Researches Reviews of the Department of Geography, Tourism and Hotel Management
52–2/2023

Review article

ENABLING SMART CONTRIBUTIONS FOR SUSTAINABLE URBAN DEVELOPMENT

Marija Cimbaljević[A], Jelena Dunjić[A]*

Received: August 25, 2023 | Accepted: November 15, 2023

DOI: 10.5937/ZbDght2302129C

ABSTRACT

Urbanization as a global tendency continuously imposes an issue about smart solutions that make life comfortable, safe and environmentally friendly in cities. It is a challenge to transform a city into a smart and sustainable, with the aim to be adaptive enough to address the challenges of the future and to react to innovative or unexpected developments. Smart sustainable city concept is still evolving and meets with different perceptions of technological, environmental, economic and social relations. Therefore, this paper aims to deliver possible basis for the functioning of a smart and sustainable city in the so-called "smartization" process. Smart technologies that asses, monitor and manage data and processes in space are widely discussed. This research is based on a holistic approach in order to show that a successful transformation with clear progress can be achieved by implementing smart technologies with sustainable monitoring process and by integrating the main stakeholders to make the path to smartness successful for all people involved. In that manner cities are accelerating their transformation towards sustainable objectives, creating cleaner, cooperative places which fosters use of resources more efficiently and is flexible to future changes and innovations.

Keywords: *smart city, sustainable city, smart technologies, sustainable development, smartization*

INTRODUCTION

The challenge of sustainable urban development has resulted in 'smart cities' and appeared as a hot topic of research and practice globally. Due to growing globalization and hyper-urbanization, cities are increasingly oriented to turn into smart cities, confronting with the question of ensuring economic and environmental stability. Today, the smart city concept is viewed as a vision, manifesto or promise aiming to constitute the 21st century's sustainable and ideal city. As there is constant increase of urban population, it makes greater pressure on urban areas. Therefore, cities try to find solutions for increasing number of inhabitants and to make public services more efficient. These solutions are found in smart technologies, which usage is increasing in all aspects of living. It means that smart cities require smart solutions enabled by smart technology, particularly Internet that connects and integrates sensors or cameras and other smart devices which enable people to communicate with those devices or other complex systems (Atzori et al., 2010). In the background of technology application in smart cities is achieving sustainable development and enhancing natural resource management. Transforming any city into a smart city, with a focus on sustainability, is the current trend that has gained momentum. In the literature, smart city concept has been differently defined. One of the simple alle-

[A] University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management, Trg Dositeja Obradovića 3, Novi Sad, Serbia.

[*] Corresponding author: marija.cimbaljevic@dgt.uns.ac.rs

gations highlights that smart cities are based on using all available technologies and resources in an intelligent and coordinated manner to develop urban centers, that distinguish oneself with interconnectivity and sustainability (Barrionuevo et al., 2012). There are also numerous perspectives on what defines a smart city, and some of the most common perspectives are ecological, technological, economic, organizational, and societal (Ahvenniemi, 2017).

Concept „smart city" from the perspective of urban development refers to achieving economic social, and environmental sustainability as well as improving quality of life (Albino et al., 2015). Albino et al. (2015) highlight the significance of fostering integrated development across various facets for the advancement of smart cities. They emphasize that cities possess varied visions and priorities in attaining their objectives, underscoring the need for a cohesive approach to development (Albino, Berardi & Dangelico, 2015). It implies on utilizing technologies and connected data sensors in city operations, monitoring and managing of public assets and transportation systems in terms of city infrastructure, monitoring water supplies and energy consumption, as well as their application in many others community services. However, the most recent interest in smart cities can be attributed to the percentage of the total energy use which ultimately depends on behavior of end users. For example, in Amsterdam this issue has been considered by using innovative technology in order to create sustainable greener city and to change people's energy-related behavior to tackle climate challenges (Lee et al. 2014). In achieving sustainable development goals it is important to provide incentives for collaboration between national and international organizations as well as citizens, with emphasis on establishing integration across all sectors of the city (Martin et al., 2014).

Due to a steady concentration in urban areas cities should improve economically, socially, and environmentally sustainable goals to face challenges and improve their positioning. Still, a holistic approach to sustainable urban development and management is needed to improve the quality of life of citizens, effective resource consumption and advocate a participative management. In this paper, a holistic approach of smart sustainable city has been proposed based on the integration of smart technologies and principles of sustainable development. Regardless smart cities are criticized as being fuzzy phrase with the focus on extreme dependency on technology (Kunzmann, 2014), the aim was to improve that cities that want to become smarter seek to harness the power of ICT. Although, cities face a range of challenges and threats to their sustainability, new high-tech solutions for urban planning and living can be of great importance (Nijaki & Worrel, 2012). Using smart technology innovations with sensor technologies or networked smart devices (e.g. smart phones, computers) enable adequate application of smarter transport, smarter energy solution, smarter mobility, creation of smarter buildings or even smarter citizens.

The purpose is to band together the fundamental indicators, smart technologies and leading initiatives in achieving the objectives of smart sustainable city and begin the integration of smart solution in every aspect of the urban space, so-called smartization process. In this context, the aim was to represent the concept of smart sustainable cities as efficient, green, socially inclusive and technologically supported city.

LITERATURE REVIEWS

The challenge of smart sustainable urban development beyond smart city growth

Post industrial period brought raising concern about environment, resource management, health issues, and quality of life in general. The main reason for the concern was the fact that in the industrial period there was undivided attention to the development and technological progress, but without taking into consideration that resources might be non-renewable. This concern resulted in major attention to finding a way to continue with development and technological progress, but at the same time to be more careful with nature, resources and environment. The term sustainable development was first adopted and popularized in the Report

of the UN Commission for environment and development (WCED) *Our common future*. According to the WCED (1987) sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development has become central concept of this age (Sachs, 2015). Unlike the industrialization period, contemporary development relays on advanced technologies to improve efficiency, find substitutes for non-renewable resources and contribute achieving sustainability.

It is estimated that by 2050, about 66% of world population will live in urban areas (United Nations, 2015) causing major challenges regarding air pollution, congestion, waste management and human health. For neutralizing environmental issues (GHG emissions, increasing energy efficiency, etc.), as well as achieving financial and social wellbeing, utilization of new smart technologies is essential. Technologies are required to be smart, integrated, easy to use, cost- and resource-efficient, since their main aim is to support decision-making, design, planning, development, and management activities of urban areas (Yigitcanlar, 2015). The main purpose of the smart city is to make urban life quality as high as possible (Bakici, Almirall, & Wareham, 2013). Initiatives such as the Kyoto protocol, IBM smart planet and the Europe 2020 strategy have advanced the smart city movement significantly (Kummita & Crutzen, 2017). Nowdays, governments are interested in investing in smart systems finding support in major global technology companies (IBM, Cisco, Schneider Electric, Siemens, Oracle, etc.) (Alizadeh, 2017) as a main witnesses of that process. Also there are international initiatives for reducing the pace of climate change (such as Paris Agreement) which can benefit a lot from smart approach for achieving sustainability goals. Even though sustainability as well as smart are buzz words, still smart city targets gained momentum regarding sustainability goals. On the other hand, smart and sustainable cities share similar goals (Albino, Berardi, & Dangelico, 2015) to be environmental friendly, socially inclusive and economically acceptable (Ahvenniemi, 2017).

Despite gaining major popularity in academic and civil circles, this concept is often criticized for being too much utopian oriented with unrealistic expectations regarding planning and execution (Kummitha & Crutzen, 2017). Some of main fears are technology replacing human work – job loss, corporations dominating technologies, alienation in personal contact and relationships, public overexposure, extreme dependency on technology, etc. However, the initial idea of smart cities as well as sustainable development is to contribute to the quality of life of increasing urban population. As many other initiatives, smart concept could go extreme and unconstructive. Therefore, responsible management, careful and professional implementation are crucial for avoiding negative consequences, bringing sustainability on its highest level. Finally smart city projects are big and expensive investments that are supposed to drive societal and environmental transformations. Sustainable urban development and smart growth are supposed to be means for overcoming negative issues of antropogenization in contemporary high-tech era.

Synergy of smart technology in a sustainable environment

In recent years, advancements in technology have been driving innovation in smart cities. These developments play a significant role in enhancing services for citizens and various stakeholders, aiming to encourage active involvement from all parties (Cosgrave et al., 2013). The term "smart" in this technological context typically implies the integration of automatic computing principles such as self-configuration, self-healing, self-protection, and self-optimization (Spangler et al., 2010), while also suggesting intelligence and connectivity. On the other side, urban „smartness" means transforming the way in which data are collected and used as well as the way services are provided. It also include the possibility of elaborating and using big data in order to activate a new organization of the system itself and the capability of energy saving (Fistola and La Rocca 2013). In this sense it could be mentioned the term of minimizing entropy adopting new technologies to monitor and redefining the organization of the urban system. A very good example is the Tower of Winds in Tokyo, a water reservoir built in the '60s, that is transformed in urban system with the aim to catch information from its environment such as natural light, weather conditions, wind speed and external noise. Thus modify the intensity and direction of var-

ious light sources and activate different configurations of the building. The aim was to keep the building interact with its surroundings even in the absence of natural light. If we want to save energy it is necessary to use technologies, and that is why those two components are engines of the smart city.

Derzko (2006) determine six aspects or levels of smartness for technology: (1) Adapting: modifying behavior to fit the environment; (2) Sensing: bringing awareness to everyday things; (3) Inferring: drawing conclusions from rules and observations; (4) Learning: using experience to improve performance; (5) Anticipating: thinking and reasoning about what to do next; (6) Self-organizing: self-generating and self-sustaining at the cellular or nano-technology level. Smartness also means to be able to simplify data acquisition in smart city in the way to manage heterogeneous data that are collected. But the most important, if cities want to achieve sustainability, it is necessary to implement smart solutions by using smart technology.

Generally, technologies that have significant role for data acquisition are: Internet of Things, Sensor Networks, Mobile ad hoc networks (MANETs), Unmanned Aerial Vehicles (UAVs), Vehicular Ad hoc Networks (VANETs), Social Networks, 5G, Device-to Device (D2D) communication and Crowd-sourcing techniques (Gharaibeh, Salahuddin, Khalil, 2017). Authors of this paper believe that to this classification should be added more complex vehicle technology, specifically V2X communication technology (Boban et al., 2017) Besides wireless communication, its key component is accurate positioning information what has importance in achieving the safety benefits. These technologies are explained in more detail below.

The Internet of Things (IoT) facilitates the development of various stages for transmitting diverse types of data through participatory sensing systems, allowing communication between physical devices (Gutierrez et al., 2013). A multitude of technologies associated with IoT, such as sensors, smartphones, RFID technology, among others, bridge the gap between the digital realm and the real world in the real time (Miorandi et al., 2012). Sensor technologies (RFID, NFC, BLE, etc.) play a crucial role in delivering real-time data, while advanced big data analytics are essential for processing, modeling, and visualizing this data to optimize business processes and performance. By integrating sensors the data collects from the surrounding, process with real time monitoring and analyzes.

Sensor networks have application in city infrastructure and services in order to optimize, for example smart buildings, waste management, health monitoring, autonomous vehicles, environmental monitoring (monitoring air soil and water), power grids, etc., to enable proper semantics for the heterogeneous data used in different applications, as well as successful transition towards them (Zhang et al., 2018). Obtained data is delivered in real-time through the cloud to the users or service providers. Since cities are too complex, smart management requires a wide range of smart cities applications starting from smart waste collection system to water and energy supply. Communication process is based on sensor nodes that co-ordinate and collect different information from the surrounding environment, which can share the same power source, communication and processing unit (Brienza et al., 2015; Gaur & Scotney, 2015). Since sensor networks consist of a wireless sensing nodes, they should be energy efficient (Gaur & Scotney, 2015; Sagl, Resch & Blaschke, 2015) because of the distributed processing capability. As sensor networks have an ability to transmit data remotely with low power consumption they are crucial components of smart sustainable cities. For example, digital sensors installed in garbage containers, allow a real-time monitoring, and information like this improve the ability for make better decisions in municipal management office.

Mobile ad hoc networks (MANETs) as an important technology for the emergence of the smart city concept and represents infrastructure-less network of mobile devices connected wirelessly (Zanjireh & Larijani, 2015). It is based on mobile nodes/devices with embedded sensors, computing resources, and wireless technologies providing real time data transmission. Since MANETs have no infrastructure support and nodes are fault tolerant supporting mobile devices (Lobo, Acharya & D'Souza, 2017), each device in MANETs can move independently and change its links to other devices frequently (Zanjireh & Larijani, 2015). The presence of one/multiple and different transceivers between nodes, as well as adaptive routing protocols enables mobile ad hoc networks to be formed quickly. Therefore, these networks have been widely found its application in disaster rescue operations, air/land/navy defense, sensors for environment, road safety, health and other communication services.

Vehicular ad hoc networks (VANETs) is another communication medium, needed for effective data management to generate information that offers an intelligent way to manage between vehicles and roadside equipment (Khekare & Sakhare, 2013). The rapid increase in urban population cause transportation problems, full of traffic, pollution and air congestion which can significantly impair quality of life and road safety. With the aim to get sophisticated cities and minimize those issues, VANET technology is paid much more attention. The main purpose of those vehicular networks is to provide instant information to the drivers while vehicles are moving on the roads. Real time traffic alerting can help in reducing trip time and fuel consumption, so it can significantly contribute to pollution decrease (Ferrari et al., 2011). Probably the most important of creating such network is to achieve traffic controlling and increase road safety. However, one of the disadvantages smart cities have to face is that there is still not enough cars with VANET enabled protocols installed.

One of the areas in which is reflected the functionality, reliability, operation time and safety in smart cities are ***Unmanned Aerial Vehicles*** (UAVs). As a flexible and mobile platform (UAVs) can provide efficient infrastructure and services at reduced cost through number of useful tools and accurate information support. Some of the most important functions (navigation and providing data transfer to ground) are realized through control system, monitoring system, data processing system and landing system, as a main components of UAVs (Kharchenko & Prusov, 2012). Although it used to be present limited view of this technology as this inventions were only used for military purposes, currently they became widely used in civil applications. The most important are traffic management, telecommunications, mapping, emergency services, surveillance, weather monitoring, resources exploration and environmental analysis (Budde, 2014). Also, Khan and associates (2018) discussed about opportunities for drones in smart cities where it can play an important role as package delivery drone, traffic monitoring, policing, drone taxi, ambulance drone, pollution control drone, firefighting and rescue operation. For example, UAVs were involved in mapping and surveying disaster areas to determine which areas have the highest need of infrastructure repair, caused by Hurricane in Florida (Smyth, 2017). Roads and Transport Authority (RTA) in Dubai deploy drones on Dubai roads for traffic monitoring and road accidents by using push notifications (via apps and social media) to inform the public of road hotspots and available parking spaces (Tesorero, 2016). Amazon created a competition to legalize their drone delivery project named "Prime Air" in several international locations and made more than five billion deliveries to Prime customers in 2017. Pizza company **Domino** delivered the first pizza to a New Zealand couple by drone in 2016 (Desjardins, 2017).

As society moves towards urban environments, ***Social Networks*** can provide real-time understanding of a situation. It implies that city management will need to be data-driven, which in turn enables a better functioning urban environment, more specifically real-time connectivity, faster response and troubleshooting. A good example is CITIVIVA, a unique web-based service, which combines a Social Network and a Cloud Service Platform (SaaS), where citizens, service companies and municipal governments work together to improve quality of life. Accessing their virtual community in Social Network, residents check what happens, post issues, and with city governments or public service companies up-vote best solutions. On the other hand, by connecting social and sensor networks it can be achieved a lot of added-value services for smart cities through different application such as: CitySense (Murty et al., 2007) or GoogleLatitude (Page & Kobsa, 2010). Psomakelis et al., (2016) pointed out that by combining data from physical (sensors) and social sources (social networks) obtained data are more credible, complementary and contributes to better insights as well as analysis.

Since smart cities are meant to be hubs of hyperconnectivity, ***5G*** is expected to play a very important infrastructure in transmissions process as a trending wireless technology. 5G as a heterogeneous network is based on radio access technology (RAT), antenna improvements and use of higher frequencies (GSA, 2015). Besides that, 5G can be characterized as software-based communication network architecture, making it possible to collect and maintain large amounts of data thanks to a higher speed and large capacity (Magedanz, 2017). Except for personal communications, the scope of 5G services includes mobile phones, wearable devices, sensors, vehicles, robots, etc. (Yu, Lee & Jeon, 2017). There is a lot of 5G technology trials (Orsino et al., 2016; Rao & Prasad, 2018), but it is also planned to launch 5G during the *Olympic Games in Tokyo in order to prove that this technology can be able to provide higher data rates, expected performance and reliability, im-*

proved indoor coverage, enable digital connectivity and support the delivery of much more innovative applications in the future.

As known, the importance of IoT can be seen through capability of a device to connect to the Internet. ***Device-to Device*** (D2D) represents important communication technology that enables devices to communicate directly with each other, to collect real time data, process the huge amount of information and deliver them to the end users (Condoluci et al., 2015). In the context of smart cities, for example, energy efficiency is of high interests and D2D communications are viable solution to reduce the energy consumption for the devices (Orsino et al, 2016). If it is about proximity-based services, when mobile users need to exchange data at high rate, D2D communications can improve energy efficiency in the way that direct communication can potentially offload the base station (BS) and improve energy consumption (Fodor et al., 2012). D2D is one of the horizontal topics (HTs) within METIS project (Mobile and wireless communications Enablers for Twenty-twenty (2020) Information Society) with the aim to demonstrate D2D as a technology that provide low power, high data rate and low latency services between end-users (Fodor et al., 2016).

In order to make city smarter, one of the prerequisite is the use of collaborative technologies that enable greater collaboration between citizens and governments (Tešić et al., 2020). First of all, it refers on providing data or services mutually, that can be useful in resolving an issue. Since citizens are much more included in the innovation process, and thereby they have access to vast amounts of data and variety of technologies, it can be said that ***crowd-sourcing*** as well as co-creation are highly employed methods by cities. Some of the adopted crowd-sourcing applications are Tranquilien app used to give passengers a better chance of obtaining a seat on public transport (Trassard, 2013) or Waze community-based traffic and navigation app used for avoiding traffic jams, accidents, share real-time traffic and road info (Digital Initiative, 2015). Authors Kumar, Singh and Gupta (2018) discusses about innovative ideas that make transport system advanced and smart, which is based on the crowd-sourcing technique. Various research on the topic of crowd-sourcing in smart cities has been done recent years (Kumar, Singh & Gupta, 2018; Chowdhury, Dhawan & Agnihotri, 2016; Pouryazdan et al., 2016; Breetzke & Flowerday, 2016).

Finally, ***Vehicle-to-everything*** (V2X) communication is a wireless technology aimed at enabling vehicles to communicate with moving parts of the traffic system in the surroundings (Life augmented, 2018). Different research have targeted presence of this network in smart cities. In their research, Kokuti et al., (2017) discuss about different V2X communication technologies utilized for multiple autonomous vehicles in off-road environments. These technologies encompass inter-vehicle communication (V2V), bidirectional pedestrian communication (V2P and P2V), and bidirectional infrastructure communication (V2I and I2V). Conversely, according to Fong et al. (2017), smart cities are enveloped by various highly localized vehicular networks, such as vehicle-to-vehicle (V2V), vehicle-to-home (V2H), and V2I. Similarly, Djahel et al. (2015) have proposed a solution rooted in vehicle-to-infrastructure (V2I), positing that the integration of V2X communication technologies and V2I can aid in reducing traffic congestion in urban areas. A possible application scenario of this technology would be to provide safety benefits, to integrate automatic payments for tolls, parking, and similar fees, to transfer important information to the driver regarding inclement weather, road conditions, etc.

HOLISTIC PROCESS AS A CRUCIAL FOR A SUCCESSFUL TRANSFORMATION TO A SMART SUSTAINABLE CITY

For adoption and implementation of smart sustainable city concept it is very important to reach city targets, referring to societal goals (well develop local democracy, very high quality of life) in regard to smart sustainable development (green and innovative economy, very low resource consumption). That implies that the primary focus is on impact indicators. By reviewing the literature, authors proposed indicators as constituent elements of smart sustainable city solutions taking into account that implemented high-tech solutions can help to achieve environmentally, socially and/or economically sustainable impacts (see Figure 1). Radical tech-

nological developments and their applications set focus on the concept of sustainability which is based on so-called 3 Ps concept – social sustainability (People), environmental sustainability (Planet) and economic sustainability (Prosperity) (SCOPE, 2007).

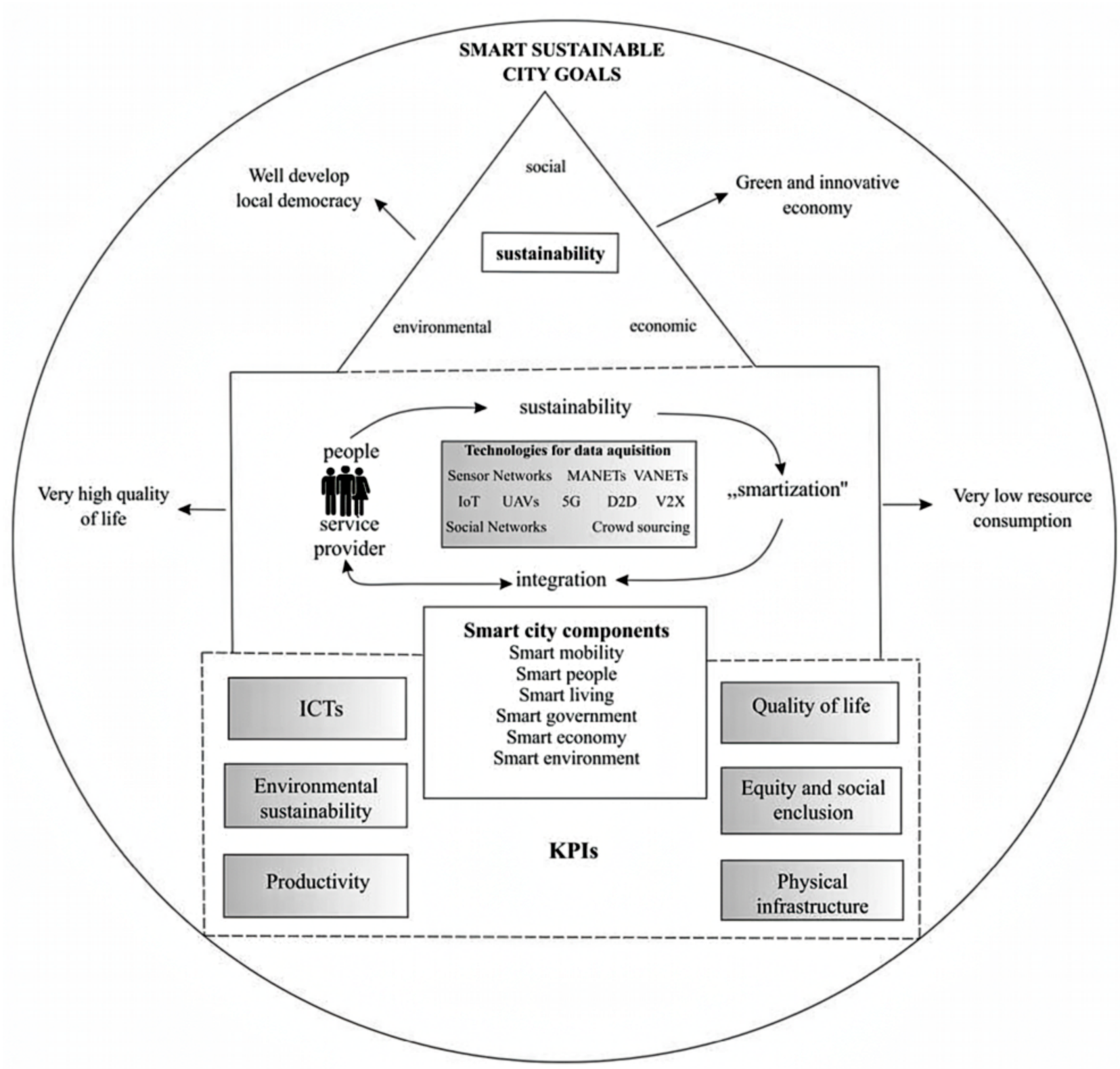

Figure 1. Smart sustainable city assessment frameworks – „smartainable" city

In order to identify the driving function of smart technologies in smart city amenities, for such activities was necessary to introduce systemic organization of city indicators as a support for speeding up of wide-scale deployment of smart city solutions and services despite the risk of being outdated when better technological solutions are found. Therefore, the goal of the key performance indicators (KPIs) is based on the triple bottom line provided by technological solutions but with respect to the quality of life of citizens. According to ITU's (2014) work on Smart Sustainable Cities, six indicators (with sub-indicators) were suggested to measure the performance of various smart sustainable city (SSC) ventures. In this case, it could be followed the progress achieved in smart city transitions, compare their performance to other cities in order to see which standards are important in achieving the goals of a smart sustainable city (U4SSC, 2017). These indicators include: ICTs, environmental sustainability, productivity, quality of life, equity and social inclusion and physical infrastructure[1]. Evaluation of the SSC progress using KPIs can be conducted before, after, or during SSC policy implementation (Hara et al., 2016). The purpose of identifying the KPI is to establish the criteria to evaluate technology contributions. In this way, can be obtained a set of credible, relevant, objective and comparable indices

[1] More detailed about analysis of the key dimensions and sub-dimensions can be read in ITU-T Focus Group Technical Specifications document (2014).

to assess the progress in making cities smarter and more sustainable. In Overview of Key Performance Indicators it is emphasized that a smart city must be sustainable and therefore it justifies why KPIs can be found in the framework.

Lack of information and understanding the structure of the underlying system often leads us to wrong conclusions about applied smartness, its limits and performances. Understanding the city with smart system, needs a holistic approach in the combination with the smart city components as integral elements that make up ultra-modern urban area. First operational definition of a Smart city given by Giffinger et al. (2007) state that smart city is well performing in six characteristics, with the important role of citizens activities. The components include economics, people, governance, mobility, environment and quality of life (Giffinger et al., 2007). Therefore, smart city requires sustainable policies in aspects related to mobility, environment, living, energy use as many other. Each of these components has a special significance in the functioning of a smart city, but it is undoubtedly that without involvement of people, smart city will not be able to function. For that reason harvesting the potential benefits from all relevant sectors is the real challenge. As smart sustainable city has clear vision considering effective counterbalance to technology pressure, we should not neglect the challenges such as social cohesion, secure digital environment or resilience. Also, city government must promote the use of open data, because if people know what they are participating in they will be engaged and empowered and positively contribute to the city and community. It is probably premature to say that there is no unique concept according to which a smart city should function. Still, many recent trends implied how to implement meaningful choices and responsible values when it comes to emerging technologies in order to ensure economic and environmental stability. With this systemic approach we try to identify the impacts of technological innovation involved in smart city concepts with the aim to indicate that it does not always exist hidden impacts of technological power over nature. With the smart management, planning, resource use, smart data management technology can generate environmental gains and sustainable outcomes.

CONCLUSION

The concept of a smart sustainable city is still a new concept that requires to perceive a wide picture in the functioning of a city that is considered as being smart. On one side, there are technological challenges (solar panels, wind turbines, electric vehicles, building management systems, smart grids, etc.) in the process of creating a more sustainable city. And on the other side, there is a need for such systems to indeed provide sustainable solutions for cities with the overall benefit. Being a smart technology, is not just about achieving short-term effects. It is about integrating technology into a system - a single unit that operates on the win-win (city/actors – environment) principle. Therefore, the main question of this paper is, whether smart solution can really contribute and bring sustainability to cities? The paper points out the need for holistic approach in answering this issue. Although this has been achieved, it imposes the need to consider this issue in a much wider context. This could be a stepping stone for future studies.

There are several challenges related to the successful operating of smart sustainable city. Initial, but also very important would be installation of smart technologies, enabling technology to gather data and communicate in the environment and enabling technology to provide solutions to problems. In addition, it is important to consider the principles of sustainable development in a smart environment. They can be achieved by mobilizing all city's resources using smart technologies and coordinating its stakeholders.

Various perspectives share the idea that innovative methods and smart solutions and/or technologies constitute smart sustainable environment. It is also stated that services and activities available in smart sustainable city should be easy to use, efficient, widely accepted and sustainable for the environment. This attitude requires a long-term holistic development of smart and sustainable urban environment including: innovative and flexible infrastructure, governance structures that foster creativity, integration of different actors and especially behavior (changes) on the principle of sustainability. By analyzing important elements for constitut-

ing a smart city, with the idea for creating more sustainable living, authors suggest the following definition. *Smart sustainable city is unique environmental complex with centralized infrastructure and governance based on the sensor technology or open source software that provide a supposed smartness of the city in order to obtain high quality of life, well develop local democracy, green and innovative economy and very low resource consumption*.

In order to make the growing importance of the smart sustainable cities with the central role on ICTs an adequate required skills in the labor force are required. Research has shown (Glaeser & Berry, 2006) that the most rapid urban growth rates have been achieved in cities that investing in human capital and educated labor force. By building skills that make people more employable, job markets can become more efficient.

Finally, it is crucial to achieve a common goal of a sustainable and smart city, to become more sustainable, green, intelligent and livable. Since smart city approach is a way of developing a sustainable city it could mean than high-tech solutions should be developed and applied on principles of sustainability. Other words, smart technology solutions convert, for example waste streams into valuable resources in sustainable ways. Surely, it must be followed by high level of mobility allowing information, resources or energy to flow easily. Today, even the most advanced smart cities have a long way toward achieving what constitute sustainability, support the same goal to ensure the needs of present and future generations with respect to economic, social, and environmental principles.

REFERENCES

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities?. *Cities*, 60, 234-245. doi:10.1016/j.cities.2016.09.009

Albino, V., Berardi, U., & Dangelico, R.M. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*. 22(1), 3-21. doi: 10.1080/10630732.2014.942092

Alizadeh, T. (2017). An investigation of IBM's Smarter Cites Challenge: What do participating cities want?. *Cities*, 63, 70-80. doi: 10.1016/j.cities.2016.12.009

Atzori, L., Iera, A. & Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks*, 54(15), 2787–2805. doi: 10.1016/j.comnet.2010.05.010

Bakıcı, T., Almirall, E., & Wareham, J. (2013). A smart city initiative: the case of Barcelona. *Journal of the Knowledge Economy*, 4(2), 135-148. doi: 10.1007/s13132-012-0084-9

Barrionuevo, J.M., Berrone, P., & Ricart, J.E. (2012). Smart Cities, Sustainable Progress. *IESE Insight*, 14, 50–57.

Boban, M., Kousaridas, A., Manolakis, K., Eichinger, J., & Xu, W. (2017). Use Cases, Requirements, and Design Considerations for Vehicle-to-Everything Communications. *IEEE Vehicular Technology Magazine*. 99, 110-123. doi: 10.1109/MVT.2017.2777259

Breetzke, T., & Flowerday, S.V. (2016). The usability of IVRs for smart city crowdsourcing in developing cities. *The Electronic Journal of Information Systems in Developing Countries*, 73(1), 1-14. doi: 10.1002/j.1681-4835.2016.tb00527.x

Brienza, S., Galli, A., Anastasi, G. & Bruschi, P. (2015). A Low-Cost Sensing System for Cooperative Air Quality Monitoring in Urban Areas. Sensors, 6(15), 12242-12259. doi: 10.3390/s150612242.

Budde, P. (2014). *Global Smart Infrastructure - Smart Cities and Artificial Intelligence the Way Forward*, Communication Pty Ltd.

Chowdhury, S.N., Dhawan, S.D., & Agnihotri, A. (2016). Crowd-Sourcing for Smart Cities. *In Proceedings of the IEEE International Conference On Recent Trends In Electronics Information Communication Technology (RTEICT)*, Bangalore, India, 360-365. doi: 10.1109/RTEICT.2016.7807842

Condoluci, M., Sardis, F., Mahmoodi, T. (2015). Softwarization and Virtualization in 5G Networks for Smart Cities. *Internet of Things IoT Infrastructures Second International Summit, IoT 360° 2015 Rome, Italy, October 27–29, 2015 Revised Selected Papers, Part I,* Springer, Cham, 179-186. doi: 10.1007/978-3-319-47063-4

Cosgrave, E., Arbuthnot, K., & Tryfonas, T. (2013). Living labs, innovation districts and information marketplaces: A system approach for smart cities. *Procedia Computer Science*, 16, 668–677.

Derzko, W. (2006). Smart technologies in the new smart economy. In Gretzel, U., Werthner, H., Koo, C., & Lamsfus, C. (Eds.), Conceptual foundations for understanding smart tourism ecosystems, *Computers in Human Behavior*, 50, 558-563.

Desjardins, J. (2017). Amazon and UPS are betting big on drone delivery. Retrieved from: https://www.businessinsider.com/amazon-and-ups-are-betting-big-on-drone-delivery-2018-3.

Digital Initiative (2015). Waze – Crowdsourcing Maps and Traffic Information. Retrieved from: https://digit.hbs.org/submission/waze-crowdsourcing-maps-and-traffic-information/

Djahel, S., Jabeur, N., Barrett, R., & Murphy, J. (2015). Toward V2I Communication Technology-Based Solution for Reducing Road Traffic Congestion in Smart Cities. *International Symposium on Networks, Computers and Communications (ISNCC),* Hammamet, Tunisia. doi: 10.1109/ISNCC.2015.7238584

Ferrari, G., Busanelli, S., Lotti, N., & Kaplan, Y. (2011). CrossNetwork Information Dissemination in VANETs. *11th International Conference on ITS Telecommunications*, 351-356. doi: 10.1109/ITST.2011.6060081

Fodor, G., Dahlman, E., Mildh, G., Parkvall, S., Reider, N., Miklos, G., & Turanyi, Z. (2012). Design aspects of network assisted device-to-device communications. In Penda, D.D., & Johannson, M. (2015). Mode Selection for Energy Efficient D2D Communications in Dynamic TDD Systems, IEEE Transactions on Communications, 65(3), 1260-1273.

Fodor, G., Roger, S., Rajatheva, N., Slimane, B., Svennson, T., Popovski, P., Mairton B. da Silva Jr, H., & Ali, S. (2016). An Overview of Device-to-Device Communications Technology Components in METIS, IEEE Access, 4, 3288-3299.

Fong, B., Situ, L., & Fong, A.C.M. (2017). Smart Technologies and Vehicle-to-X (V2X) Infrastructures for Smart Mobility Cities. *Smart Cities: Foundations, Principles and Applications*, First Edition. (eds.) Song, H., Srinivasan, R., Sookoor, T., & Jeschke, S. John Wiley & Sons, Inc. Published 2017 by John Wiley & Sons, Inc. doi: 10.1002/9781119226444.ch7

Gaur, A. & Scotney, B. (2015). Smart City Architecture and its Applications based on IoT. *Computer Science*, 1(52), 1089-1094.

Gharaibeh, A., Salahuddin, M., & Khalil, I. (2017). Smart Cities: A Survey on Data Management, Security and Enabling Technologies. *IEEE Communications Surveys & Tutorials*, 19(4), 2456-2501. doi: 10.1109/COMST.2017.2736886

Giffinger, R., Fertner, C., Kalasek, R., & Milanović, N.P. (2007), Smart Cities: Ranking of European Medium-Sized Cities, Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology. Retrieved from: http://www.smart-cities.eu/press-ressources.htm

Gleaser, E.L., & Berry, C.R. (2006). Why Are Smart Places Getting Smarter? Taubman Center Policy Briefs, 2006-2. Harvard University, John F. Kennedy school of government.

GSA - Global mobile Suppliers Association (2015). The road to 5G: Drivers, applications, requirements and technical development. Retrieved from: https://www.huawei.com/minisite/5g/img/GSA_the_Road_to_5G.pdf

Gutiérrez, V., Galache, J.A., Sánchez, L., Muñoz, L., Hernández-Muñoz, JM., Fernandes, J., & Presser, M. (2013). SmartSantander: Internet of Things Research and Innovation through Citizen Participation. In Galis, A., & Gavras, A. (Eds.), *The Future Internet*, 173-186. doi: 10.1007/978-3-642-38082-2_15

Hara M., Nagao, T., Hannoe, S., & Nakamura., J. (2016). New Key Performance Indicators for a Smart Sustainable City. Sustainability, 8(3), 206. doi: 10.3390/su8030206

ITU-T Focus Group Technical Specifications (2014). Overview of Key Performance Indicators in Smart Sustainable Cities; International Telecommunication Union: Geneva, Switzerland.

Khan, M.A., Alvi, B.A., Safi, E.A., & Khan, I.U. (2018). Drones for Good in Smart Cities: A Review. *International Conference on Electrical, Electronics, Computers, Communication, Mechanical and Computing (EECCMC) 28th & 29th January 2018*, India, 1-7.

Kharchenko, V., & Prusov, D. (2012). Analysis of Unmanned Aircraft Systems Applications in the Civil Field. *Transport*, 27(3), 335-343. doi: 10.3846/16484142.2012.721395

Khekare, G.S., & Sakhare, A.V. (2013). A Smart City Framework for Intelligent Traffic System Using VANET. *International Mutli-Conference on Automation, Computing, Communication, Control and Compressed Sensing (iMac4s)*, Kottayam, India, 302-305. doi: 10.1109/iMac4s.2013.6526427

Kokuti , A., Hussein, A., Mar´ın-Plaza, P., de la Escalera, A., & Garc´ıa, F. (2017). V2X Communications Architecture for Off-Road Autonomous Vehicles. *IEEE International Conference on Vehicular Electronics and Safety (ICVES)*, Vienna, Austria, 69-74. doi: 10.1109/ICVES.2017.7991903

Kumar, H., Singh, M.K., & Gupta, M.P. (2018). Smart mobility: Crowdsourcing solutions for smart transport system in smart cities context. *In Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance, Galway, Ireland, April 2018 (ICEGOV'18)*, 482-488. doi: 10.1145/3209415.3209417

Kummitha, R. K. R., & Crutzen, N. (2017). How do we understand smart cities? An evolutionary perspective. *Cities*, 67, 43-52. doi:10.1016/j.cities.2017.04.010

Kunzmann, K. R. (2014). Smart cities: A new paradigm of urban development. *Crios*, 4(1), 9–20. doi: 10.7373/77140

Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, 89, 80–99. doi: 10.1016/j.techfore.2013.08.033

Life augmented (2018). Vehicle-to-Everything (V2X). Retrieved from: https://www.st.com/en/applications/telematics-and-networking/vehicle-to-everything-v2x.html#overview-block-title.

Lobo, P., Acharya, S., & D'Souza, R.O. (2017). Quality of service for MANET based smart cities. *International Journal of Advanced Computational Engineering and Networking*. 5(2), 6-11.

Magedanz, T. (2017). 5G technologies and smart cities. The Open Group Blog. Retrieved from: https://blog.opengroup.org/2017/06/20/5g-technologies-and-smart-cities-thomas-magedanz/

Martin, N.J., Rice, J.L. & Lodhia, S.K. (2014). Sustainable development planning: A case of public participation using online forums. *Sustainable Development*, 22(4), 265–275. doi: 10.1002/sd.1541

Miorandi, D., Sicari, D., De Pellegrini, F., & Chlamtac, I. (2012). Internet of Things: Vision, applications and research challenges. Ad Hoc Networks, 10(7), 1497-1516. doi: 10.1016/j.procs.2018.05.042

Murty, R., Gosain, A., Tierney, M., Brody, A., Fahad, A., Bers, J., & Welsh, M. (2007). CitySense: A Vision for an Urban-Scale Wireless Networking Testbed. Harvard University Technical Report. TR-13-07.

Nijaki, L. K., & Worrel, G. (2012). Procurement for sustainable local economic development. *International Journal of Public Sector Management,* 25(2), 133–153. doi: 10.1108/09513551211223785

Orsino, A., Araniti, G., Militano, L., Alonso-Zarate, J., Molinaro, A., & Iera, A. (2016). Energy efficient IoT data collection in smart cities exploiting D2D communications. *Sensors*, 16(6), 836. doi: 10.3390/s16060836

Page, X.W., & Kobsa, A. (2010). Navigating the social terrain with google latitude. *iConference Urbana-Champaign, IL*, 174-178.

Pouryazdan, M., Kantarci, B., Soyata, T., & Song, H. (2016). Anchor-Assisted and vote-based trustworthiness assurance in smart city crowdsensing, *IEEE Access*, 4, 529–541. doi: 10.1109

Psomakelis, E., Aisopos, F., Litke, A., Tserpes, K., , M., & Campo, P.M. (2016). Big IoT and social networking data for smart cities: Algorithmic improvements on Big Data Analysis in the context of RADICAL city applications. *Proceedings of the 6th International Conference on Cloud Computing and Services Science – Volume 1: Data Diversity Convergence, Rome, Italy*, 396-405.

Rao, S.K., & Prasad, R. (2018). Impact of 5G Technologies on Smart City Implementation. *Wireless Personal Communication*. 100, 1, 161-176. doi: 0.1007/s11277-018-5618-4

Sachs, J. D. (2015). *The age of sustainable development*. Columbia University Press.

Sagl, G., Resch, B. & Blaschke, T. (2015). Contextual Sensing: Integrating Contextual Information with Human and Technical Geo-Sensor Information for Smart Cities. *Sensors*, 7(15), 17013-17035. doi: 10.3390/s150717013

SCOPE, 2007. Sustainability Indicators: A Scientific Assessment. Edited by T. Hák, B. Moldan and A.L. Dahl. Washington: Island Press. 2

Smyth, J. (2017). Drones and the Future of Disaster Response. Retrieved from: http://www.openhealthnews.com/articles/2017/drones-and-future-disaster-response

Spangler, W. S., Kreulen, J. T., Chen, Y., Proctor, L., Alba, A., Lelescu, A., & Behal, A. (2010). A smarter process for sensing the information space. *IBM Journal of Research and Development*, 54(4), 1-13. doi: 10.1147/JRD.2010.2050541

Tesorero, A. (2016). Drones to monitor dubai roads in 2017. Khaleej Times Transport. Retrieved from: https://www.khaleejtimes.com/nation/transport/drones-to-monitor-dubai-roads-in-2017.

Tešić, D., Blagojević, D., Lukić, A. (2020). Bringing „smart" into cities to fight pandemics – with the reference to the COVID-19. *Researches Reviews of the Department of Geography, Tourism and Hotel Management*, 49(1), 99-112. doi: 10.5937/ZbDght2001099T

Trassard, P. (2013). Tranquilien combines open data and crowdsourcing to streamline public transport. Retrieved from: https://atelier.bnpparibas/en/smart-city/article/tranquilien-combines-open-data-crowdsourcing-streamline-public-transport-flows

U4SSC, (2017). Collection Methodology for Key Performance Indicators for Smart Sustainable Cities.

United Nations (2014). Introduction and Proposed Goals and Targets on Sustainable Development for the Post 2015 Development Agenda. Retrieved from: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---actrav/documents/meetingdocument/wcms_247951.pdf

WCED (World Commission on Environment and Development), B. C. (1987). Our common future. *Report of the world commission on environment and development*.

Yigitcanlar, T. (2015). Smart cities: an effective urban development and management model?. *Australian Planner*, 52(1), 27-34. doi: 10.1080/07293682.2015.1019752

Yu, H., Lee, H., & Jeon, H. (2017). What is 5G? Emerging 5G Mobile Services and Network Requirements. *Sustainability*, 9, 10, 1848. doi: 10.3390/su9101848

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of Things for Smart Cities. IEEE Internet Things Journal. 1, 22–32. doi: 10.1109/JIOT.2014.2306328

Zanjireh, M. M., & Larijani, H. (2015). A Survey on Centralised and Distributed Clustering Routing Algorithms for WSNs. *IEEE 81st Vehicular Technology Conference: VTC2015-Spring*, Glasgow, Scotland. doi: 10.1109/VTCSpring.2015.7145650

Zhang, T., Zhao, Q., Shin, K., & Nakamoto, Y. (2018). Bayesian-Optimization-Based Peak Searching Algorithm for Clustering in Wireless Sensor Networks. *Journal of Sensor and Actuator Networks*, 7(2), 2-19. doi: 10.3390/jsan7010002

CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ORCID Marija Cimbaljević https://orcid.org/0000-0001-6649-6123
Jelena Dunjić https://orcid.org/0000-0002-5427-378X