SMART CITY EVOLUTION, FROM EARLY CONCEPT TO INTERNATIONAL STANDARDS. SMALL VS. BIG CITIES STUDY CASE

Ioan RADU [a]*, Alexandra Irina PĂDUREAN (BADEA) [a], Mihai Ludovic DEMETER [a], Daniel ALEXANDRU [a]

[a] The Bucharest University of Economic Studies, Romania

ABSTRACT
Ever since the first use of the term of „smart city" scholars and researchers have asked what the concept means. Is there a commonly accepted definition of the term? Do we define it through the elements that are building up within? The „smartness" of the city, is it rather a stage or a process? The concept of „smart city" is more and more used in the public policy speech, so there has to be a commonly accepted method to establish which city is smarter than the other one. In the following article the "smartness" of a city will be analysed in terms of mobility and urban transport and we will determine whether in the process of becoming „smart", smaller cities are more likely to get there faster than bigger cities.

KEYWORDS: *indicators, smart city, smart transport.*

1. INTRODUCTION

By 2050 the urbanization process will have reached two-thirds of the global population, therefore in order to achieve de 2030 Agenda for Sustainable Development there is a need for cities that are more efficient, more compact, with better infrastructure (in terms of transportation, health, social services). The economy will have to provide "decent and sustainable livelihoods including those enabled by technology and nature-based industries. Partnerships and networks among peer cities can help municipal leaders build on good practices and a store of expertise, as can investing in building a "science of cities." (Independent Group of Scientists appointed by the Secretary-General, 2019).
The study further shows that "Innovative governments, a committed private sector and an active – and often, young and well-educated – citizenry can overcome inequalities and create liveable cities in both developing and developed countries. Liveable cities can be smart cities that use technology to provide services in a more efficient and equitable manner." One of the 20 actions to strengthen the science-policy interface to accelerate progress and transformation for sustainable development refers to a close collaboration between national, local authorities and the private sector, in order to promote policies and investments to a liveable city, though investments in "sustainable infrastructure, water and sanitation and other services and "smart city" technologies, including, where workable and mutually beneficial, through public-private partnerships" (Independent Group of Scientists appointed by the Secretary-General, 2019).
Every scholar and researcher can formulate or even find in the specialized publications and textbooks many definitions or attempts to define what the concept of smart city means. Most of the articles define the smart city based on the requirements or the components that it has to meet, and many mistake the smart city with the sustainable city. The term *smart city* is used in various fields

* Corresponding author. E-mail address: iradu13@gmail.com

and themes. Each of these fields uses their own language, definitions and objectives. Thus, it is difficult (or, as this article is trying to demonstrate) it has been difficult, until recently, to find a definition that includes all aspects of the smart city.
The best example of the hardship to produce a comprehensive definition can be found on the web page Smart Cities Council as well as other web-based sources (such as Wikipedia): "*The smart city sector is in the 'I know it when I see it' phase, without a universally agreed definition. The Council defines a smart city as one that has digital technology embedded across all of it`s functions functions.*" (Smart Cities Council, Definitions and overviews)
Most of the articles available define it by replacing the term „smart" with „intelligent", „digital" or „sustainable", yet, besides being shorter and more appealing, the term „smart" is broader than the elements of intelligence and sustainability. However, one can never speak of a smart city apart from the IT&C elements embedded within.
As far as this article is concerned we will offer an analysis of the bibliometric studies on the concept of smart city, through the looking-glass of the main concepts that they contain, such as IT&C, sustainability and so on, and settle on the working definition that is the most comprehensive and suitable.

2. CONCEPTS AND INDICATORS

2.1 Smart city concept

The definition of the "smart city" concept, itself, has been evolving, the last 20 years. For example, the first reference as an object of scientific enquiry is attributed to Gibson et al. in 1992 within the book entitled The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks (Mora, Bolici, & Deakin, 2017). In 2007 Giffinger refers to a "citythat is well performing in a forward-looking way in six characteristics (economy, people, mobility, governance, environment, living)" a smart mixture of aptitudes and activities of self-determined, independent and conscious citizens (Giffinger, Fertner, Kramar, Meijers, Kalasek, & Pichler-Milanović, 2007). In 2009 Caragliu, Del Bo, & Nijkamp offer a more complex definition "a city is **smart** when investments in human and social capital and in […] modern communication infrastructure fuel a sustainable economic growth and a high quality of life", still taking into consideration a smart involving governance for the sustainable use of natural resources (Caragliu et. al, 2009).
There are a few bibliometric analysis of the concept, many of them cross-referenced in most of the studies and articles, as we can see in the table 1.

Table 1. Bibliometric analysis of "smart city" concept

Year	Authors	Title, Journal	References
2007	Durán-Sánchez, M. de la Cruz del Río-Rama, A. Sereno-Ramírez, and K. Bredis Durán-Sánchez et al.	"Sustainability and Quality of Life in Smart Cities: Analysis of Scientific Production", chapter (available on-line) in Sustainable Smart Cities: Creating Spaces for Technological, Social and Business Development (e-book)	description of scientific research on smart cities by way of a bibliometric analysis and through a review of the literature indexed in Web of Science and Elsevier's Scopus databases
2015	M. Tregua, A. D'Auria, and F. Bifulco	"Comparing Research Streams on Smart City and Sustainable City," China-USA Business Review 14: 4	an analysis of the relationship between sustainable and smart cities using 367 journal articles and books indexed in Web of Science

Year	Authors	Title, Journal	References
2015	Ricciardi and S. Za	"Smart City Research as an Interdisciplinary Crossroads: A Challenge for Management and Organization Studies," in L. Mola, F. Pennarola, & S. Za, eds., From Information to Smart Society: Environment, Politics and Economics	an examination of about 100 (114) documents stored in the websites of two international conferences on smart cities "to define the boundaries of smart city research and to draw a map of [its] interdisciplinary community"
2015	M. de Jong, S. Joss, D. Schraven, C. Zhan, and M. Weijnen,	"Sustainable-Smart-Resilient-Low Carbon-Eco-Knowledge Cities; making Sense of a Multitude of Concepts Promoting Sustainable Urbanization" Special Issue of the Journal of Cleaner Production: Toward a Regenerative Sustainability Paradigm for the Built Environment: from vision to reality, vol. 109	an identification of the conceptual differences and relationships between twelve dominant city categories (sustainable city, eco city, low carbon city, liveable city, green city, smart city, digital city, ubiquitous city, intelligent city, information city, knowledge city, resilient city). This study was conducted by way of a bibliometric analysis and through the academic literature retrieved from Web of Science and Scopus.
2016	Ojo, Z. Dzhusupova, and E. Curry	"Exploring the Nature of the Smart Cities Research Landscape," in J.R. Gil-Garcia, T.A. Pardo, and T. Nam, eds., Smarter As the New Urban Agenda: A Comprehensive View of the 21st Century City	an examination of the smart-city knowledge domain using Scopus' journal articles and conference papers related to both smart cities and intelligent cities, which we consider equivalent terms. 170 publications were exported from the Scopus to Microsoft Excel for further analysis
2017	Mora, Luca & Deakin, Mark & Bolici, Roberto.	The First Two Decades of Smart-City Research: A Bibliometric Analysis. Journal of Urban Technology	1,067 source documents identified with a keyword search and combining the analysis of the citations between them, together with citation and publication counts, which are the two most basic bibliometric measures in Google Scholar; ISI Web of Science; IEEE Xplore; Scopus; SpringerLink; Engineering Village; ScienceDirect; and Taylor and Francis Online (Mora, Bolici, & Deakin, 2017)
2018	Azevedo Guedes, A.L.; Carvalho Alvarenga, J.; Dos Santos Sgarbi Goulart, M.; Rodriguez y	"Smart Cities: The Main Drivers for Increasing the Intelligence of Cities", in Sustainability, 2018, 10(9), 3121	a wide and detailed literature review, in which 20 potential smart city drivers were identified. 1827 articles identified from the last 10 years, duplicates, abstracts that were not clear enough, papers published in journals without a peer review system or that did not provide full text were also excluded, as were articles whose language was not English or Portuguese. For the remaining 259 articles, we performed a selective reading to verify if

Year	Authors	Title, Journal	References
	Rodriguez, M.V.; Pereira Soares, C.A.		our perception of the contribution to the research from the abstracts was proven. This step resulted in the exclusion of 116 papers. The remaining 143 articles were analyzed in detail and 110 articles were effectively used, of which 61 were the basis for the choice of drivers (Azevedo Guedes, Carvalho Alvarenga, dos Santos Sgarbi Goulart, Rodriguez, & Pereira Soares, 2018)
2019	Guo, Yi-Ming & Huang, Zhen-Ling & Guo, Ji & Li, Hua & Guo, Xingrong & Nkeli, Mpeoane	"Bibliometric Analysis on Smart Cities Research" in Sustainability, 2019, 11(13), 3606	a bibliometric analysis of more than 4,409 publications ,between 1998 and 2019, related to smart cities using software like VOSviewer and CiteSpace (Guo, Huang, Guo, Li, & Guo, 2019)
2019	Fosso Wamba, Samuel & Queiroz, Maciel	Conference paper "A Bibliometric Analysis and Research Agenda on Smart Cities", in the book: ICT Unbounded, Social Impact of Bright ICT Adoption (proceedings of the IFIP WG 8.6 International Working Conference "ICT Unbounded, Social Impact of Bright ICT Adoption" on Transfer and Diffusion of IT, TDIT 2019, held in Accra, Ghana, in June 2019)	Articles searched in Web of Science (WOS) database. The search resulted in 1,226 articles. The articles were analyzed by employing an excel spreadsheet and VOSviewer to network analysis (Fosso Wamba & Queiroz, 2019)
2019	Dias, Gonçalo Paiva	"Assessing the Impact of Smart Cities on Local E-government Research: A Bibliometric Study", Journal of Information Systems Engineering & Management, vol. 4	Data retrieved from the Scopus database the 19th February 2019. As described previously, three sets of documents were retrieved: documents addressing smart cities; documents addressing local e-government; and documents addressing both subjects simultaneously. The presence of specific expressions in the title, abstract or keywords of the documents were used as criterion for the selection of documents. Only documents published between 2009 and 2018 were retrieved. A total of 13,563 documents were retrieved using this search string (Dias, 2019)

Source: adapted from (Mora, Bolici, & Deakin, 2017)

Each of the bibliometric study provides more de 10 different definitions of the concept, with the consideration of the common main smart domains (economy, mobility, governance, people, environment, and living) and their components (for example: smart living includes culture, safety, health, education).
Since there is so much debate on the definition of the terms, we will use the **definition** provided by the latest standard available in this domain, ISO 37122:2019 "Sustainable cities and communities — Indicators for smart cities". (International Organization for Standardization, 2018)
A smart city is referred as a "city that increases the pace at which it provides social, economic and environmental sustainability outcomes while responding to challenges such as climate change, rapid population growth, and political and economic instability by improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and other modern solutions to deliver better services and a higher quality of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment." (International Organization for Standardization, 2018)

2.2 Smart transport

Of all the public utility services, the local public passenger transport service faces an alarming problem, specific to the big cities in the 21st century, namely congestion. Given the fact that the number of inhabitants tends to increase in the big metropolises and the transport infrastructure fails, most of the time, to keep up, a good performance in the field of public transport, is essential to ensure a good capacity for urban mobility. As an example, Bucharest is faced with a high level of congestion, being ranked as the 11th most congested city in terms of traffic, from a group of 403 cities analyzed worldwide (TomTom Traffic Index, 2019).
Thus, the planning of the transport, the network and the transport lines, the typology of the transport fleet from the point of view of consumption and the degree of digitization of the service, represent major factors of economic-social and environmental performance for both large and small local communities.
For this to happen a great deal of emphasis was put on using the digital trend of the 21th, century for creating a better and smarter transport system. In this case, the advancements in technology, for both the public service operators trough better sensing and imaging technology, video cameras and radio – frequency identification, and for the citizens trough the rise of smartphones and advanced communication technologies, large amount of data can now be gathered, processed and be used in creating valuable information, useful for the citizens and the public service operators alike (Sumalee & Hung, 2018).
The rise of such technologies are the main drives for creating smart or intelligent services and ultimately cities, as shown in the table bellow.

Table 2. Smart city rankings

Applications	**Technologies**	**Examples**
Smart Cities	Internet of Things	Connecting devices and transport elements such as smart cars, buses trains, and airplanes with mobile devices used by people.
Smart Vehicles	Wireless Technologies	Data connectivity and collection of data from and towards the users.
Electric Vehicles	Sensing Technologies	Possibility of connecting elements like traffic lights road signs etc. trough sensors.
	Global positioning systems	Creating the possibilities for users to find best routes in real-time conditions.

Source: adapted from (Sadiku, Adebowale, & Sarhan, 2017)

2.3 Shared economy

Closely to the concept of smart transport there is the concept of shared economy. It is not a new one, but increasingly newly rediscovered, due to the need to efficiency, cost reduction, space and time effectiveness. Human race has known eras when sharing goods was a common practice, but in the ages of industrial development and economic growth, the era of consumerism, everyone seemed to want to use exclusively their own goods. However, with the process of urbanization, the concept becomes more and more fashionable.

Shared economy defines a process of "distributing goods and services, differently from the traditional model of corporations hiring employees and selling products to consumers. In the sharing/shared economy, individuals "share" things like their cars, homes and personal time to other individuals in a peer-to-peer" manner. (Hamari, Sjöklint, & Ukkonen, 2016)

New economic models are emerging in urban life, with the aim of better management, a more sustainable economy and alternative ways of handling the buildup of barely-used goods. "Smart, sustainable cities must produce without plundering, consume without wasting and recycle without destroying. This requires collaborative consumption, production and use. A sharing economy prioritizes collaborative consumption that frees users from the 20th-century consumption-driven approach. It also transforms the vision of those who produce goods and services, because in a sharing economy, the ownership of technical objects is questioned and it is their purpose that is valued, which creates new economic models." (Mairie de Paris, 2019)

An Oxford Economics survey conducted on almost 400 senior executives from industrial sectors shows that "the share of companies competing through service contracts or products-as-a-service is expected to rise by more than 150 percent over the next 3 years. A large part of this trend involves the so-called sharing and collaborative economy that has become a true trendsetter in recent years. Nevertheless, considering the economic importance of the sharing economy and its broader impact on society, scholars and practitioners need to respond to this emerging process by examining the related legal, economic and societal challenges." (Hojnik & Weingerl, 2018)

2.4 Smart city indicators

A group of Brazilian researchers (Azevedo Guedes, Carvalho Alvarenga, dos Santos Sgarbi Goulart, Rodriguez, & Pereira Soares, 2018) performed a study aimed at understanding the dimensions that characterize smart cities and the drivers that stimulate today's cities to become "smarter", in order to classify how smart a city is.

The results showed that the twenty drivers identified as important in the literature review (rom a range of 1.827 articles identified and 110 articles effectively used after a selection) were also considered important by experts, and from these, 15 drivers mainly focus on the governance of cities and the other five focus on technology. In addition, five drivers were rated as "extremely important" by all experts. The indicators were prioritized from the results of a survey conducted with 807 professionals working in the field in question. The results showed that the seven indicators identified as the most important for increasing city intelligence are related to city governance.

The word smart is always attached to a set of indicators to explain the cities performance factors from certain contexts. However, there is no consensus on the main factors that should be considered to make cities smarter and sustainable.

How can any city adapt or prepare to make sure that there will be enough available resources for a sustainable future, or even improve the use of these resources? Nobody can improve what they can't measure. Since there is such a difference of perception on the definition on the smart city, imagine if one tried to assess the 'smartness' of a city, or to rank them.

The growth of the cities has created imbalances and inequalities that the Smart City tries to overcome (Guerra, Borges, Padrão, Tavares, & Padrão, 2017), however there are many rankings, using different scales, as seen in the following table.

Table 3. Smart city rankings

Title	Factors/ Indicators	References
Top 50 Smart City Governments	**Factors** vision; leadership; budget; financial incentives; support programmes; talent-readiness; people-centricity; innovation ecosystems; smart policies; track records	(Eden Strategy Institute and ONG&ONG Pte Ltd, in partnership with OXD (ONG&ONG Experience Design), 2018)
IDM Smart City Index 2019 (102 cities)	**Factors** Health and safety; Mobility; Activities; Opportunities (work and school); Governance **Indicators** affordable housing; fulfilling employment; air pollution; basic amenities; green spaces; security; school education; road congestion; unemployment; recycling; citizen engagement; public transport; social mobility; energy efficiency; corruption	(The IMD World Competitiveness Center's Smart City Observatory, in partnership with Singapore University of Technology and Design (SUTD), 2019)
European Smart Cities (70 cities) - Smart cities – Ranking of European medium-sized cities	Smart Economy (6 factors → 12 indicators) Smart People (7 factors → 15 indicators) Smart Governance (3 factors → 20 indicators) Smart Mobility (4 factors → 9 indicators) Smart Environment (4 factors → 9 indicators) Smart Living (7 factors → 9 indicators)	(Giffinger, Fertner, Kramar, Meijers, Kalasek, & Pichler-Milanović, Smart cities - Ranking of European medium-sized cities, 2007)
IESE Cities in Motion Index 2019 (174 cities)	Economy (13 indicators) Human Capital (10 indicators) Higher education; Business schools; Movement of students; Universities; Museums and art galleries; Schools; Theaters; Expenditure on leisure and recreation; Expenditure on education Social Cohesion (16 indicators) Environment (11 indicators) Governance (12 indicators) Urban Planning (5 indicators) International Outreach (6 indicators) Technology (13 indicators) Twitter; LinkedIn; Mobile phones; Wi-Fi hot spot; Innovation cities index; Landline subscriptions; Broadband subscriptions; Internet; Mobile telephony; Web Index; Telephony; Internet speed; Computers Mobility and Transportation (10 indicators) Cities in Motion (10 indicators)	(Berrone, Ricart, Duch, & Carrasco, 2019)

Source: authors

It is very clear that in order to measure the progress towards a smart city, the assessment scale has to be agreed upon by most of the users. An international standard to do so is the most objective way to create a measurement system. Until the adoption of ISO 37122:2019 (in May 2019) there were at least 15 models and sets of indicators that provide a set of domains and indicators that measure their

dimensions. Some models list and reward smarter cities, others certify, others compare, and so each model tries to fit a single goal, which is the development towards the smart city.

Table 4. Smart city maturity assessment models

Model	Domains			Geographic localization
GIFFINGER-BASED MODEL	Economy	People	Governance	Europe
	Mobility	Environment	Life	
SMART CITY MATURITY MODEL (SCMM)	Governance	Technology	Transportation	India
	Energy	Environment	Water	
	Health	Safety	Housing	
BRAZILIAN SCMM MODEL	Education	Governance	Technology	Brazil
	Transportation	Energy	Environment	
	Water	Health	Housing	
WCCD CERTIFICATION MODEL BASED ON ISO 37120:2018 (Sustainable cities and communities — Indicators for city services and quality of life)	Main economy	Energy	Incident and emergency response	The evaluation is done through a web platform called WCCD (World Council on City Data), available to any city in the world interested in taking the test to obtain certification.
	Solid finance	Environment	Health	
	Education	Waste	Recreation	
	Governance	Urban planning	Safety	
	Telecommunications and innovation	Sewage	Housing	
	Transport	Water and sanitation		
TECHNOLOGY MATURITY MODEL - TMM	Education	Governance	Transport	United States of America - Illinois Institute of Technology
	Energy	Water	Health	
IDC (International Data Corporation) - GOVER MODEL	Strategy	Culture	Processes	Worldwide
	Technology/data			
SMART CITY FOR ALL MODEL - SM4A	Strategy	Culture	Governance	Worldwide Sustained by the Global Alliance for Information and Communication Technologies and Development, launched in 2006
	Technology/data			
URBAN SYSTEMS / RCSC MODEL - RANKING CONNECTED SMART CITY	Economy	Education	Entrepreneurship	Brazilian
	Governance	Technology and innovation	Mobility	
	Energy	Environment	Urbanism	
	Health	Safety		
ESC MODEL - EUROPEAN SMART CITIES	Economy	Governance	Living	Europe
	Mobility	Environment	People	
SCIP MODEL - SMART CITY INDEX PORTUGAL	Governance	Innovation	Sustainability	Portugal
	Quality of life	Connectivity		

Model	Domains			Geographic localization
RBCIH MODEL - BRAZILIAN NETWORK OF SMART AND HUMAN CITIES	Anthropology	Governance	Technology	Brazil - The idea behind RBCIH creation was between the partner company SATOR and Urban System
	Architecture / urbanism	Security		
NBR ISO 37120 MODEL - SUSTAINABLE DEVELOPMENT OF COMMUNITIES	Economy	Finance	Education	Worldwide
	Governance	Telecommunication and innovation	Transportation	
	Energy	Environment	Solid waste	
	Urban planning	Sewage	Water and sanitation	
	Response to incidents and emergencies	Health	Recreation	
	Safety	Housing		
ISO 37122 MODEL - INDICATORS FOR SMART CITIES	Economy	Finance	Education	(International Organization for Standardization, 2009)
	Governance	Telecommunication	Transportation	
	Energy	Environment and climate change	Urban / local agriculture and food security	
	Urban planning	Wastewater	Water	
	Culture	Health	Housing	
	Security	Leisure	Population and social conditions	
	Solid waste			
WEISS MODEL - ASSESSMENT MODEL FOR READINESS	Administration and governance	Management of public services	Management of public infrastructure	Worldwide
	Electronic services to the community	Service platform	Innovation and entrepreneurship	
IBMCCI MODEL - MULTIDIMENSIONAL BRAZILIAN INDEX OF SMART CITIES CLASSIFICATION	Quality of life	Technological readiness	Innovation	Brazilian
	Environmental sustainability			

Source: adapted from (Brito Santos, De Oliveira Nunes, & Da Silva de Santana, 2018)

Smart cities are established by essential domains for their development and among the analyzed models, correlating with the characteristics that a smart city should have, the one that best fit was ISO 37122, due to standardized definitions and methodologies for a set of performance key indicators as tools to thus become more sustainable and smarter in data development and construction. The aim of standardization is to build a data culture and have globally comparable and standardized city data, let cities learn from each other to become smart and sustainable cities.
Building on the foundations of ISO 37120:2008 "Sustainable cities and communities — Indicators for city services and quality of life" (International Organization for Standardization, 2018), ISO 37122:2019 was created specifically to measure performance and progress against a standardized

framework towards a smart city and to provide a documented ground for benchmarking and good practice exchange. The standard considers sustainability as its general principle and "smart city" as a guiding concept in the development of cities. Depending on their objectives in term of smartness, cities will choose the appropriate set of indicators to be reported.
The **80 indicators** are set to meet the following criteria:

- **Completeness**: indicators should measure and balance all relevant aspects for evaluation of the smart city.
- **Technology neutral**: not favoring one technology over another, existing or future.
- **Simplicity**: indicators can be expressed and presented in an understandable and clear way.
- **Validity**: indicators are an accurate reflection of the facts and data that can be collected using scientific techniques.
- **Verifiability**: indicators are verifiable and reproducible. Methodologies are rigorous enough to give certainty to the level of implementation of the criteria.
- **Availability**: quality data are available, or it is feasible to initiate a secure and reliable monitoring process that will make them available in the future.

Each of the components of the indicators, corresponding to 19 domains has a four-layered structure: a general description; requirements; data sources and data interpretation.
For the following part of the study, we will simulate the measure of smartness; form the transportation point of view in a big city and in a small city, both from Romania. We chose to compare **the indicators for transportation** because it is one of the most tangible, a domain which benefitted from projects financed by the European Union and most of the public administration have had the opportunity to develop the transportation infrastructure.

3. SMART CITY DEVELOPMENT IN SMALL VS BIG CITIES

For the purpose of this article, we have chosen the smart transportation indicators, proposed by the International Standard ISO 37122:2019, and the comparison between the biggest city in Romania, the capital, Bucharest (1,883 million inhabitants), and one the most famous for the steps towards becoming smart, Alba Iulia (63,536 inhabitants). The map of the smart city project all over Romania shows over 100 projects promoted by Municipality of Alba Iulia, and only 9 projects promoted by the Municipality of Bucharest (Romanian Association for Smart City and Mobility, 2019). The Municipality of Alba Iulia promotes its projects through a dedicated web page https://albaiuliasmartcity.ro/.
In order to get the necessary data we have addressed questions to the relevant institutions such as: the municipalities of Bucharest and Alba Iulia, the transport authorities in both cities, the Community Public Services for the regime of Driving Licenses and Registration of Vehicles, press releases and other articles containing relevant data.
In this section we will address all the 14 indicators for transportation.

3.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information

Bucharest: no data available
Alba Iulia: no data available. There are **4 projects** developed by the public authority
Autoscope Smart City Traffic Monitoring
To monitor both the traffic data from a point and for a complete evaluation of a section - the entry / exit of Alba Iulia, and Alexandru Ioan Cuza Road, Image Sensing Systems has developed traffic monitoring solutions combining radar detectors and detectors with Bluetooth technology. The Bluetooth detector is a non-intrusive sensor that detects and analyzes traffic using active Bluetooth devices. The data is processed by an extremely sophisticated cloud system that, based on the Big

Data Analytics criterion, analyzes the multitude of information transmitted in real time, processes an impressed number of data and provides traffic data, such as: journey times, average speed of displacement, information on traffic distribution between several monitored points, etc. This data is available in real time, the system being extremely flexible, with 7/24 operation.

CityAlert & Smart Alert and Apps

The municipality has the possibility to inform the citizens in real time by sending push notifications to them, so that the inhabitants of the city are always connected to the pulse of their city (CityAlert), and has created the possibility for the citizens to transmit the observed incidents on the city streets directly from the mobile phone to the City Hall Dispatch (SmartAlert). As a result, at the end of the testing period, 225 notifications issued from The Inspectorate for Emergency Situations and one additional notification from the municipality

City Analytics

The city administration can visualize in real time the busy areas and the flows of pedestrian traffic, the time spent in certain areas and the frequency of revisiting. One year after the installation of the Orange Wi-Fi hotspots and the City Analytics application, the municipality benefits from historical statistics and can identify the fluctuations in urban traffic caused by the events hosted by the city. As an example, 134,000 people attended the AlbaFest events in June, of which 105,000 were present in the Alba Iulia Fortress. Of these, 55,000 were unique visitors, and 27,000 visited the city for the first time.

3.2 Number of users of sharing economy transportation per 100 000 population

Bucharest: no data available about the number of users. There are, however **12 private companies** providing the service: UBER; YANDEX; CLEVER, LIME; APE, RIDER; LIME; E-TOW; WOLF-E; FLOW; E-Spark; GET Pony.

Alba Iulia: no data available about the number of users. There are, however **2 private companies** providing the service: BlaBlaCar & GET Pony. Results during the test period (September 1 - October 9, 2018) of GetPony Car Sharing App: 789 entries; 560 active accounts; 1900 rides; 27,240 minutes.

Percentage of vehicles registered in the city that are low-emission vehicles

Bucharest: 683 out of the total of 1,381,620 (data available in 2018) – 0.05%

Alba Iulia: 32 out of the total of 35,000 (data available in 2018) – 0.09%

Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population

Bucharest: 700 – **37.17**

Alba Iulia: 60 bicycles offered by a private company (I'Velo Relax (ProAlba)) – **95.24.** Since September 2019 Alba Iulia has a project financed by the EU to build 18 bike sharing stations and buy 240 electric bicycles.

Percentage of public transport lines equipped with a publicly accessible real-time system

Bucharest: 100%

Alba Iulia: 100% (GlimpsePlus – under analysis)

Percentage of the city's public transport services covered by a unified payment system

Bucharest: 100%

Alba Iulia: 100% (Users of public transportation in Alba Iulia benefit from many improvements similar to those of modern cities in Europe: electronic ticketing, voice box systems in stations and buses, introduction of ticket validity periods, a facility that allows more shifts between means of transportation, SMS or mobile payment of Wallet travel tickets, free wireless internet in the means of transportation.)

Percentage of public parking spaces equipped with e-payment systems

Bucharest: 0%

Alba Iulia: 0%.

Percentage of public parking spaces equipped with real-time availability systems

Bucharest: 0%

Alba Iulia: 0%. However, after the evaluation of piloting the City Parking app (that includes mapping the dedicated parking places for people with disabilities so that they can find an extremely easy parking place and guide the user to the nearest parking lot so as to minimize the search time of an available place: real-time display of the number of parking places available in the areas managed by the municipality; parking slot sharing; various parking payment systems (SMS, wallet, Mobile Pay)), there were some notable results: 119 accounts of which 16 active.

Percentage of traffic lights that are intelligent/smart

Bucharest: 149/541 - **27.54%** (Opportunity study on the way of delegating the management of the Traffic Management service in the Municipality of Bucharest)

Alba Iulia: 0%.

City area mapped by real-time interactive street maps as a percentage of the city's total land area

Bucharest: no data available.

Alba Iulia: no data available.

Percentage of vehicles registered in the city that are autonomous vehicles

Bucharest: no data available.

Alba Iulia: no data available.

Table 5. Smart city indicators – Bucharest vs. Alba Iulia

	Indicators	Bucharest	Alba Iulia
1.	Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information	no data	no data
2.	Number of users of shared economy transportation per 100 000 population	12	2
3.	Percentage of vehicles registered in the city that are low-emission vehicles	0,05%	0,09%
4.	Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population	37,17	95,24
5.	Percentage of public transport lines equipped with a publicly accessible real-time system	100%	100%
6.	Percentage of the city's public transport services covered by a unified payment system	100%	100%
7.	Percentage of public parking spaces equipped with e-payment systems	0	0
8.	Percentage of public parking spaces equipped with real-time availability systems	0	0
9.	Percentage of traffic lights that are intelligent/smart	27,54%	0%
10.	City area mapped by real-time interactive street maps as a percentage of the city's total land area	no data	no data
11.	Percentage of vehicles registered in the city that are autonomous vehicles	no data	no data
12.	Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters	1,29%	100,00%
13.	Percentage of roads conforming with autonomous driving systems	no data	no data
14.	Percentage of the city's bus fleet that is motor-driven	20,57%	14,44%

Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters

Bucharest: 2/155 – **1.3%** (The public transportation service offers Wi-Fi on the two transport lines coming from Otopeni)

Alba Iulia: 100% (All 7 routes, in 15 out of the 90 buses. Within a year of operating Wi-Fi hotspots on buses, more than 10% of the city's population accessed Wi-Fi, generating over 2 TB of data in sessions lasting an average of 30 minutes.)

Percentage of roads conforming with autonomous driving systems

Bucharest: no data available.

Alba Iulia: no data available.

Percentage of the city's bus fleet that is motor-driven

Bucharest: 21 %.

Alba Iulia: 14 %.

Synthetic results

4. CONCLUSIONS

The above presented indicators may not be enough to assess the level of maturity of the cities in terms of becoming smart or intelligent but represents a start in having an idea about where we are and what we, as a collectivity, should strive for, in developing better and more intelligent cities for tomorrow.

A conclusion that can be extracted from the data presented in this article is that it can be easier for small cities like Alba Iulia to become smart in terms of local administration investments, when compared to big cities like Bucharest, given the big difference in size and infrastructure that should be modernized. In opposition, in terms of private initiative, bigger cities are more attractive for companies offering smart services like smart transport alternatives and shared economy related services (12 shared economy related transport services in Bucharest vs 2 in Alba Iulia), this being the trend in big cities, for the private to take over the public administration and to develop smart solutions based on a demand and offer principles.

Even so, not taking into consideration ongoing projects in both cities, for those indicators where there is available information, we can safely state that, with the awareness of the smart city challenge that all the cities in the world are facing, it is more difficult for a big city, such as Bucharest to meet the requirements of the standard, than it is for a smaller city. The municipality of Alba Iulia, for example, has, at it has been stated earlier, over 100 smart projects to develop vertical areas such as: mobility, public administration, IT&C and public utilities, innovation and business, health, tourism, education, environment, sustainable buildings, urban planning and public safety. Each of these projects is developed in a public-private-partnership manner, but the initiative belongs to the public administration.

REFERENCES

IMD Smart City Index. (2019). *The IMD World Competitiveness Center's Smart City Observatory, in partnership with Singapore University of Technology and Design (SUTD).* Retrieved September 2, 2019, from: https://www.imd.org/research-knowledge/reports/imd-smart-city-index-2019/

Azevedo Guedes, A. L., Carvalho Alvarenga, J., dos Santos Sgarbi Goulart, M., Rodriguez, M., & Pereira Soares, C. A. (2018). Smart Cities: The Main Drivers for Increasing the Intelligence of Cities. *Sustainability*, 10 (9), 1-19.

Berrone, P., Ricart, J. E., Duch, A., & Carrasco, C. (2019). *IESE Cities in Motion.*

Brito Santos, L., De Oliveira Nunes, E., & Da Silva de Santana, E. (2018). The use of ISO 37122 as standard for assessing the maturity level of a smart city. *International Journal of Advanced Engineering Research and Science (IJAERS), 5*, 1-8.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). Smart Cities in Europe. *Journal of Urban Technology*, 18, 45-59.

Dias, G. P. (2019). Assessing the Impact of Smart Cities on Local E-government Research: A Bibliometric Study. *Journal of Information Systems Engineering & Management, 4 (2)*, 1-6.

Eden Strategy Institute and ONG&ONG Pte Ltd, in partnership with OXD (ONG&ONG Experience Design). (2018). *Top 50 Smart City Governments.* Singapore.

Fosso Wamba, S., & Queiroz, M. M. (2019). A Bibliometric Analysis and Research Agenda on Smart Cities. *ICT Unbounded, Social Impact of Bright ICT Adoption. TDIT 2019. IFIP Advances in Information and Communication Technology*, 558, 325-335. Springer, Cham.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., & Meijers, E. (2007). *Smart cities – Ranking of European medium-sized cities* Vienna: University of Technology.

Giffinger, R., Fertner, C., Kramar, H., Meijers, E., Kalasek, R., & Pichler-Milanović, N. (2007). *Smart cities - Ranking of European medium-sized cities.* Vienna: University of Technology.

Guerra, I., Borges, F., Padrão, J., Tavares, J., & Padrão, M. H. (2017). Smart cities, smart tourism? The case of the City of Porto. *Revista Galega de Economía, 26-2*, 129-142.

Guo, Y.-M., Huang, Z.-L., Guo, J., Li, H., & Guo, X.-R. N. (2019). Bibliometric Analysis on Smart Cities Research. *Sustainability*, 11 (13), 1-18.

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The Sharing Economy: Why People Participate in Collaborative Consumption. *Journal of the Association for Information Science and Technology 67(9)*, 2047-2059.

Hojnik, J., & Weingerl, P. (2018). *Sharing Economy in Europe - Opportunities and Challenges*. Ljubljana: Zavod 14 and European Liberal Forum.

Independent Group of Scientists appointed by the Secretary-General. (2019). *United Nations, Department of Economic and Social Affairs.* Retrieved August 6, 2019 from https://sustainable development.un.org/content/documents/24797GSDR_report_2019.pdf

International Organization for Standardization. (2018). ISO 37120:2018 (Second edition) *Sustainable cities and communities — Indicators for city services and quality of life*, Geneva, Switzerland.

International Organization for Standardization. (2019). *Sustainable cities and communities — Indicators for smart cities.* Geneva: ISO copyright office.

Mairie de Paris. (n.d.). *Paris, smart and sustainable – Looking ahead to 2020 and beyond.* Retrieved August 6, 2019, from Paris Ville Intelligente et Durable: https://api-site-cdn.paris.fr/images/99354

Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research: A Bibliometric Analysis. *Journal of Urban Technology*, 24 (1), 3-27.

ProAlba. (n.d.). *Rental center I'Velo*, Retrieved August 7, 2019 from http://proalba.ro/veste-buna-pentru-albaiulieni-s-a-deschis-centrul-de-inchirieri-biciclete-ivelo-din-alba-iulia-tarife-si-program

Romanian Association for Smart City and Mobility. (2019). *The Map of Smart City Projects*. Retrieved September 3, 2019, from https://map.romaniansmartcity.ro/

Sadiku, N. M., Adebowale, E. S., & Sarhan, M. M. (2017). Smart Transportation: A Primer. *International Journal of Advanced Research in Computer Science and Software Engineering*, 7, 6-7, doi:10.23956/ijarcsse/V7I3/01312

Smart Cities Council. *Cities Council, Definitions and overviews*. (n.d.). Retrieved August 8, 2019 from Smart Cities Council: https://smartcitiescouncil.com/smart-cities-information-center /definitions-and-overviews

Sumalee, A., & Hung, H. W. (2018). Smarter and more connected: Future intelligent transportation system. *IATSS Research, 42*(2), 67-71.

TomTom Traffic Index. (n.d.). *The Tom Tom Traffic Index*. Retrieved August 8, 2019 from: https://www.tomtom. com/en_gb/traffic-index/ranking.