carriers and stationary assets. Different types of sensors, usually small and unostentatious, could be attached to the interior or exterior of postal vehicles. They could capture information e.g. about air quality or other environmental measurements, mobile, wireless, and radio signal strength, gas leaks or biological and chemical materials, traffic patterns, road and bridge integrity. Mobile assets can collect a data snapshot from multiple locations once per day, which is cost-effective because one sensor is able to cover a wide geography. For the purposes of Smart city data collection, this means data can be collected on a near-daily basis, allowing for changes in that data to be measured over time.

Stationary objects can house sensors that continuously collect data from a single location, offering a necessary level of granularity. For example, collection box on a busy street corner equipped by a sensor or conveniently located post office could measure how foot traffic changes over the time of a day, they could also be regarded as Wi-Fi hotspot locations. Many Smart cities place sensors in streetlights because of the access to electricity as a power source for sensors, but sometimes the lights are owned by a utility company rather than the city, so permission to use them is not always forthcoming. In these cases, collection boxes could serve as possible substitutes. They are not wired, so sensors would have to be battery-powered or solar-powered, but they are often in prime locations on a street.

Some information about the surrounding environment cannot be collected automatically because sensor technology is insufficiently developed and data must be collected manually by letter carriers via using any handheld device or smartphone with the preinstalled mobile application allowing to collect information about city problems in various spheres of municipal economy. For these purposes a public website and application for online interaction of the residents with city authorities could be used, but the message about a city problem will have higher priority because it comes from a trusted source. The example of such a website and application is «Nash Petersburg» in Saint Petersburg (Nash Petersburg, 2017).

It should be mentioned that the most of Smart city projects introduction initiatives are supported by the governance. In some Russian cities, attempts to introduce certain "smart services" are being made under the influence of a variety of government programs. First of all, this applies to the largest megapolises, where there is some evidence of the interest of the city authorities for the introduction of smart initiatives and where the budgetary provision allows to implement such projects.

The initial phase of Smart city growth offers the opportunity to get involved the Postal Service while these initiatives are just in development. In addition, international researches show that most of the interested parties see the value in partnering with the Postal Service to turn existing postal assets into dual-purpose data collection points.

Smart cities projects exist to benefit cities and citizens, however, the Postal Service itself would also stand to benefit from these efforts, as a way to potentially generate new revenue as Smart city services could also represent a new source of it. Becoming involved in these projects could translate into cost savings for the Postal Service itself and for its efficiency gains (e.g. better pavement conditions would reduce vehicle maintenance costs), help the Postal Service advance its sustainability plans. It also could help to the Postal Service to strength its role as a national public infrastructure and service provider, what is especially important given that trust is starting to be recognized as a highly valuable strategic asset (Oxford Strategic Consulting Report, 2017). It can be argued that the most successful postal services, especially those that are successfully diversifying their services, are actively utilizing the consumer's acceptance of their brand promise to extend their service offerings.

3. ENLARGEMENT OF THE RUSSIAN POST CAPABILITIES IN THE SMART CITY PROJECTS

The Russian Post is a Russian state company, operator of the Russian state postal network and a member of the Universal Postal Union. It is in the departmental subordination of the Ministry of Communications and Mass Media of the Russian Federation. The enterprise is a commercial organization, legal entity, has an independent balance sheet, settlement and other bank accounts, etc. The Russian Post was included in the list of backbone enterprises of Russia in 2015.

The company's structure includes:

- the central administrative unit consisting of 22 divisions (directorates, departments, secretariat);
- 11 macro-regional branches which combined 82 branches on a regional basis. Macro-regional centers are the following cities: Moscow, St. Petersburg, Tver, Voronezh, Nizhny Novgorod, Samara, Rostov-on-Don, Stavropol, Ekaterinburg, Novosibirsk, Khabarovsk;
- about 42000 post offices: 763 large post offices, 7.647 post offices in towns of different sizes, and 34.081 in rural areas, which represent the largest networks in the country.

It should be mentioned, that more than 30 thousand post offices are located in populated areas with a population of fewer than 20 thousand people, 17.4 thousand post offices are unprofitable, more than 35 thousand – require major repairs.

The mission of the Russian Post is to unite people. They provide reliable and affordable postal services in Russia and around the world. They preserve the economic and political integrity of Russia and contribute to its integration into the world community. They create quality jobs and strive to realize the potential of each of their employees. The strategic goal is to make Russian Post a profitable, client-oriented, efficient and technology company, a reliable and modern provider of postal, logistics and financial services for the whole country (The Russian Post strategy, 2015).

The following main business segments are identified in the Russian Post:

- Block of postal business;
- Block of parcel business and express delivery;
- Block of financial business;
- Block of property affairs and security;
- Block of information technologies and development of new products;
- Block of logistics.

The enterprise has the following revenue structure (Figure 3):

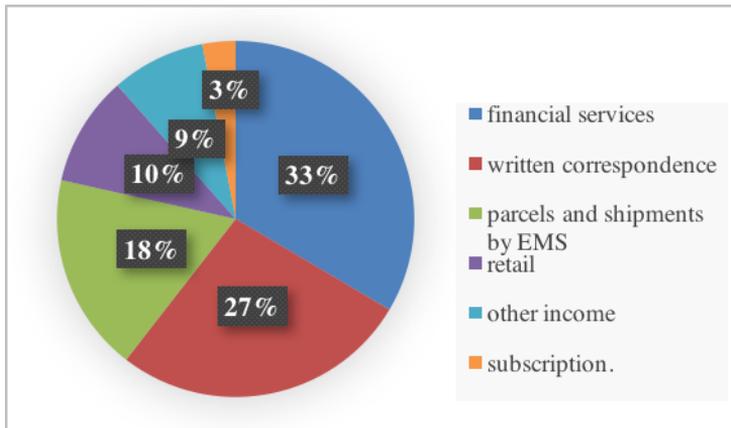


Fig. 3. Revenue structure of the Russian Post.

In the Russian Post, there is a strategic competence model whose main domains are presented in Figure 4.

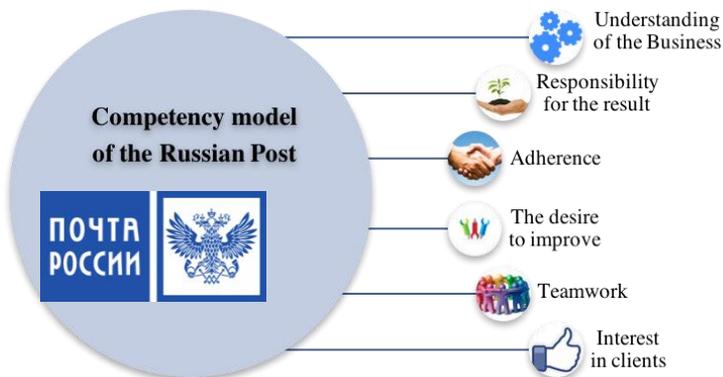


Fig. 4. Strategic competence model of the Russian Post.

Speaking about the possibility of involvement of the Russian Post assets in the Smart City projects in the context of the enterprise's products and services, first of all, the products and services of the logistics block should be mentioned. They are directly related to the postal vehicle's movement which is the most valuable objects for collecting data for smart initiatives. Also under consideration the products including various activities of couriers and postmen to receive and deliver written correspondence, parcels, invoices, etc. of the block of postal business, the block of parcel business and express delivery, as well as the block of financial business. A beneficial effect on the involvement of postmen in the objectives of Smart city projects will also provide Russian Post initiative to equip them with smartphones to provide financial services at home: accepting payments for housing and communal services, insurance, loans. Currently, 25.000 postmen are already equipped with such mobile postal terminals.

3.1. META-MODEL OF THE DATA WHICH COLLECTION IS POSSIBLE USING THE RUSSIAN POST ASSETS

Based on the information proposed by M. Ravnitzky in the article (Ravnitzky, 2011), was developed a model for the description of the urban data, which can be collected involving the assets of the Russian Post by using sensors and other reading devices. The model contains the following fields:

- a brief description of the data
- a note on the existence of the data collection process implementation in the city;
- a source of the data (in the case when the data collection process already implemented in the city);
- the agency interested in or responsible for data collection;
- the required frequency of data collection;
- postal asset recommended for data collection;
- compliance of the defined data collection with the mission of the Russian Post.

Using the model, the data that can be collected using the assets of the Russian Post could be analyzed. This model is also relevant for the data that has already been collected in the city because using postal assets data collection can be implemented with greater frequency and coverage than at the moment, which will lead to an increase in their quality and relevance (Pavlovskaya & Kononova, 2017).

4. CONCLUSION

The revision of the urbanization opportunities provides updated information on city growth and global urbanization processes. Recognizing the importance of information technologies, the revision expands the Smart city architecture concept, takes in consideration the Postal assets and opportunities. The study shows that the Russian Post mission correspond the smart city vision and goals. The Russian Post also strives to match the trend of data-driven enterprises that allows to consider it as a potential strategic partner in the construction of data-driven city.

It can be concluded that there are many opportunities to involve the Russian Post in the processes of building and managing Smart cities, the main of which are related to the use of postal assets to collect large amounts of data. By analogy with the Internet of things technology the described approach could be named the Internet of Postal Things (IoPT). IoPT – Instrumenting the postal infrastructure with low-cost sensors to enable them to collect, communicate, and act upon a broad variety of data – could help the Postal Service generate operational efficiencies, improve the customer experience, and develop new services and business models.

Smart cities projects exist to benefit cities and citizens, however, becoming involved in these projects the Russian Post could translate this interaction into cost savings, to its efficiency gains, to advance its sustainability plans, to strength its role as a

national public infrastructure and service provider, as well as to fit its mission in the best way and achieve its goals.

A comprehensive view of the Russian Post product landscape is currently under development, therefore the required changes, taking into account the involvement in Smart city initiatives, can be introduced into it. Simultaneously there is no need for significant changes in the postal service and its functionality. It is enough to add the Postal service capabilities to the existing Smart city architecture and update the communications between the key city domains, connecting them with the Postal services.

It is also important to apply the architectural approach to the construction of Smart cities, allowing to get a comprehensive and multidimensional view of the city as a complex system. Then the involvement of new, previously unaffected areas, participants, such as Postal Service, should be more easily and in compliance with the interests of all stakeholders.

The relevance of the work is further conditioned by increased government activity in Smart cities development in Russia, which is caused by “Digital Economy of the Russian Federation” document release, where the Smart city direction is allocated. In accordance with the document city authorities, scientific and business communities in Saint Petersburg started the mega-project “Smart Saint Petersburg” where the described research results could be used (Mega-project “Smart Saint Petersburg”, 2017).

At the moment, within the framework of the research, a mass survey of Russian citizens are conducted (including employees of public authorities and subordinate organizations, representatives of the scientific and business communities), as well as an interview of the employees of the Russian Post. The purpose of the study is both to identify trends in the relation of the citizens from different regions and age groups to the Smart city projects and to the participation of the Russian Post in them and to identify the relation, assessment of the Russian Post potential in the implementation of Smart cities and smart technology projects of the Russian Post staff.

As a direction for future research, we should highlight a more detailed study of the data required to collect in the framework of Smart city projects and the possibility of its collection and aggregation using the assets of the Russian Post.

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