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IMPLEMENTATION OF SMART SOLUTIONS IN SERBIAN CITIES: ARE WE CLOSE TO SMART CITIES?

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Abstract

In this paper, the aim of the research refers to the analysis of the views of the citizens of seven cities in Republic of Serbia on the concept of smart cities. The concept of smart cities is being adopted worldwide, with the exponential growth of smart technologies. In the empirical part of the paper, research was conducted by the author of the paper in connection with the subject of the research. The research instrument used in this paper is a survey that was created online and then distributed to survey students. The sample of respondents consisted of 294 respondents, from whom it was planned to get opinions on the concept of smart cities, to what extent it positively or negatively affects everyday life. The research results indicate the level of respondents' ignorance of the concept of smart cities. Also, there is the uneven implementation of smart solutions in rural and urban areas in Republic of Serbia. The recommendation is to enable the even development of all cities and educate the population about the concept of smart cities, in the sense that there are no significant threats to security and privacy, and that resources such as time and costs are highly, their savings, closely connected with the concept of smart cities.

Keywords: Artificial Inteligence, Republic of Serbia,Smart Cities, Smart Solutions, Survey.

Introduction

The Internet of Things (IoT) is closely related to the concept of smart cities. The number of inhabitants at the world level is constantly increasing, cities are becoming bigger and bigger. Along with this growth of the urban way of life, there is also a continuous development of technologies, which can greatly help citizens in their daily lives: smart payment systems, smart transport options and signaling, management of waste, water, electricity, e-services, are just a few of options. The concept of smart cities is constantly developing, but uneven implementation of the concept is carried out due to technological, economic and administrative barriers and challenges.

The purpose of this paper is to gain insight into the characteristics (constructions) of the concept of smart cities and their application in seven cities in Republic of Serbia (from different parts of the country), first through theoretical foundations, and then with the author's research/survey results. The paper pointed out the aspects of real implementation - how far we have come with shaping cities in Republic of Serbia into smart cities. The paper gives special attention to the identification of opportunities and challenges for the realization of the concept of smart cities in Republic of Serbia.

Literature review

The concept of connecting everyday objects over existing networks has become very relevant with the advent of smart devices and their recent advancements. The Internet of Things (IoT) is the result of the evolution of conventional networks that connect millions of connected devices. IoT connects to applications in smart homes, cities, distribution & storage within supply chains (in real time), distance learning, etc. Carrying out city operations with the help of ICT has made cities efficient in various aspects, where smart city is an application of IoT. IoT provides the basic components for building smart cities, ie. data generation, data management and application handling. [7, 8, 12] Figure 1 shows the main pillars of smart cities.

A smart city connects physical, social, business and ICT infrastructure. Smart city is defined as an advanced modern city that uses ICT and other technologies to improve the quality of life, competitiveness, operational efficiency of urban services, while ensuring the availability of resources for current and future generations in terms of social life, economic and environmental aspects. Adapting to the demands of quality of life, modern smart cities are particularly focusing on sustainable and efficient solutions for energy management, transportation, healthcare, governance etc.

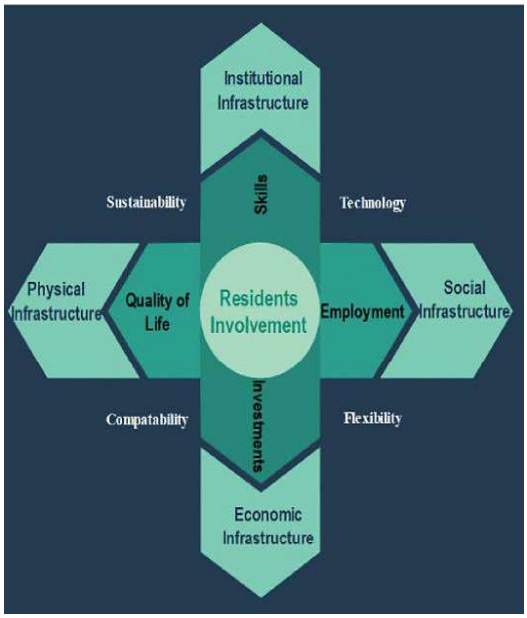

Figure 1. Main pillars of smart cities [13]

Smart city is the ideal solution for solving the challenges arising from drastic urbanization, population growth, deterioration of energy sources, environmental pollution, etc. Therefore, we can argue that adherence to smart city standards offers countless advantages in the implementation and management of smart cities, while facilitating real-time performance monitoring. But, smart cities must ensure individual privacy and security to ensure the participation of their citizens.

Current examples of cities incorporating smart city principles include cities around the world, like New York, Toronto, Copenhagen etc. Privacy protection for city users is of utmost importance for the success of a smart city. If citizens are reluctant to participate, the key benefits of a smart city will disappear. [2] Areas of further research include security monitoring tools, access controls and security buffers such as firewalls, micro firewalls and smart cards. [2]

Recent debates on sustainable urban development are intrinsically linked to smart cities [1]. In fact, it is currently difficult to imagine a smart city without linking it to aspects of sustainability and vice versa. Technology-related approaches, in short, aim to improve the efficiency of services and infrastructure. On the other hand, governance-related approaches focus on governance and interactions between different stakeholders in the city, connecting and developing socioeconomic and productive interactions among networks of urban actors. Technology provides the means to improve and connect actors and services in order to achieve sustainable urban development, improve the socioeconomic, ecological, logistical, managerial and competitive performance of the city and the quality of life of its population, thus ensuring that the needs of current and future generations are met. [3]

Methodology

Statistical data processing and analysis were done using the software IBM SPSS (Statistical Package of Social Science) version 25. In this paper were used descriptive statistics to describe the sample and an independent t test to examine differences in relation to gender and school of students. A level of 0.05 was used for the threshold value of significance.

Results and Discussion

294 respondents participated in the research, of which 132 were male and 162 were female (Table 1). Most respondents were aged 18 to 30 (46.9%), followed by respondents aged 31 to 40 (32%) (Table 1). Most respondents have completed basic studies (37.4%), while the smallest number of respondents have completed doctoral studies (1.4%) (Table 1). Respondents are relatively evenly distributed according to the cities included in this research (Table 1). The vast majority of respondents are citizens of their city (62.6%) (Table 1). The cities included in the research are: Novi Sad, Beograd, Ćuprija, Zaječar, Čačak, Niš and Prokuplje.

Table 1. Sociodemographic characteristics of respondents

		f	%
Gender	Male	132	44.9
	Female	162	55.1
Age of the respodents	18-30 years	138	46.9
	31-40 years	94	32.0
	41-50 years	42	14.3
	51 > years	20	6.8
Level of education	High school	100	34.0
	Bachelor	110	37.4
	Master studies	80	27.2
	Doctoral studies	4	1.4
How long have you been employed?	up to 2 years	24	23.5
	from 2-5 years	39	38.2
	from 5-10 years	21	20.6
	>10 years	18	17.6
City	Novi Sad	33	11.2
	Čačak	23	7.8
	Beograd	62	21.1
	Prokuplje	44	15.0
	Niš	55	18.7
	Zaječar	35	11.9
	Ćuprija	42	14.3
Status of respondents in the city	Citizen	184	62.6
	Public sector	49	16.7
	Private sector	61	20.7

* f- frequency

Based on the results shown in Table 2, it can be concluded that the vast majority of respondents have heard of the term smart cities (77.9%), have heard of smart payment (92.2%) and are concerned about privacy due to the increased use of smart technology (74.5).

Table 2. Familiarity with the terms smart cities and technologies

		f	%
Have you heard of the term smart cities?	Yes	229	77.9
	No	64	21.8
Have you heard about smart payment, smart meters, etc.?	Yes	271	92.2
	No	23	7.8
Do you have privacy concerns due to the increasing use of smart technology?	Yes	219	74.5
	No	75	25.5

Based on the results shown in Table 3, it can be concluded that the degree of agreement of respondents is the highest for the statements that the city has cultural and historical significance (M=4.35, SD=0.61), the city has good mobile signal coverage (M=4.29, SD=0.56) and the majority of individual households/buildings have access to the Internet (M=4.24, SD=0.51), while the lowest degree of agreement for statements that finding a job in the city is easy and the labor market meets the needs of residents (M=2.04, SD=0.97) and the city uses smart waste disposal in the city (M=2.52, SD=0.97).

Table 3. The degree of agreement of respondents with the statements related to the environment

	M	SD
The city I live in is well planned and the city management manages it well.	2.65	0.95
There are parts of the city that are not included in the plans.	3.91	0.74
The city is successfully solving all existing problems in the city.	2.55	0.93
Roads are in good condition.	2.92	1.16
Street lighting (LED or other) is modern and functional.	3.47	0.97
Pedestrian crossings are well marked.	3.27	1.11
There is a separate section for pedestrians.	3.35	1.08
The city pays great attention to the maintenance of green areas, as well as their expansion (planting trees etc.).	2.79	1.05
Residents are regularly informed about the plans of the city/ development.	2.66	0.86
The population is high in my city (construction that is concentrated).	3.84	0.97
The city has cultural and historical significance.	4.35	0.61
Most individual households/buildings are equipped with smart remote electricity meters.	3.68	0.90
The electricity supply is stable - without interruptions.	4.00	0.68
Most individual households/buildings have internet access.	4.24	0.51
The city has good mobile signal coverage.	4.29	0.56
The city provides online services through e-administration: identity cards, passports etc.	3.75	1.02
Smart traffic signs have been installed in the city.	3.20	1.20
There are real-time traffic systems in the city.	2.94	1.20
There is good public transportation in the city that works well.	3.46	1.08
The water network works well.	3.47	1.02
The city has provided a smart reading of water consumption.	3.01	0.90
The water distributed from the city's water supply is safe to drink and is constantly monitored.	3.04	1.17
When there is a fault in the water network, there are some smart solutions for quick detection of the fault, which are then quickly repaired.	3.00	0.89
The water goes through new treatment cycles.	3.09	0.82
The city uses smart waste management during disposal.	2.52	0.97
Recycling of various types of waste is supported in the city.	2.93	1.18
The city attaches great importance to raising awareness about air, water and land pollution, as well as prevention.	2.86	1.04
Health services are easily available through e-services.	3.45	0.99
Schools have distance or e-learning options.	3.72	0.79
There are business incubators in the city.	2.99	1.20
There are career development centers in the city.	3.24	1.16
There is a surveillance system in certain places in the city.	3.67	0.91
The city has developed an alarm system in case of natural disasters.	3.54	0.87
Citizens are expected to be involved in the development of the city.	2.80	0.88
Information about the city budget is available and transparent to citizens.	2.55	0.79
I am familiar with the city's plans and strategies regarding the improvement of infrastructure and other important sectors in the city in terms of smart equipment and solutions.	2.61	0.77
The response of the police, firefighters or hospital staff to the call is quick.	3.75	0.78
Finding employment in my city is easy and the labor market meets the needs of the residents.	2.04	0.97
Investing in smart systems and solutions can contribute to economic growth, saving costs and time, improving services and the safety of citizens.	4.16	0.75
Lack of funds, capacity, adequate human resources, infrastructure and accompanying legal legislation can be potential barriers for cities in adopting smart solutions (IoT).	4.16	0.76

*M - mean; SD - standard deviation

The reliability of the smart cities scale was tested using the Cronbach alpha coefficient. Based on the value of the Cronbach alpha coefficient, it can be concluded that the reliability is excellent (Table 4).

Table 4. Reliability scale

	Number of items	Cronbach alpha coefficient
Smart cities	40	0.942

The research examined whether there is a significant difference in the degree of agreement of the respondents with the statements made regarding smart cities in relation to the gender of the respondents. The t test of independent samples was used to examine differences in relation to gender.

Based on the results of the t test shown in Table 5, it can be concluded that there is no significant difference in the degree of agreement for the stated statements in relation to the gender of the respondents.

Table 5. Differences in the degree of agreement for the statements

made in relation to the gender of the respondents

	Middle value	t	p
Male (N=131)	3.35 ± 0.54	-1.022	0.307
Female (N=162)	3.41 ± 0.53		

* N -number od respodents; t test - data sets follow a normal distribution; p - statistical significance at the level of 0.05

The research examined whether there is a difference in the degree of agreement of respondents with the statements made regarding smart cities in relation to the age of the respondents. One-factor analysis of variance (ANOVA) was used to examine differences in relation to age.

Based on the results of the ANOVA test shown in Table 6, it can be concluded that there is a significant difference in the degree of agreement for the statements made in relation to the age of the respondents. The post hoc test found that there is a significant difference between respondents over 50 years old and respondents aged 18 to 30 (p=0.009) and respondents aged 31 to 40 (p=0.025), where older respondents are significantly less satisfied with the current state of affairs in city.

Table 6. Differences in the degree of agreement for the statements

made in relation to the age of the respondents

	Middle value	F	p
18-30 years (N=138)	3.44 ± 0.48	3.841	0.010*
31-40 years (N=93)	3.41 ± 0.56		
41-50 years(N=42)	3.30 ± 0.63		
51 > years (N=20)	3.04 ± 0.47		

*Statistical significance at the level of 0.05

The research examined whether there is a difference in the degree of agreement of the respondents with the statements made regarding smart cities in relation to the level of education of the respondents. One-factor analysis of variance (ANOVA) was used to examine differences in relation to the level of education.

Based on the results of the ANOVA test shown in Table 7, it can be concluded that there is a significant difference in the degree of agreement for the stated statements in relation to the level of education of the respondents. The post hoc test determined that there is a significant difference between respondents with completed high school and respondents with completed basic studies (p=0.004) and respondents with completed master studies (p<0.0005), where the more educated respondents are more satisfied with the current situation in the city.

Table 7. Differences in the degree of agreement for the statements made

in relation to the level of education of the respondents

	Middle value	F	p
High school (N=100)	3.18 ± 0.60	9.745	<0.0005*
Bachelor (N=110)	3.43 ± 0.42		
Master studies (N=79)	3.59 ± 0.52		
Doctoral studies (N=4)	3.08 ± 0.57		

* Statistical significance at the level of 0.05

The research examined whether there is a difference in the degree of agreement of respondents with the statements made regarding smart cities in relation to the respondent's city. One-factor analysis of variance (ANOVA) was used to examine differences in relation to the city.

Based on the results of the ANOVA test shown in Table 7, it can be concluded that there is a significant difference in the degree of agreement for the stated statements in relation to the level of education of the respondents. The post hoc test determined that there is a significant difference between respondents from Prokuplje and respondents from Novi Sad (p<0.0005), Čačak (p<0.0005), Beograd (p<0.0005), Niš (p<0.0005), Zaječar (p<0.0005) and Čuprija (p<0.0005), where respondents from Prokuplje are the least satisfied with the current situation in the city. The post hoc test found that there is a significant difference between respondents from Ćuprija and respondents from Novi Sad (p<0.0005), Čačak (p=0.001), Beograd (p<0.0005), Niš (p<0.0005), Zaječar (p<0.0005), where respondents from Ćuprija are the least satisfied with the current situation in the city.

Table 8. Differences in the degree of agreement for the statements made in relation to the respondent's city

	Middle value	F	p
Novi Sad (N=33)	3.66 ± 0.32		
Čačak (N=23)	3.49 ± 0.15		
Beograd (N=62)	3.75 ± 0.58		
Prokuplje (N=44)	2.66 ± 0.35	41.658	<0.0005*
Niš (N=55)	3.47 ± 0.46		
Zaječar (N=35)	3.57 ± 0.17		
Ćuprija (N=41)	3.05 ± 0.27		

* Statistical significance at the level of 0.05

The research examined whether there is a difference in the degree of agreement of the respondents with the statements made regarding smart cities in relation to the characteristics of the respondents. One-factor analysis of variance (ANOVA) was used to examine the differences in relation to the property.

Based on the results of the ANOVA test shown in Table 9, it can be concluded that there is no significant difference in the degree of agreement for the statements made in relation to the characteristics of the respondents.

Table 9. Differences in the degree of agreement for the statements

made in relation to the characteristics of the respondents

	Middle value	F	p
Citizen (N=183)	3.33 ± 0.52		
Public sector (N=49)	3.50 ± 0.53	2.524	0.082
Private sector (N=61)	3.45 ± 0.59		

* Statistical significance at the level of 0.05

The research investigated whether there is a significant difference in the degree of agreement of respondents with the statements made regarding smart cities in relation to their knowledge of the concept of smart cities. To examine the differences in relation to the knowledge of the concept of smart cities, the t test of independent samples was applied.

Based on the results of the t test shown in Table 10, it can be concluded that there is a significant difference in the degree of agreement for the stated statements in relation to the knowledge of the concept of smart cities, where respondents who know the concept of smart cities are more satisfied with the current state of the city.

Table 10. Differences in the degree of agreement for the statements

made in relation to the knowledge of the concept of smart cities

	Middle value	t	p
Yes (N=228)	3.51 ± 0.48	8.552	<0.0005*
No (N=64)	2.92 ± 0.47		

* Statistical significance at the level of 0.05

The research investigated whether there is a significant difference in the degree of agreement of respondents with the statements made regarding smart cities in relation to the knowledge of the concept of smart payment. To examine the differences in relation to the knowledge of the concept of smart payment, the t test of independent samples was applied.

Based on the results of the t test shown in Table 11, it can be concluded that there is a significant difference in the degree of agreement for the statements made in relation to the knowledge of the concept of smart payment, where respondents who know the concept of smart payment are more satisfied with the current situation in the city.

Table 11. Differences in the degree of agreement for the statements

made in relation to the knowledge of the concept of smart payment

	Middle value	t	p
Yes (N=270)	3.44 ± 0.51	9.875	<0.0005*
No (N=23)	2.66 ± 0.34		

* Statistical significance at the level of 0.05

The research examined whether there is a significant difference in the degree of agreement of respondents with the statements made regarding smart cities in relation to concerns regarding privacy. An independent samples t test was used to examine differences in privacy concerns.

Based on the results of the t test shown in Table 12, it can be concluded that there is a significant difference in the degree of agreement for the statements made in relation to privacy concerns, where respondents who are not concerned about their privacy due to the increasing use of smart technology have a significantly lower degree of satisfaction the current situation in the city.

Table 12. Differences in the degree of agreement for the statements made in relation to privacy concerns

	Middle value	t	p
Yes (N=218)	3.44 ± 0.53	3.317	0.001*
No (N=75)	3.21 ± 0.51		

In accordance with the literature review and research results in this paper, we can agree with the findings of other conducted research that dealt with the concept of smart cities, that smart cities are the paradigm of the future, with multiple benefits for citizens. [9, 11, 15] However, we can conclude that in the context of the implementation of smart technologies in Republic of Serbia, the implementation was either not carried out in the right way or there is aversion or resistance of citizens towards these technologies. This is especially pronounced in smaller cities than Beograd or Novi Sad. Additional efforts are needed in order to improve the necessary infrastructure for smart technologies, as well as to inform residents about the features of the concept. With proper information, citizens would have reliable information, and the level of concern regarding security and privacy would be reduced. [10] And the author Hussain (2024), agrees and states that in the future it is necessary to strengthen aspects of cyber security related to the concept of smart cities, in order to counter potential cyber threats and violations within the infrastructure of smart cities and IoT networks. In addition, interoperability issues between different IoT devices and systems also pose a significant challenge, requiring standardization efforts and innovative solutions for seamless integration. [5]Syed et. all. (2021), also focus on security and privacy issues of IoT in smart cities, such as encryption, authentication protocols, data anonymization techniques and other methods to prevent unauthorized access to the IoT network and propose a solution in the form of blockchain technology. They also point to the potential of AI. [14] Author Janssen et. all. (2019), claims that security and privacy, business models, data quality, scalability, complexity and governance have strong driving power and also could be key challenges in smart cities. [6] However, economic growth and savings are the most important benefits that motivate smart city activities, and budget and internal capacity constraints are the most important barriers. [4]

Conclusion

Our presentation of the opinions of respondents from seven cities in Republic of Serbia represents a stable basis for understanding the importance and application of the concept of smart cities in Republic of Serbia, and what could be explored in some subsequent research. The intention was to point out the difference or similarities in the opinions of respondents in rural and urban areas in Republic of Serbia, regarding smart solutions within the concept of smart cities. The main limitation in this research could be related to insufficient familiarity of the respondents (general population in our research) with the concept of smart cities, considering that in Republic of Serbia, a more comprehensive implementation of smart solutions is necessary in order to create smart cities, which already exist in the world, and which would could be explored in future research. Technology is constantly developing, and it is inevitable that city administrations in Republic of Serbia should strive for the most efficient application of smart solutions.

Finally, it is necessary to eliminate the aversion of city dwellers to new technologies, primarily in terms of security and privacy of citizens. The results of our research indicate a tendency to raise environmental awareness among citizens, which is assessed by concern regarding the method of waste removal, but also the water supply system. These are two areas that need to be given more attention in the future, as well as for even development to take place in all cities in Republic of Serbia, with regard to the concept of smart cities, because the concept of smart cities can contribute to fast services and cost reduction in all sectors.

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