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A Comparison Between Smart City Approaches in Road Traffic Management

Mădălin-Dorin Pop*, Octavian Proștean**

Politehnica University of Timişoara, Bd. Vasile Pârvan 2, Timişoara 300223, Romania

Abstract

The population growth and economic development increase the need for mobility. As consequences, we can mention the environmental impact of CO_2 emissions and that the road accidents are among the top 10 causes of death worldwide. As a solution to this problem, the concept of Intelligent Transportation Systems emerged. Part of this concept is smart city approach, consisting in a combination of Internet of Things and Information and Communication Technology to manage city issues. After 2014, a lot of regulations were established by the European Parliament, regarding smart city concept implementation. The purpose of this paper is to present a comparison between the implementation of smart city approach in different locations from Romania.

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Keywords: smart city, road traffic managementType your keywords here, separated by semicolons ;

1. Introduction

Population is continuing growing in urban agglomerations and around them. Some consequences of this growth have led to increased consumption, increasing the volume of public infrastructure services, increasing the amount of waste which has directly influence on the environment by increasing pollution level.

* Corresponding author. Tel.: +40-761-481-375.
E-mail address: madalinpop20@gmail.com
**Corresponding author. Tel.: +40-723-527-051.
E-mail address: madalinpop20@gmail.com

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Based on the city size, we can see a lot of issues that should be solved: public health, safety residents, waste disposal, public transport, public lighting etc. More than that, we can see that nowadays technology can be seen as a critical factor in some basic activities on which a modern society is dependent. Some of these activities are: water supply, power and gas supply, food production, health services, remote communications, public administration, waste collection etc.

Governments prepared many plans to use the technology in order to simplify all these city issues. For locals' administrations, we can talk about smart management and administration. In this case local administration tries to make plans for the city thinking about how the taken measures can improve citizens life. Some examples related to transport management in a smart city are:

- Implementation of a system that can announce in real-time the timing for public transport in each station;
- Implementation of green transportation systems such as: public bike sharing systems, charging stations for electric and hybrid vehicles;
- Implementation of intelligent parking systems
- Implementation of intelligent traffic lights systems;
- Implementation of public lighting using alternative energies and intelligent sensors.

2. Smart city concept

Smart city can be defined as an ultra-modern urban area that can be implemented based on a strategy that can improve the quality of life for citizens. As we can see, this concept is very complex involving "different sectors, multiple stakeholders, high inter-dependency, cross-sectoral cooperation, inter-departmental coordination, and novel dynamic, and interactive services" (Bastidas, V., Bezbradica, M., & Helfert, M., 2017).

Taking in account that this concept is considered as reference of several communities where quality of life is a priority we can say that are some goals that should be achieved. "The efficient use of resources and the reduction of wastes and emissions, in short sustainability, are key goals in the management of a smart city and the companies that operate in it. In this context, traffic and transportation activities produce a significant impact in the use of resources, and production of emissions, noise, and wastes" (Latorre-Biel, J.I., Faulin, J., Jiménez, E., & Juan, A.A., 2017). All these objectives should be sustained by polices and regulations that can supervise how them are implemented using smart city frameworks. The aim of these frameworks is to make a mapping between a smart city architecture and how this can align to a proposed smart city strategy.

3. Models in smart city analysis

3.1. Giffinger's approach

In order to describe a smart city, we can start from the model proposed by Giffinger. For each of those six characteristics are defined many factors. In Fig. 1 we can see the smart city model adapted to show the smart mobility indicators.

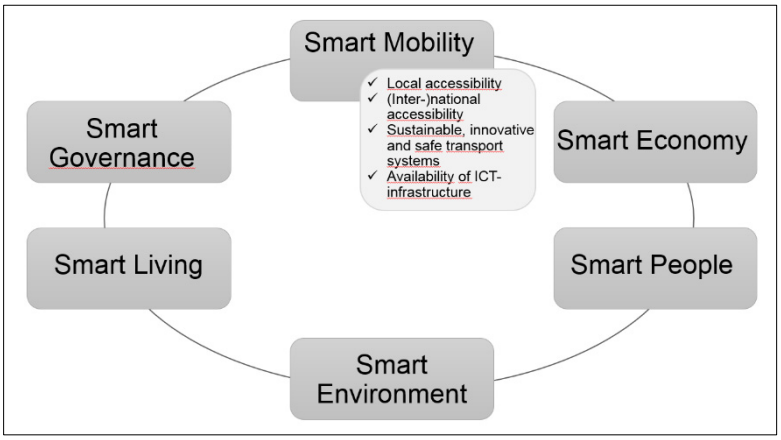

Fig. 1. Smart city model

Table 1 shows the six characteristics together with assigned factors and corresponding number of indicators. Also, it illustrates a comparison between these characteristics, factors and indicators of a smart city depending on the number of inhabitants. We can see that in bigger cities we have more indicators to describe Smart Living and Smart Mobility. If we look to the factors, we can say that sustainability of the transport system factor has increased with 50% compared to medium-sized-cities.

Table 1. Characteristics, factors and indicators of a smart city.

Characteristics	Medium-sized cities (cities from 100 000 to 500 000 inhabitants)		Larger cities (cities from 300 000 to 1 million inhabitants)	
	Factors	Indicators	Factors	Indicators
Smart Economy (Competitiveness)		15		15
	Innovative spirit	3	Innovative spirit	3
	Entrepreneurship	3	Entrepreneurship	3
	Economic image & trademarks	1	City image	2
	Productivity	3	Productivity	3
	Flexibility of labour market	3	Labour market	2
	International embeddedness	2	International integration	2
Smart Mobility (Transport and ICT - Information and Communication Technology)		11		13
	Local accessibility	3	Local Transport System	2
	(Inter-)national accessibility	1	(Inter-)national accessibility	1
	Availability of IT-infrastructure	3	ICT-infrastructure	4
	Sustainability of the transport system	4	Sustainability of the transport system	6
Smart Environment (Natural resources)		10		10
	Environmental conditions	2	Air quality (no pollution)	4
	Air quality (no pollution)	3	Ecological awareness	4
	Ecological awareness	3	Sustainable resource management	2
	Sustainable resource management	2		
Smart People (Social and Human Capital)		11		11
	Level of qualification	2	Education	1
	Lifelong learning	3	Lifelong learning	2
	Ethnic plurality	2	Ethnic plurality	3
	Open-mindedness	4	Open-mindedness	5
Smart Living (Quality of life)		25		31
	Cultural facilities	3	Cultural and leisure facilities	6
	Health conditions	6	Health conditions	5
	Individual security	2	Individual security	3
	Housing quality	3	Housing quality	4
	Education facilities	5	Education facilities	4
	Touristic attractiveness	1	Touristic attractiveness	5
	Economic welfare	5	Social cohesion	4

Smart Governance (Participation)		9		10
	Participation public life	4	Political awareness	3
	Public and social services	2	Public and social services	3
	Transparent governance	3	Efficient and transparent governance	4

3.2. Boyd Cohen's approach

Another model of smart cities representation was made by Boyd Cohen and it is called "Smart Cities Wheel". This model was developed in order to support smart city strategies, "to develop baselines and to transparently track the progress" (Kishore, A.N.N., & Sodhi, Z., 2015).

This model (Fig. 2) has as starting point the same six characteristics that were defined by Giffinger. We can see that, compared to Giffinger model, in this case for each characteristic are assigned a fixed number of factors. Each characteristic contains three factors and an average of approximately 3.5 indicators per factor, totaling 62 indicators.

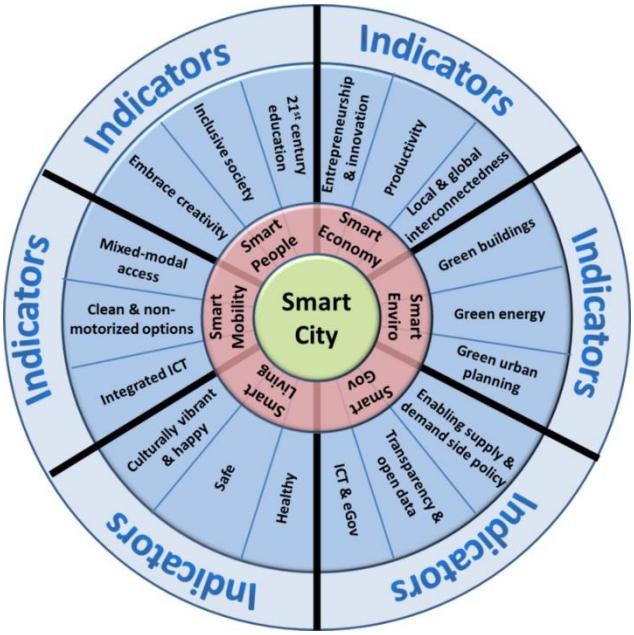

Fig. 2. Smart Cities Wheel (Kishore, A.N.N., & Sodhi, Z., 2015)

"An assumption in the Smart City Wheel is that all Smart Cities are on the journey towards becoming smarter, including the cities in the ranking list. Highlighting the importance of strategic priority analysis […] will be to balance between the built environment in a city or a region" (Kishore, A.N.N., & Sodhi, Z., 2015). Taking in account this approach, we can say that all cities have the same chances to become smart, the decisions taken by locals' administrations being the key point in this process.

3.3. Standardization and aggregation

In both presented models, the ranking is based on the score obtained by adding the points corresponding to each indicator. Because these indicators are different it is necessary to standardize the values. The method used for standardization presented by Giffinger and his research team, is based on z-transformation. "This method transforms all indicator values into standardized values with an average 0 and a standard deviation of 1. This method has the

advantages to consider the heterogeneity within groups and maintain its metric information. Furthermore, a high sensitivity towards changes is achieved" (Giffinger, R., Kramar, H., Haindlmaier, G., & Strohmayer, F., 2015).

$$z_i = \frac{x_i - \bar{x}}{s} \qquad (1)$$

The next step is to aggregate the values on the indicator level. After obtained values are aggregated, them will be taken in account the coverage rate of each indicator. This thing can be helpful if we want to include in our study cities that not cover all indicators and can be done only using available values.

4. Policies and regulations

European Innovation Partnership on Smart Cities and Communities has developed a Strategic Implementation Plan (SIP) to create a legal framework for smart city project implementation. This action is defined as "a significant improvement of citizens' quality of life, an increased competitiveness of Europe's industry and innovative SMEs together with a strong contribution to sustainability and the EU's 20/20/20 energy and climate targets" (European Innovation Partnership on Smart Cities and Communities, 2013). The same document specifies a framework with eleven priority areas (Fig. 3). For each priority area, the document defines a list of goals, preconditions, potential actions and the steps needed to monitor the level of smart city projects implementation.

Fig. 3. Smart city management model (European Innovation Partnership on Smart Cities and Communities, 2013)

In SIP are also presented some key recommendations for smart city implementation:

- "Use agreed standards, protocols and common data formats that facilitate interoperability across systems, prevent vendor lock-in and foster competition;
- Make data accessible also to third parties (whilst fully respecting consumer privacy and protection of legitimate business interests) so to foster the development and uptake of novel applications;
- Re-use existing infrastructure and put it to multiple use" (European Innovation Partnership on Smart Cities and Communities, 2013).

4.1. Impact on road transport management

European Commission has developed a list of potential actions to increase the development of road traffic management depending on priority area. Many of them are presented in Table 2 (European Innovation Partnership on Smart Cities and Communities, 2013).

Table 2. Potential actions in road transport management based on priority area.

Priority area	Potential actions
Sustainable Urban Mobility	• Improve clean power for transport: vehicles and infrastructure • Foster seamless door-to-door multi-modality in urban transport • Open up intelligence in urban transport systems • Enable tools for seamless door-to-door multi-modality • Promote sustainable and integrated mobility planning • Promote use of cleaner vehicles
Districts and Built Environment	• Monitoring Tools for Energy
Integrated Infrastructures	• City Information Platforms • Road systems • Intelligent multi-modal transport solutions • Parking systems • Peer to peer transport information
Citizen Focus	• Tools for Community Insight and Engagement • Digital Inclusion initiatives • Polluter pays solutions
Policy and Regulation	• Smart City Strategy and implementation plan • Innovative funding models • Smart city networks • Improving regulatory processes
Integrated Planning and Management	• Big Data for planning and management • Urban Simulation and Planning
Knowledge Sharing	• Readiness Check-Lists • Bilateral Mayoral Exchange • Study visits; Peer reviews; Mentoring
Baselines, Performance Indicators and Metrics	• EU smart city Indicator framework • Metrics Standards
Open Data	• Energy Efficiency Data • Transport system data apps • Data Time Horizon Analysis
Standards	• City Information Platform Interfaces • M2M Data Exchange standards • City Level Energy Management and Trading systems • Alternative fueling infrastructures • More effective use of public transport • City maintenance platforms
Business Models, Finance and Procurement	• Integrated Business Models • Financing

5. Romanian Smart Cities

Data collected and analyzed for Europe shows that, among time, in Romania were included as smart cities: Cluj-Napoca, Craiova, Sibiu and Timisoara. The results of this research for Romanian smart cities are presented below. We can see in Table 3, for each Romanian Smart City, the place in Europe Smart Cities ranking, the corresponding place for Smart Mobility characteristic, the weakness and strengths points of Smart Mobility indicators and the average scoring for Smart Mobility indicators.

Table 3. Romanian smart cities scoring (Giffinger, R., Kramar, H., Haindlmaier, G., & Strohmayer, F., 2015).

City	Year	Place	Smart Mobility Place	Weakness		Strengths		Average
				Indicator	Value	Indicator	Value	
Cluj-Napoca	2015	NA	NA	Sustainable, innovative and safe transport systems	-1.506	Local transport system	0.58	-0.522
Craiova	2007	68	70	International accessibility	-1.761	Sustainable, innovative and safe transport systems	0	-1.412
	2013	71	69	International accessibility	-1.778	Sustainable, innovative and safe transport systems	-0.299	-1.056
	2014	75	77	International accessibility	-1.713	Sustainable, innovative and safe transport systems	-0.333	-1.054
Sibiu	2007	63	64	Availability of ICT-infrastructure	-1.384	Sustainable, innovative and safe transport systems	0	-0.871
	2013	68	67	International accessibility	-1.005	Sustainable, innovative and safe transport systems	-0.63	-0.887
	2014	73	73	Availability of ICT-infrastructure	-1.037	Sustainable, innovative and safe transport systems	-0.65	-0.911
Timisoara	2007	55	62	Availability of ICT-infrastructure	-1.384	International accessibility	0.203	-0.757
	2013	69	66	Sustainable, innovative and safe transport systems	-1.871	International accessibility	0.389	-0.791
	2014	76	72	Sustainable, innovative and safe transport systems	-1.93	International accessibility	0.433	-0.8
	2015	NA	NA	Sustainable, innovative and safe transport systems	-1.9	International accessibility	-0.362	-0.795

Table 4 shows the actions taken by locals' administrations to increase the quality of mobility in the corresponding cities. In Romania, we can find stations for electric vehicles charging in three smart cities: Cluj-Napoca, Sibiu and Timisoara.

Table 4. Actions taken by Romanian smart cities.

Actions	Cluj-Napoca	Craiova	Sibiu	Timisoara
Charging stations for electric vehicles	✓	-	✓	✓
Bike sharing programs	✓	-	-	✓
Additional local transportation systems	✓	-	-	✓
Mobile applications for mobility	✓	✓	✓	✓
Intelligent traffic lights systems	✓	✓	-	✓
Intelligent parking systems	✓	✓	-	✓

Bike sharing program is another important project that can be found in Timisoara (VeloTM) and in Cluj-Napoca (ClujBike). This program aims to offer an alternative option for mobility that can help in CO_2 emissions reduction. More than that, bike sharing programs have an impact on daily citizens life, encouraging a way to combine the need to travel with the need to do sports. Also, this program helps the tourist to travel through the city.

Other projects for local transportation systems can be found in Cluj-Napoca and Timisoara. In Cluj-Napoca started a project for acquisition of electric buses for public transportation. The costs of this project are 32.094.021,91 RON and is made within a Swiss-Romanian cooperation program. Timisoara included in local transportation system an alternative transportation system, Vaporetto. This project is ongoing and will provide nine stations for transportation.

All Romanian smart cities offer mobile applications for citizens and tourists to inform them, in real-time, the timing for each station of public transport.

In Cluj-Napoca, Craiova and Timisoara we can find traffic management centers used to monitoring traffic lights. Also, in these cities we can find parking systems that offer the possibility to pay the parking using SMS and can show in real-time the number of available parking places.

6. Conclusions

Governments decisions encourage the projects that can transform cities in smart cities. This is possible using a standardized architecture and after defining actions that are compliant to the mentioned architecture.

In this paper, we can find different management approaches taken by locals' administrations such as: mobile applications used to inform citizens about the travel time when they use local transport system, bike sharing programs, free electric charging stations to encourage citizens to buy electric vehicles, intelligent parking and traffic lights systems. All these actions can contribute to a better daily life, can have positive impact on environment.

We can say that the future is smart, because a smart city can increase the quality of life and can solve partially the mobility problem that is becoming more seriously. All these are possible only if we use a smart management.

References

Kishore, A.N.N., & Sodhi, Z. (2015), Exploratory Research on Smart Cities. Theory, Policy and Practice, New Delhi: Pearl, Available at: http://pearl.niua.org/content/exploratory-research-smart-cities

Bastidas, V., Bezbradica, M., & Helfert, M. (2017), Cities as Enterprises: A Comparison of Smart City Frameworks Based on Enterprise Architecture Requirements, *2nd International Conference Smart-CT 2017 Málaga Spain Proceedings*, 20-28, ISBN 978-3-319-59512-2

Giffinger, R., Kramar, H., Haindlmaier, G., & Strohmayer, F. (2015), European Smart Cities, Available at: http://smart-cities.eu/

European Innovation Partnership on Smart Cities and Communities (2013), Operational Implementation Plan: First Public Draft, Available at: http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf

European Commission (2012), *Smart Cities And Communities -European Innovation Partnership C(2012) 4701 final*, Brussels, Available at: http://ec.europa.eu/transparency/regdoc/rep/3/2012/EN/3-2012-4701-EN-F1-1.PDF

Cluj-Napoca City Hall (2017), *Replacing old buses with electric buses with two charging / feeding stations*, Available at: http://www.primariaclujnapoca.ro/userfiles/files/PrimCJ_1108.pdf

Latorre-Biel, J.I., Faulin, J., Jiménez, E., & Juan, A.A. (2017), Simulation Model of Traffic in Smart Cities for Decision-Making Support: Case Study in Tudela (Navarre, Spain), *2nd International Conference Smart-CT 2017 Málaga Spain Proceedings*, 144-153, ISBN 978-3-319-59512-2