СРПСКО ДРУШТВО ЗА ПУТЕВЕ

Пут и саобраћај
Journal of Road and Traffic Engineering

Journal homepage: www.putisaobracaj.rs

On the move: indicators of urban mobility – smart city concept "City of Varaždin"

Majda Kodžaga[a], Ivan Cvitković[a] , Nives Domjan Kačarević[a] Katarina Stojanović[b]

[a] *University North, Koprivnica*
[b] *Faculty of Economics and Engineering Management in Novi Sad*

ARTICLE INFO

DOI: 10.31075/PIS.69.04.06
Professional paper
Received: 15.10.2023.
Accepted: 03.11.2023.
Corresponding author:
makodzaga@unin.hr
Keywords:
Mobility,
Smart City
Sustainability,
Traffic

ABSTRACT

The global trend of urbanization significantly impacts the environment and climate, presenting challenges for scientists and urban planning experts in addressing mobility issues. Sustainable transport systems are crucial for the continued development of urban environments. This paper focuses on the example of Varaždin, highlighting Smart Mobility as a key indicator. The emphasis on mobility indicators in the transport sector is essential for obtaining consistent and comparable data, establishing a knowledge base, facilitating communication with the environment, identifying best practices, and monitoring project implementation and overall progress. It's important to note that the concept of a smart city is dynamic and evolves with technological advancements even in traffic sector.

1. Introduction

The concept called "Smart City" is one of most popular concepts for the cities right now in Europe and all around the world. (Orlowski, Romanowska, 2019) A smart city is an urban area that utilizes technology and data-driven solutions to enhance the efficiency, sustainability, and quality of life for its residents. The concept of a smart city involves the integration of various technologies, including the Internet of Things (IoT), artificial intelligence (AI), sensors, and data analytics, to optimize the delivery of public services, improve infrastructure, and enhance the overall urban experience (Orlowski, Romanowska, 2019).

Smart cities leverage these technologies to address challenges such as traffic congestion, energy consumption, waste management, and public safety. In the very beginnings in Republic of Croatia, especially in big cities, Smart City concept grows in popularity. As all around the world, cities in Republic of Croatia are also facing with strong structural changes which are caused by economic, political and environmental challenges (Purnomo, Harjanto Prabowo, 2016). We can define Smart City concept as an investment in people (society), modern ways of transport (sustainable mobility) and ICT which will have for result higher quality of life (Purnomo, Harjanto Prabowo, 2016). As far as is currently known, especially the concept of Smart city rests on foundations of sustainable development, respectably creating more environmentally friendly social and economic community. Within the concept of Smart city traffic and mobility are the key points for cities to function in qualitative ways. With that said, new ideas generate that can ensure better availability, safety and efficiency in city management. At the list of priorities cities have confirmed that becoming Smart city is their high priority. In that way they achieve numerous benefits, which some are: sustainability, efficiency, better society inclusion which automatically means better quality of life (Bosch, Jongeneel, Rovers ect., 2017).

There is a six characteristics and indicators according to Colldhal and Kelemen (2013) which refers to Smart City (Figure 1): 1. Smart Mobility, 2. Smart Economy, 3. Smart Governance, 4. Smart Environment, 5. Smart People and 6. Smart Living.

In essence, the indicators of mobility in the urban environment transcend mere infrastructure they embody a city's commitment to accessibility, sustainability, and the seamless intertwining of human lives. And Varaždin is exactly one of those cities. The city of Varaždin is one of the urban areas in the Republic of Croatia that wants to be declared as Smart city. The city itself has developed the „Urban Mobility Plan of City of Varaždin – City Walk" which represents the backbone of the further development of the city within the Smart City concept (Šimunović, Brčić, Markovinović, 2018).

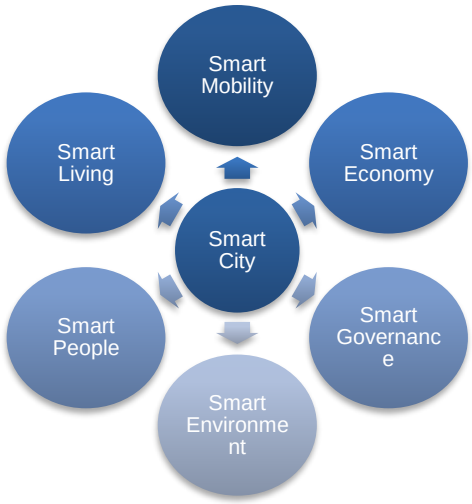

Figure 1: Smart City model - 6 characters
Source: P. Bosch, S. Jongeneel, V. Rovers, H-M. Neumann, M. Airaksien, A. Huovila, 2017.

2. Smart Mobility – the Smart City of Varaždin

SMART mobility refers to the integration of technology and data-driven solutions to enhance the efficiency, safety, and sustainability of transportation systems in urban areas. The acronym SMART stands for Specific, Measurable, Achievable, Relevant, and Time-bound, emphasizing the need for well-defined goals and measurable outcomes in the pursuit of intelligent mobility solutions (Orlowski, Romanowska, 2019). For many years, the city of Varaždin has been investing in the development of transport infrastructure in order to achieve positive effects on urban mobility and create a desirable environment for living. Before actively taking steps to transform the city of Varaždin into a Smart City, spatial planning and strategic development documents were created, through which the characteristics within the Smart City concept were influenced, that is, in this case, Smart Mobility in correlation with Urban Mobility. The city of Varaždin has set itself the task of making walking and cycling key components of the development and development of a sustainable transport system. The mentioned types of mobility are characterized by zero emission of harmful gases as well as low costs, and at the same time they contribute to maintaining the health of the individual because they lead a more active lifestyle (Cvitković, Brlek, Klečina, 2023).

Smart Mobility at this point means the area of a Smart City which representing Smart Mobility and broadly defined, the components which comprise not only the traditionally understood transport of people and goods, but also the dissemination of information by digital means. The main role of the Smart Mobility indicator area is to connect all the city's resources (Orlowski, Romanowska, 2019). Also Orlowski and Romanowska (2019) says that at this point Smart Mobility indicator means people, information and goods.

2.1. The current state of smart and urban mobility in the city of Varaždin

The city of Varaždin has made substantial investments in the development of bicycle and pedestrian paths in recent years, aligning with the Smart City concept, particularly focusing on Smart Mobility. As a vital hub for daily trips and boasting a well-established public transport system in Croatia, Varaždin has formulated an Urban Mobility Plan to comprehensively address mobility, traffic safety, and environmental concerns.The city has developed an urban mobility plan, which outlines the current state of the city in terms of mobility and traffic safety when it comes to pedestrians and cyclists, as well as bus transportatio (Cvitković, Brlek, Klečina, 2023). In the Urban Mobility Plan, the city of Varaždin covered every segment of traffic, including city logistics and traffic safety, as well as environmental and nature protection, as well as the public and private sector in terms of service providers which indicates that the Plan covers every segment of sustainable development and that the city is really moving towards a "Smart City". In 2017, an analysis was carried out in the Plan, where Šimunović and his colleagues presented a conclusion in which it is emphasized that it is necessary to pay attention to the quality of existing sidewalks, lighting, and that it is necessary to carry out an analysis of the curbs that are part of the city streets because they represent a potential danger and prevent safe movement through the city (Šimunović, Brčić, Markovinović, 2018).

It is stated that the bicycle paths are not sufficiently well connected to each other, but also that there is a very high level of danger to cyclists from motor vehicles (Šimunović, Brčić, Markovinović, 2018). In support of this, traffic accidents are one of the "typical" Smart City factors that traffic experts deal with when it comes to the Smart City concept, because through it they try to reduce them, as well as reduce the traffic jams caused by them. In this case, the analysis of road accidents revealed that there were no fatalities in road accidents where cyclists were involved, but there were those who were seriously and lightly injured, while in road accidents where pedestrians were involved, 1 person died, and the most common reason was inappropriate speed of a motor vehicle (collision with a pedestrian) (Šimunović, Brčić, Markovinović, 2018).

Namely, in 2017, a traffic count was carried out in the city of Varaždin at characteristic points, and in the same year the "Urban Mobility Plan of the City of Varaždin - City walk" was drawn up, then the count was carried out at the same characteristic points (12 of them) in 2023, when Evaluation of the said Plan was carried out, which showed the current state of the city of Varaždin in terms of urban mobility. The obtained results are shown in table 1.

Table 1. Comparison of peak loads in 2017 and 2023 on the traffic network of the city of Varaždin

	Street	Peak load 2023 (EJA)	Peak load 2017 (EJA)
1.	Koprivnčka street (before crossroads with Međimurska)	7436	9650
2.	Međimurska street (before crossroads with Koprivnička)	12210	12703
3.	Optujska street (around house number 67)	14337	10358
4.	Brače Radića (at the old entrance to the hospital)	9328	8880
5.	Jelkovečka street (around house number 89)	5247	5351
6.	Zagrebačka street (at the Hyundai saloon)	14850	12806
7.	August Cesarec street (at the park)	11594	7928
8.	Preradovićeva street (at the gymnasium)	1991	6332
9.	Preradovićeva street (at the street market)	5390	4582
10.	Vrazova street (at the McDonalds)	12936	12786
11.	Zrinski i Frankopana street	12980	13358
12.	Gospodarska street (at the Vindija)	14135	-

Source: I. Cvitković, P. Brlek, A. Klečina, 2023.

The table shows that in certain parts of the city there was an increased load compared to 2017 for example Zagrebačka street and Optujska street. Also, increase is visible on the first city ring, and is especially noticeable in Augusta Cesarca Street. The plan defines the goals and measures that need to be implemented in order to contribute to the realization of the Smart City concept in the Smart Mobility component, and the goal that is observed through the work is: "Increasing the attractiveness and quality of non-motorized traffic". In this case, the planned measures for the fulfillment of the stated goal were: preparation of the elaboration of the expansion of the pedestrian zone and incorporating the bicycle infrastructure and defining the stages until 2026.; draw up an elaboration of the construction and renovation of pedestrian routes and define the stages until 2030; create a traffic study of the bicycle network, within which the phasing of the addition and expansion of the bicycle infrastructure and network will be defined until 2030; preparation of the elaboration of the construction and renovation of pedestrian routes and define the phasing until 2030 (completed); preparation of the elaboration of the bicycle network, within which the phasing of the addition and expansion of the bicycle infrastructure and network will be defined until year 2030. preparation of studies on the introduction of a bicycle service system on call, implementation of campaigns with the engagement of an external specialist contractor (completed), regular replacement of old and installation of new lighting fixtures with LED technology (completed) and implementation of campaigns with the engagement of a public expert. (Cvitković, Brlek, Klečina, 2023). Only 3 measures were implemented, which was not enough to reduce motorized traffic and increase non-motorized traffic.

2.2. Proposals and measures for a more sustainable and smarter city

Given that the "Urban Mobility Plan of the City of Varaždin - City Walk" has defined goals that aim to influence the creation of more sustainable traffic (zero emissions, low costs), based on the previously presented data, it is evident that additional measures should be taken, i.e. measures should be implemented to fulfill general and specific goals defined by the Plan. (Šimunović, Brčić, Markovinović, 2018) Creating a more sustainable and smarter city involves a multifaceted approach that integrates technology, urban planning, and community engagement. Here are several proposals and measures which can help City of Varaždin to became a more sustainable and smarter city (Colldahl, Kelemen, 2013; Cvitković, Brlek, Klečina, 2018.; Orlowski Romanowska, 2019):

- Smart Infrastructure:
  Integrated Transportation Systems: Develop a comprehensive and integrated public transportation system that includes buses, trains, and bike-sharing programs. Implement smart traffic management systems to optimize traffic flow.
- Urban Planning:
  Green Spaces: Increase the number of green spaces within the city to enhance air quality, provide recreational areas, and support biodiversity.
- Technological Innovation:
  Smart Building Technologies: Promote the use of smart technologies in buildings, such as energy-efficient systems, automated lighting, and climate control.
- Waste Management:
  Smart Waste Collection: Implement smart waste collection systems that optimize routes based on real-time data, reducing fuel
- Digital Inclusion:
  Open Data Platforms: Foster transparency and citizen engagement by establishing open data platforms, allowing residents to access and contribute to city data.
  Resilience and Adaptation:
- Emergency Response Systems: Develop smart systems for efficient emergency response, leveraging technology to enhance coordination and minimize response times.

By implementing these proposals and measures, cities like Varaždin can move towards a more sustainable, resilient, and smarter future, improving the quality of life for residents while minimizing their environmental footprint.

3. Conclusion

The city of Varaždin stands out as one of the few cities actively embracing and implementing the Smart City concept, particularly in the realm of Smart Mobility. The strategic documentation prepared by the city underscores its commitment to achieving Smart City goals and guides significant financial investments into improving the transportation system. The allocated funds are aimed at realizing the objectives outlined in the strategic documents, emphasizing the city's dedication to advancing the Smart City concept.

However, the data presented highlights the need for further implementation of prescribed measures to enhance the current state of the transportation system and bolster its sustainability. The data, including figures on motorized traffic and accidents involving non-motorized traffic, signals the necessity for additional measures. The city acknowledges the importance of prioritizing non-motorized traffic to align with environmental consciousness and promote public health. Implementation of these measures, along with measures targeting motorized traffic, is crucial for fulfilling the conditions of a Smart City. Despite the ongoing efforts and the need for further measures, Varaždin exhibits promising potential to evolve into a full-fledged Smart City in the near future. The city's commitment, strategic planning, and financial investments lay a strong foundation for achieving comprehensive Smart City status, aligning with environmental sustainability and the well-being of its residents.

Acknowledgements
The completion of this research paper on sustainable mobility has been enriched by the collaborative efforts and support of various individuals and organizations.

References

[1] Orlowski, A., Romanowska, P. Smart Cities Concept: Smart Mobility Indicator, Cybernetics and Systems, 50:2, pp. 118-131, Feb. 2019

[2] Purnomo, F., Harjanto Prabowo, M. “Smart City Indicators: A Systematic Literature Review,” Journal of Telecommunication, Electronic and Computer Engineering, 2016. vol. 8 No. 3 pp. 161-164.

[3] Bosch, P., Jongeneel, S. Rovers, V., Neumann, H-M., Airaksien, M., Huovila, A. “CITYkeys indicators for smart city projects and smart cities“, Jan. 2017.

[4] Colldahl, C., & Kelemen, J.E., “Smart Cities: Strategic Sustainable Development for an Urban World,” 2013.

[5] Šimunović, Lj., Brčić, D., Markovinović, D. “Urban Mobility Plan of the City of Varaždin - City Walk," Nov. 2018,” Nov. 2018.

[6] Cvitković, I., Brlek, P., Klečina, A. "Evaluation of the Sustainable Urban Mobility Plan of the City of Varaždin," Traffic Study - Evaluation of the Sustainable Urban Mobility Plan”, Feb. 2023.

[7] Orlowski, A., Romanowska, P. “Smart Cities Concept: Smart Mobility Indicator”, Cybernetics and Systems, 2019. 50:2, pp. 118-131