

Small Towns and Regional Municipalities Implement SMART Solutions, Identified Issues, and Challenges

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Abstract

In the last decade, SMART services and solutions projects have been concentrated mainly in large and economically strong cities where large populations are concentrated. This is place where the potential is found that predicts return on investment as well as further development. As not all cities are predestined for this type of project, we were interested in how small towns and cities perceive their potential to engage in the implementation of such projects. We believe that the topic of SMART solutions should not be a significant priority only for large cities. We decided to analyze the needs of small cities in terms of implementing SMART solutions. We also tried to identify the challenges as well as the requirements to accelerate this process. In our analysis, we focused on the Slovak Republic, which is a good candidate for such research due to its structure of cities and municipalities. In the process of data collection, we approached more than 2,744 small towns and municipalities with a population of up to 5,000 with a request for information, and 547 town and municipality representatives responded to the questionnaire. The results of the research show an interesting and clear finding, small towns and rural areas also want SMART. In the research, we identified several not simple problems that need to be solved for the successful implementation of these goals.

Keywords: SMART CITY, clusters, SMART Services, SMART Villages, SMART regions

1. Introduction

In the last century, the concept of the SMART CITY was a creation of human technological imagination. Turning this idea into reality seemed unrealistic and was accompanied by fear. Fear of innovation, of the idea of humanity being enslaved by new technological developments, or of artificial intelligence in the position of dictator. These are images of the human imagination that negatively affect and quickly reduce the ability to accept an intelligent environment. In recent years this concept has become known worldwide, and its solutions are being used by metropolises, larger cities, and their clusters to solve problems related to the flexible provision of services to the population.

Although there is no established definition, the word 'SMART' encompasses a set of essential services for a city to become sustainable to provide its inhabitants with a standard of living or quality services that allow for more efficient use of personal and working time. In the context of development and the ideology of sustainability, the topic of SMART CITY is becoming a popular topic for scientists, urban planners, developers, and real estate companies operating in the field of modern inventive technologies.

2. Intelligent solutions concept

As mentioned in the introduction, SMART CITY as a modern concept has no precise definition, it is perceived differently in every corner of the world and from different perspectives of experts. From the true combination of different definitions, a theory can emerge that the elements of a SMART or modern city represent a tool for effective city management and improvement of citizens' lives using information technology. Trends in this area should lead to the interconnection of areas such as transport, mobility, security, energy, education, health, and others. Already in 2000, the author Robert E. Hall et al. spoke of a SMART CITY as a city that monitors and integrates the condition of all its critical infrastructures, including roads, bridges, tunnels, railways, subways, airports, seaports, roads, water, electricity, and major buildings. This allows city management to better optimize their resources, plan for preventive maintenance, monitor safety aspects, and at the same time maximize services to their citizens [1]. The European Commission defines a SMART CITY as a place where traditional networks and services are made more efficient with digital and telecommunication technologies for the benefit of citizens and businesses. SMART CITY promotes the use of information and communication technologies (ICT) to make better use of resources and manage them more

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efficiently. This means smarter urban transport networks, upgraded water supply, and waste disposal facilities, and more efficient ways of lighting and heating buildings. It also promotes more interactive and responsive city management, safer public spaces, and meeting the needs of an aging population [2]. The creation of a SMART CITY is a motivation for growth, new jobs and represents a productive investment in Europe's future, leading to a sustainable and green economy [3].

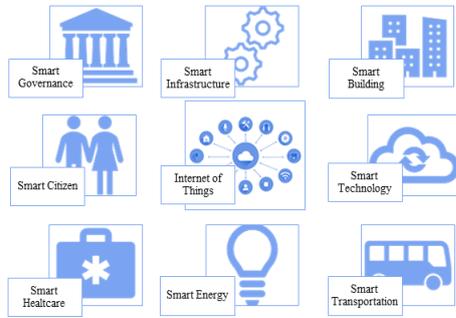


Fig. 1. The making of a SMART CITY: Model according to Mohanty (2016)

According to Yigitcanlar, SMART CITY could be an ideal way to build sustainable cities in the 21st century if a balanced and sustainable view of economic, social, environmental, and institutional development is achieved [4]. In his article, Potocar introduces SMART CITY as a concept based on the full use of the potential of existing resources, reducing energy consumption, and reducing the environmental impact of cities. In addition, SMART CITY principles allow to improve the quality of urban services and facilitate their use by residents [5]. Mohanty defined a SMART sustainable city as an innovative city that uses information and communication technology (ICT) and other means to improve the quality of life, the efficiency of urban operations and services, and competitiveness while meeting the needs of current and future generations in terms of economic, social, and environmental resources [6].

Svitek et al. in their definition emphasize that the SMART CITY (SMART CITIES) concept seeks to make appropriate use of modern technologies to create synergies between different sectors such as transportation, logistics, security, energy, building management, and others. This concept must consider the energy intensity and quality of life of the inhabitants in the respective city or region [7]. Author Mariana Cavada et al. argues that it is the contradictory definitions that are behind the inability to build a SMART CITY and to exploit the envisaged potential. The misinterpretation of the subjective parties involved in the SMART CITY program leads to an unclear vision and a distortion of the objectives. In her theory, the author argues that despite the different levels in building SMART CITY, the concept has created competition between cities and stakeholders around the world. It is this that encourages stakeholders to use indicators to measure their intelligence. If these indicators are to be reliable, they should be built on a shared understanding of what SMART CITY means. To this end, a universal definition of SMART CITY with clear objectives is needed that considers the local context and details of each city [8].

The definitions found in books and documents dealing with this issue suggest that the core of SMART CITIES and cities is information and communication technologies [9, 10]. Their involvement in everyday activities facilitates the life of citizens

and at the same time creates space for sustainable development of these cities and reduction of their operational costs. SMART CITY solutions promote cooperation with the protection or restoration of the environment, so this topic is in most cases included in the development of cities or sustainable development. The definition and understanding of what a SMART CITY is overlapped, even experts cannot define the boundaries between these concepts. Most foreign literature does not allow for such a detailed division and uses only the term SMART CITY. In our opinion, it is difficult to establish a precise definition because each city has different characteristics and visions. In this case, it is necessary to approach each city independently with the selection of the most appropriate definition.

3. SMART village and SMART regions

In recent years, many residents have been leaving their homes in small villages and leaning towards the trend of urbanization. The near future asks the question: "What will the age structure of the population in the regions concerned look like? Will young families move back to their original homes in the future? What concept will make a village or small town an attractive place to live?" The motivation of municipalities to create attractive environments for young people creates pressure to upgrade services and increases the demand for SMART sustainable environments that make life easier not only for its inhabitants. This rate of growth creates an urgent need to find smarter ways to manage and solve problems. However, most municipalities are not familiar with the term SMART CITY, so we cannot talk about implementing a strategy that is progressive enough to accommodate population growth at a local or regional level. Small towns and cities have started to be ignored in the process of building and transforming cities into smart ones. The social, economic, and political support of the inhabitants of villages is being forgotten, which may lead to a slowdown in the country's economic growth. Therefore, it is essential to encourage rural interest in participating in building a SMART environment. Motivate them to implement the concept that has been proposed for villages and rural settlements with the support of SMART technologies. By using ICT to support current systems and processes, project participants can communicate and gather information. Through mobile applications and new platforms, residents will receive news from all levels of government. SMART technologies can also lead to the automation and streamlining of primary sector activities that take place mainly in villages.

The SMART CITY concept focuses on core areas that are supported by ICT. In the SMART Village, SMART Region concepts, the core themes are expanded to include additional themes such as:

- Energy storage, rainwater harvesting, and storage
- Good and affordable medical equipment
- The efficient public transport system, interconnected transport system
- Good and quality education
- Strengthening the provision of basic services to the population

- Agricultural facilities
- E-governance.
- Use of modern technology to improve the locality.

The SMART Communities concept and its design of solutions using SMART technologies have been designed to lead to sustainable development, provide high-quality and safety while considering that SMART CITIES do not harm the environment. The solutions represent a vision of the future for the development, management, delivery of useful services to citizens and stakeholders. These solutions are based on the use of information technology and innovation to ensure efficient connectivity to transport, healthcare, sustainable energy consumption, and use of renewable and green resources, a clean environment, as well as other services offered to the population. Experience shows that such an approach can have a long-term positive impact on culture, social and sport, education, and security. The concept seeks to address a cross-section of the whole city and to influence all areas. In this way, we can guarantee success in all respects in the future. An essential aspect of success is the integration and interconnection of these areas. This includes not only new technologies and policy and governance mechanisms but also the provision of new opportunities for citizens. SMART technologies, systems, and solutions are the answer to the challenges of the future, where SMART and systematic approaches will be used to achieve an energy-efficient and sustainable economy in the city. To achieve these goals and ensure a successful transformation, the involvement of internal bodies and city forces as well as overarching cooperation with the city, other municipalities, and affiliated companies in this area are essential. A clear identity and positioning within and outside the city are important not only for the residents but also for the regional authorities. This includes a specific focus on research and technology policy in the municipalities, as well as the active involvement of their residents, local industry, research, and businesses in the processes.

The European Commission's definition characterizes SMART villages, a SMART region, as communities in rural areas that develop SMART solutions to solve problems in the local context. They build on existing local strengths and opportunities to participate in the sustainable development process of their territory. They rely on a participatory approach to develop and implement their strategies to improve economic, social, and environmental conditions, by fostering innovation and mobilizing the solutions offered by digital technologies. SMART villages benefit from cooperation and alliances with other communities and actors in rural and urban areas. The initiation and implementation of SMART villages strategies can build on existing initiatives and can be funded from a variety of public and private sources [8]. We consider the European Union's interest in rural development and the creation of the European Network for Rural Development platform as one of the fundamental steps towards fulfilling the objectives of the SMART Villages concept. Such a step may lead to uncertainty in case of clearly undefined financing methods and unstable policy of project functioning. It is funding, especially internal funding without a defined point, which can cause the gap between more developed and poorer countries to widen.

Developed countries can afford to invest in research, development, and implementation of their solutions, or they can allocate funds to buy links to existing solutions. It can therefore be argued that without political and financial support, development at the regional level will not change. SMART environments and their development have their advantages, but

also their negatives. We must remember that the whole concept was created primarily to improve the quality of life of the population, to ensure sustainable development, and, finally, to protect the environment. There is a visible effort to improve the environment in which we live, to make better use of alternative resources, to pollute less, and to make savings. The problem may be that most of these positive aspects of building a SMART CITY are only visible in the long term. Careful thought needs to be given to the individual benefits and negatives to see if the pros outweigh any negatives that may arise. Whether the possibility of attack and possible surveillance of the population is worth better air quality or investment management. These questions should be considered by each city or town separately, but about its residents. They are the ones who live there and who should be in touch with SMART CITY technologies.

4. Purpose and value of research

Our research aimed to map the current state of SMART solutions implemented in the Slovak environment and to understand the shortcomings and problems that block the implementation of these solutions in the wider environment. Understanding the current state can help to better set the future implementation of modern solutions for cities and municipalities in the 21st century to provide value-added services to residents and thus support their development and innovative approach to governance. Our goal was to identify conditions and requirements that will be accessible to all, including smaller towns, villages, and newly formed clusters or hybrid linkages between neighboring municipalities and larger towns.

A survey was previously conducted that included 140 cities and towns in the Slovak Republic. Due to the difficulty of reaching all municipalities and towns in Slovakia, only selected entities were examined in more detail by the contracting organization. The results of the survey may therefore not be indicative of the actual situation.

Our research work is the only document produced in the Slovak Republic that covers all municipalities and towns in Slovakia, not only selected parts of the country. It is also one of the documents with the highest number of respondents involved in the research.

5. Design, methodology research approach

Our research took the form of an electronic questionnaire or a face-to-face consultation. This questionnaire was developed in collaboration with ATOS IT Solutions and Services, the company providing technical support for this project. For our research, we selected all 2,927 municipalities and towns in Slovakia with a total population of 5,450,420. The questionnaire was sent to e-mail addresses that were available on the official websites of the municipalities and towns. The number of towns and municipalities with an official website is 2 594. In this case, we used the assistance of the regional authorities. The municipalities and towns without an official website are mostly small places with a total population of 53 026 inhabitants. The survey was conducted between May 2019 and February 2020. The questionnaire consisted of multiple-choice questions and statements for which the opinion of the representatives of the municipalities and towns had to be indicated. Based on previous answers, respondents were asked questions that were tailored to their current situation.

Fig. 2. Structured four groups of municipalities for SMART CITY projects, Source: Authors

There were no right or wrong answers. The collected data were imported into an Excel spreadsheet where the individual data were checked, analyzed, and then further processed. The results and analysis of the data obtained from the questionnaire survey were interpreted into graphs and tables using Excel. The aim was to include as many views and opinions as possible in the results. For this reason, we asked for cooperation and feedback on questions that directly relate to the SMART CITY concept in the Slovak environment. It is interesting to see how the views and opinions of mayors and councilors change as the population grows. The methodological output is the following analysis of all collected data, based on which it is possible to propose an architecture suitable for the implementation of SMART solutions in the Slovak environment.

6. Experimental results and observations

For the research were selected 2,927 municipalities and towns in Slovakia, which include 5,450,420 inhabitants. On the current day, the return on the completed questionnaire exceeded the limit of 597 responses, which cover 1705562 inhabitants in Slovakia. Table 1. shows the number of answers obtained from municipalities and cities in individual regions. These results must also consider the total number of municipalities and towns in the given regions, the number of which is different in each region.

Table 1. Involvement of municipalities by region

Region	up to 1000 inhabitants	from 1001 to 5000 inhabitants	from 5001 to 50000 inhabitants	From 50001 inhabitants	SUM
K1	97	15	7	2	121
K2	39	25	6	1	71
K3	21	15	6	1	43
K4	36	22	5	2	64
K5	90	13	8	1	112
K6	7	15	4	1	27
K7	55	20	2	0	77
K8	44	34	4	0	82
SUM	389	158	42	8	597

In Table 1, we cannot distinguish whether the district city of a given region was also involved in the research. You can see in Figure 3 if the questionnaire was completed by a district city or only by municipalities and cities in each district. The areas in dark blue represent the districts where the district towns were also involved. The districts where the municipalities and towns of the given district were involved are shown in pale blue, the district town was not involved. The white color is the districts from which the district town, city, or municipality did not participate in the research. Of the 79 districts in Slovakia, only two districts did not participate in the research. By focusing on

the composition of the answers obtained according to the approximate number of inhabitants in each city or municipality, the largest representation in the selected sample has municipalities up to 1000 inhabitants, on the contrary, the smallest representation consisted of cities from 25,001 to 50,000 inhabitants. If the number of inhabitants with research is used as the main variable, the largest cities and smallest municipalities moved the most. In Slovakia, we have 10 cities with more than 50,000 inhabitants, 8 of them participated in the research. Many small municipalities involved in the research are considered an advantage in case of interest in creating a larger common territory, e.g., cluster. Based on the filtering questions asked at the beginning of the questionnaire, we were able to divide the respondents into 4 basic groups. In the first round, we created two basic groups, which divided the respondents based on awareness of the concept of an intelligent city. Of the 2,927 municipalities and places that asked for feedback, only 364 respondents met the SMART CITY connection. From the point of view of the covered population, the connection SMART CITY met 1530475 inhabitants, which represents 28% of the total population of Slovakia and 88% of the sample of inhabitants involved in the research. Less than 1/3 of the population of our country met the combination of SMART CITY and its solutions. This information is more than surprising given that more than half of the population solves problems by sparking, traffic jams, or existential problems such as lack of drinking water, poor waste management, or unregulated use of limited resources, for the elimination of which SMART CITY solutions can be used. The main groups were divided into 2 subgroups according to use, interaction, and interest or lack of interest in this concept. We will focus on these specific groups below.

Fig. 3. Involvement of district towns, cities and municipalities

Table 2. Involvement of municipalities per inhabitants

Region	Answer - YES	Answer - NO
up to 1000 inhabitants	203	186
from 1001 to 5000 inhabitants	114	44
from 5000 to 50000 inhabitants	39	3
more than 50001 inhabitants	8	0
SUM	364	233

6.1 Intelligent solutions in Slovakia - GROUP 1

In this part of the work was analyzed a group of respondents included in Group 1. 79 respondents use or have used intelligent solutions. Only eight municipalities and cities that were represented in the questionnaire have a document that contains the concept of a SMART CITY. They include mostly large cities with a larger population. In another strategic document, such as the Economic and Social Development Program, up to 25 municipalities and cities have this concept included.

Graph 1. Incorporation of the SMART CITY concept into strategic documents

Graph 2. The phase of projects in the environment of municipalities and cities

Up to 35 municipalities and cities plan to include the concept in strategic documents. Here we can include municipalities with a population of about 5000. The number of municipalities and cities that do not have or do not plan to include plans to build a SMART CITY in their strategic documents is 11. The current state of implementation of SMART CITY technologies in Slovakia is shown in Graph 3 below. From the 79 municipalities and cities, 50 of them are in the planning and creation of plans, 21 projects are actively deployed, one project is in the phase of evaluating the level of project readiness for implementation, 7 projects are in the phase of implementing a solution for a program or policy.

The following graph shows the areas from which intelligent solutions have been selected and implemented. Respondents had the opportunity to choose more than one answer. The most common answers include the area of process management, the area of communication with the population, the area of waste management, and the area of energy.

Graph 3. Areas of implemented solutions

Graph 4. Benefits and motivation to use SMART technologies

Representatives of municipalities and cities received many benefits in implementing individual solutions. Each element in Graph 4 below should be assigned a value from 1 to 5, according to the weight they give to that element. Value 1 was the smallest, value 5 was the largest. The preferences of the individual elements were calculated by the weighted arithmetic mean of all values. Support for city development, effective city management, environmental protection, and the expansion of services to residents and visitors form a set of elements that are of the greatest importance to mayors and mayors in building a SMART CITY.

When implementing solutions from the SMART CITY concept, cities and municipalities encountered many problems that defended them from applying innovations. Respondents could choose multiple answers. The weight of the individual elements was calculated by the weighted arithmetic mean of all values. As in the previous example, respondents had to assign a weight from 1 to 5. A value of 1 was the smallest, a value of 5 the largest.

The main and at the same time the most common problem is the limited financial and budgetary possibilities, the weight of which exceeds 80%. The other four problems are closely related to technology, in particular the lack of supporting or internal infrastructure.

Graph 5. Barriers to building an intelligent environment

Given that municipalities and cities face problems not only financial or technological, but they would also welcome the possibility of support and consultation.

Graph 6. Forms of support in the implementation of SMART CITY projects

Table 3. Questions set I.

Region	Answer - YES	Answer - NO
Loss of sovereignty	58	21
Willingness to cooperates	77	2
Financial independence	63	16
Support (state, EU)	75	4
Credit	40	39
Cooperation with a technology company	75	4
Catalogue of services	70	9
Cross-border cooperation	66	13

The preferred form of external support in the implementation of the SMART CITY project can be seen in Chart 6. Out of 79 respondents, up to 57 chose the possibility of inspiration from implemented projects, 51 respondents chose the possibility of consulting on how to obtain subsidies and finance a SMART environment project. They showed the least interest in help and advice in creating partnerships or the opportunity to inspire municipalities and cities with their ideas. The answers to a group of questions are shown in the last graph, which shows this group of respondents. They mainly concerned the financial condition of the municipality and the willingness to cooperate, either with the surrounding municipalities or towns.

6.2 Intelligent solutions in Slovakia - GROUP 2

In this subchapter of our work, we focused on the answers of respondents who indicated that they had already encountered the term SMART CITY. However, they do not use the solutions offered by this concept. The number of respondents in this group is 285 municipalities and cities. The question in this block examined whether representatives of municipalities and cities plan to participate in one of the projects to build a SMART CITY in the future. More than 163 respondents to this group answered in the affirmative. This means that more than half of municipalities and cities plan to get involved in such projects in the future. The other, smaller half of the group do not plan to get involved in the SMART CITY project, even though they have already encountered this concept. The red color in the graph below shows 122 municipalities and cities that do not plan to participate in such projects.

Graph 7. Interest in the implementation of SC in the future

According to the results of a survey of 285 respondents, only 110 have information on the Call for applications for subsidies to support small and medium-sized enterprises in the implementation of innovative solutions in cities and municipalities, announced by the Ministry of Economy of the Slovak Republic.

Graph 8. Awareness of the calls of the Ministry of Economy of the Slovak Republic

The reasons that the representatives chose as a barrier in the implementation of SMART solutions are shown in Graph 9. Respondents had to assign a weight from 1 to 5 to each problem, depending on whether the weight of the problem is low or high for them.

Graph 9. Limitations in building SC according to respondents

The weighted arithmetic average of all values for a particular problem was used to calculate the weight assigned by the representatives to the individual constraints. The biggest constraint that prevents change in a SMART environment is the budget constraint. Its weight is 82%. On the contrary, the smallest limitation (46%) is the reluctance of representatives to engage in innovative projects. Constraints affecting the construction part of the SMART CITY and technology, such as the lack of supporting infrastructure, insufficient level of technological skills or dependence on older systems.

Graph 10. Possibilities of external support in building SMART CITY

If the municipality and cities changed their environment to intelligent, Graph 10 creates the form of external support that was most often preferred by the respondents. Out of 285 respondents, more than half would choose the opportunity to be inspired by the implemented projects and professional advice on subsidies and finance the project on the contrary, the least attractive form of support is help and advice through an online platform, which would be chosen by only 9 municipalities and cities.

Table 4. Questions set II.

Region	Answer - YES	Answer - NO
Cooperation with other municipalities	271	14
Loss of sovereignty	185	100
Financing	83	202
Support (State, EU)	271	14
Credit	81	204
Cooperation with a technology company	257	28
Catalogue of services	214	71
Possibility to get acquainted with projects	259	26
Cross-border cooperation	182	103

The answers to the group of questions are shown in the last table, Table 4., in this part of the redistribution of respondents. They mainly concerned the financial possibilities of the municipality and the willingness to cooperate either with the surrounding municipalities or the technology company. Interestingly, almost all municipalities or cities would be willing to cooperate with another municipality, when the question of the loss of sovereignty, this number decreased rapidly. Respondents could answer yes or no to the questions asked.

7. Finding and discussion

For our research, we selected 2 927 municipalities and towns in Slovakia with 5 450 420 inhabitants. The return rate of completed questionnaires to date has exceeded 597 responses, covering more than 1.7 million inhabitants of Slovakia. The responses we received were evenly distributed in all parts of the country. These results also consider that the total number of municipalities and towns in the regions varies from region to region. As a result, we obtained the most responses from the regions that are composed of the largest number of towns and villages. If we focus on the composition of the responses received according to the approximate number of inhabitants in the town or municipality, the largest representation in the sample is found in municipalities with up to 1,000 inhabitants, while the smallest representation was found in towns with 25,001 to 50,000 inhabitants. To refine the respondents' visions, the related questions were divided into two groups. The first group consisted of those who have already implemented or are implementing solutions. The second group consisted of respondents who are not currently implementing SMART solutions or have not used them in the past.

- To find out true information about the awareness of the SMART concept in the Slovak environment, we asked the respondents whether they had encountered the concept. It was interesting to find out that more than half of the population had encountered the concept; in terms of population, it was up to 1.5 million out of the total population involved in the research.

- Many of the small communities involved in the research saw an advantage in forming a larger shared space, e.g., a cluster. In the second place, they see in this decision a loss of independence
- Lack of awareness of the issue on the part of the population as well as municipal representatives causes many barriers to further development
- The results of the research show that despite some successful implementations of SMART solutions, the Slovak Republic lags significantly behind European countries.
- We dare to say that this situation is caused by the unclear vision of municipal and city leaders, also by a feeling of fear, as well as by the lack of supporting technologies and finances.
- In our opinion, fear is a concomitant phenomenon of a lack of awareness. Leaders are aware that SMART technologies, which provide solutions to the problems that municipalities face daily, could change attitudes towards their use.

We believe that the analysis produces a comprehensive view and valuable evidence for further research. Our results can serve as a basis for supporting the implementation of SMART solutions in the Slovak environment and proposing actual solutions for mayors who make decisions in the interest of their citizens. In the present paper, we present only a poor spectrum of information from the collected data. Subsequent analysis can provide information on other factors (unemployment, population density, location, education, economically active population, etc.) that influence and can support the process of implementation of the desired changes.

8. Conclusion

Even though the level of urbanization in Slovakia does not reach a high value it causes existing problems for small municipalities and brings new problems for large cities.

The results of the research show that despite some successful implementation of intelligent solutions, the Slovak Republic drop significantly behind European countries. By recognizing that it is intelligent technologies that provide solutions to the problems that local governments face every day could change the attitude towards their use.

We think that the created analysis provides a comprehensive view and valuable input for further research. Our results can serve as a base for supporting the implementation of SMART solutions in the Slovak environment and the proposal of current solutions for mayors who are making decisions in the interests of their citizens. In the presented document we present only a lean spectrum of information from the collected data. Following analysis can provide information about other factors (unemployment, population density, location, education, economically active population, etc.) that affect and can support the process of implementing the required changes

Also, the results of the research can serve as a strategy for creating hybrid linkages and clusters. If the results of the work raise at least some awareness of the concept using ICT, this will be considered as a great contribution to the visibility of the SMART CITY concept. Because the whole smart city concept was created for people and is about people.

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