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# Smart city research advances in Southeast Europe

Ivana Ninčević Pašalić *, Maja Ćukušić, Mario Jadrić

*Department of Business Informatics, University of Split, Faculty of Economics, Business and Tourism, Cvite Fiskovića 5, 21000 Split, Croatia*

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ABSTRACT

Smart city (SC) research is an engaging research area as evidenced by a rising number of publications indexed in the most relevant global citation databases. However, research advances are not equally discussed and distributed within Europe. This study puts a focus on the specific geographic location of Southeast Europe (SEE), intending to fill the gap in understanding the research advances in this part of Europe. The aim of this descriptive review was to systematically investigate peer-reviewed publications focused on SC research in SEE in order to present the findings and the state-of-art in this research domain. Seventy-four papers were thoroughly studied, analysed and classified based on their focus on SC themes and common sub-themes. While smart governance had been studied extensively in the SEE region, topics related to the smart economy and smart people received low attention from researchers. Mapping the selected papers to the Plan-Do-Check-Act (PDCA) cycle showed that SC research in SEE is still in the conceptualising and planning stages, with very little evidence from the real implementation and follow-up activities. From the stakeholders' perspective, the focus is on the institutional point of view as most of the papers present their findings in relation to (national or local) government bodies or policies, without balancing with corresponding businesses' or individuals' (users') point of view. In general, user involvement was found to be very low in regards to current SC research in the SEE region.

## 1. Introduction

Smart city (SC) concepts have been proven to be successful at representing environments of open and user-driven innovation where both experiments and the validation of future services and products are being conducted (Schaffers et al., 2011). The importance of smart cities derives from the future projections of a growing urban population that will reach 70 % of the worldwide population by the end of 2050 (UN, 2015). Pressure to face changes and challenges, such as old infrastructure, environmental changes, poverty, employment, and competitiveness, is rising (Han et al., 2016; Kourtit, Macharis, & Nijkamp, 2014), and the goal of any smart city is to provide and to maintain a high quality of life (Snow, Håkonsson, & Obel, 2016).

Even though the SC concept is popular among researchers, there is a need for a well-defined definition that can include diverse ideas and experiments (Vanolo, 2014). Due to the popularity of the concept, there are various definitions of a smart city in different areas, including macroeconomics, urban planning, marketing and especially IT-related disciplines. Describing a concept that is a crucial aspect of every research in this area, the majority of smart city definitions focus on technology and its role in the city's environmental, economic and cultural development (Ismagilova, Hughes, Rana, & Dwivedi, 2019). In this study, the following definition has been chosen as most appropriate, as it includes the key parameters of SC: "Smart cities use an IS centric approach to the intelligent use of ICT within an interactive infrastructure to provide advanced and innovative services to its citizens, impacting quality of life and sustainable management of natural resources" (ibid, p. 90). Due to its comprehensiveness and all-inclusiveness, the term "smart" in the smart city concept has been selected for examination and analysis, as it covers multiple smart city conceptual dimensions connecting technological, human and institutional components (Nam & Pardo, 2011). Although a smart city has many conceptual relatives in terms of terminology, all can be categorised into three dimensions: technology (digital city, intelligent city, ubiquitous city, wired city, hybrid city and information city), people (creative city, learning city, humane city and knowledge city) and community (smart community) (ibid). Similarly, other authors point that the origin of the SC concept has some common characteristics with that of "intelligent", "information", "knowledge" and other types of city concepts but that there are also differences in scope and emphasis (Lee, Hancock, & Hu, 2013). A smart city is a relevant topic for various stakeholders and has become a large research area that is gaining

* Corresponding author.
*E-mail addresses:* ivana.nincevic.pasalic@efst.hr (I. Ninčević Pašalić), maja.cukusic@efst.hr (M. Ćukušić), mario.jadric@efst.hr (M. Jadrić).

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significant attention from academics and practitioners, including members of the business and public sectors (Ismagilova, Hughes, Dwivedi, & Raman, 2019; Van den Bergh & Viaene, 2016; European Parliament, 2014; Kitchin, 2014). Although many studies have provided a literature review of smart cities (Albino, Berardi, & Dangelico, 2015; Ismagilova, Hughes, Dwivedi et al., 2019, Ismagilova, Hughes, Rana, et al., 2019; Gupta, Chauhan, & Jaiswal, 2019), there is a lack of studies focusing on the specific geographical area of Southeast Europe (SEE); when compared to those in Northern and Western Europe, the smart city initiatives and solutions in this geographical area are systematically implemented relatively rarely (Kola-Bezka, Czupich, & Ignasiak-Szulc, 2016). Studies show that in terms of smart city efforts, there is a geographical divide between Western and Eastern Europe, as 12 of the top-14 ranked capital cities in smart city efforts are in Western European, while 11 of the cities ranked at the bottom are Eastern European cities (Akande, Cabral, Gomes, & Casteleyn, 2019). This paper focuses on the SEE region, as there are no (comprehensive) studies or smart city rankings that include research advances in this region. Some of the differences noted in studies point to a development gap between Western and Eastern European cities (ibid), but these rare studies (Kola-Bezka et al., 2016) focus on SEE's European Union (EU) member countries; the failure of these studies to include the non-EU countries of the region presents a research gap. For example, the 2018 Smart Sustainable Cities rankings and the European Smart Cities rankings do not consider non-EU European cities. In addition, there is a lack of studies examining the public administration style of Eastern Europe (Bonson, Royo, & Ratkai, 2015). Compared to other European countries, the countries in SEE went through the transition to a market economy and multiparty democracy "under particularly difficult conditions" (Uvalic, 2012).

Similar to the objectives of the review studies by Irani, Gunasekaran, and Dwivedi (2010) and by Gupta et al. (2019), the aim of this descriptive literature review is to reveal an interpretable pattern from the existing literature, evaluate the present-day research advances in the smart city domain and to generate new knowledge by identifying gaps. This descriptive and comprehensive review aims to highlight current accomplishments in smart city research in SEE by identifying the following:

1) The most commonly researched themes and sub-themes;
2) The reported level of progress in the process of managing smart city concepts (mapped to the plan-do-check-act framework);
3) The most frequently presented stakeholder's perspective (among those of individuals, businesses, and the government);
4) The evidence of user involvement in smart city initiatives; and
5) The differences in research contributions between SEE countries.

The paper is organised as follows. Section 2 describes the method used to identify the relevant studies included in this review. Section 3 presents a deeper understanding of the most researched themes and sub-themes, including both empirical and non-empirical studies. Section 4 maps the studies to PDCA stages, identifies the main stakeholder's perspective, examines the level of user involvement in the studies, and provides an overview of the studies per country. Section 5 presents the synthesis of smart city research per country. Future research propositions are given in Section 6. The paper is concluded with Section 7, which contains final remarks, lists limitations of the study and outlines the future research directions.

## 2. Literature search method and general outline of resulting papers

To explore the smart city research advances in Southeast Europe, to identify the relevant publications, an approach based on a keyword search was conducted during May and June 2019. The Web of Science (WoS) and Scopus databases were searched for the keywords comprising SMART CIT* AND the following SEE countries: "Albania" for Albania, "Bosnia "OR "Herzegovina" for Bosnia and Herzegovina (B & H), "Bulgaria" for Bulgaria, "Croatia" for Croatia, "Macedonia" for North Macedonia, "Montenegro" for Montenegro, "Romania" for Romania, "Serbia" for Serbia and "Slovenia" for Slovenia. These keywords were searched for in either an article's title, an abstract or a keywords list. As the aim of this review was to obtain insight into the current state of SEE smart cities' research regardless of the domain, the research was not restricted in terms of research areas. In addition, in order to capture all aspects of the smart city concept, the following closely related keywords were also searched in the WoS and Scopus databases: "intelligent cit*", "digital cit*", "information cit*", knowledge cit*", "wired cit*" and "ubiquitous cit*".

The first search resulted in a total of 196 document (89 from the Web of Science and 107 from Scopus) for all SEE countries. After the initial screening of all 196 abstracts for keywords and after eliminating repetitive papers (the ones listed in both databases and conducted for more than one SEE country), 69 documents were determined to fit the set relevance criteria; a total of 23 documents needed further review and an analysis of the whole paper. Following the two phases—the initial screening and the reading of the whole papers—the authors agreed that the base for this exploratory study would comprise 74 documents in total.

Among the 74 documents, 60 % were published in conference proceedings, 35 %, in scientific journals, and the rest were published as book chapters. The papers appeared in 39 different conference proceedings/symposia and 25 different journals, thus demonstrating the multidisciplinary nature of the research on smart cities. There was an unequal distribution of the studies within the SEE region; i.e., 3.7 % of the papers focused on SC in Albania, 2.5 % on SC in Bosnia and Herzegovina, 6.2 % in Bulgaria, 14.8 % in Croatia, 4.9 % in North Macedonia, 31 % in Romania, 17.3 % in Serbia and 19.8 % in Slovenia. No results were found for Montenegro. There were only 3 identified papers that focused on SC in Albania, while there were 25 identified papers that focused on SC in Romania. This would suggest that in the cities that were investigated, there were substantial differences in the smart city research presented in the papers and in the population of these countries (in Section 5). An analysis of the timeline, i.e., the evolution of smart city research, reveals that SC research in the region started slowly in 2011 and 2012 (a total of 4 studies) and intensified during the period of 2013–2016 (approximately 5 studies per year). It reached its highest level in 2017 (11 studies) and maintained that higher level in 2018 and 2019.

A comparison of the keyword search results for SEE countries with that for Western European countries shows that there is a noteworthy difference in the number of first search results. For example, a Smart cit* keyword search for Spain alone resulted in over 160 documents indexed in the Scopus database (compared to 107 for all SEE countries).

## 3. Classification and review of the papers based on the main focus on smart city themes

Based on the well-known classification by Giffinger et al. (2007) and popularised by the European Parliament (2014), six key smart city research themes (smart economy, smart environment, smart governance, smart living, smart mobility, and smart people) were used to classify the selected papers. This classification was used, since the six SC themes (or as the cited authors label them, topics or dimensions) have been the research focus of many scholars and practitioners for the last decade.

To have a better understanding of the type of research conducted in the SEE area, in line with the view that empirical studies in MIS rely on observations and data, whereas non-empirical studies emphasise ideas and concepts, the papers were also classified as predominately empirical or non-empirical studies (Alavi & Carlson, 1992). The classification of the papers per central theme and type of study is presented in Table 1.

**Table 1**
Empirical vs non-empirical research across six key smart city themes.

| SC themes | Empirical research papers | | Non-empirical research papers | | Paper count |
|---|---|---|---|---|---|
| | f | % | f | % | |
| Smart Economy | 1 | 33.33 | 2 | 66.67 | 3 |
| Smart Environment | 9 | 56.25 | 7 | 43.75 | 16 |
| Smart Governance | 8 | 33.33 | 16 | 66.67 | 24 |
| Smart Living | 3 | 20 | 12 | 80 | 15 |
| Smart Mobility | 5 | 50 | 5 | 50 | 10 |
| Smart People | 3 | 50 | 3 | 50 | 6 |
| Grand total | 29 | 39.19 | 45 | 60.81 | 74 |

Most of the papers (61 %) are descriptive, conceptual and theoretical, i.e., non-empirical. Less frequently, the studies are based on observations and data representing the empirical type of study (39 %).

The smart environment and smart people are the only two themes where the empirical research surpassed the non-empirical research, while studies that fall under the smart governance theme are the most frequent ones. Following the breakdown of the papers into sub-themes in Table 2, more insight into the type and main focus of the papers is given later in this section. Within a theme, based on the content analysis of the paper (title, keywords, abstract and the whole paper in some cases), sub-themes were identified. The table lists only the papers for which it was possible to find common keywords in at least two papers within a theme. For example, "energy" is a sub-theme of the smart environment theme. Consequently, the papers with unique keywords are not listed in the table but will be addressed within the corresponding theme in later sub-sections in specific cases. In addition, there may be the same sub-themes within different themes. For example, as a sub-theme, the Internet of Things (IoT) may be discussed within studies relating to smart governance and in respect to city governance but may also be discussed in studies relating to sensors and as a part of smart living, it may be discussed in reference to its impact on the living and wellbeing of citizens.

### 3.1. Smart economy

A smart economy refers to the city's competitiveness, and it is characterised by innovative spirit, entrepreneurship, trademarks, productivity, labour market flexibility, international embeddedness, and the ability to transform (Giffinger & Gudrun, 2010). The theme describes actions aimed at strengthening the municipality's economy by improving the business climate and improving its attractiveness for investors and talents in order to grow the economy innovatively by utilising information and communication technologies (ICT) (Beesmart, 2019). Overall, the smart economy is one in which existing resources are employed for the development and implementation of innovative solutions (Zygiaris, 2013). According to the classification results shown in Table 2, smart economy research in SEE is scarce, as only two papers have been identified within this theme. The research of Lucaciu (2018) is focused on the methodology for the evaluation of the programmes supporting smart growth based on knowledge and innovation drivers, which are vital in the smart economy. It concludes that the design of evaluation frameworks should consider the broader use of quantitative methods of evaluation to fully explore the innovative environment of smart city investments. In their paper, Suciu and Florea (2014) demonstrate the importance of regional innovative clusters on the competitiveness and sustainability of the regions (based on case studies conducted in Romania), as well as the general importance of cluster development initiatives, which are important components in economic policies supporting macroeconomic stabilisation efforts, market opening and reductions in the cost of doing business.

**Table 2**
Key smart city themes and sub-themes and their contributors in the SEE region.

| SC themes, SC sub-themes and keywords/Number of papers within the theme | Author(s) |
|---|---|
| **Smart Economy/3** | |
| Competitive (advantage, policy) | Suciu and Florea (2014)<br>Lucaciu (2018) |
| **Smart Environment/16** | |
| **Energy** efficiency | Trombadore (2017)<br>Krneta et al. (2019)<br>Di Leo and Salvia (2017) |
| **Energy** management | Trombadore (2017)<br>Bacekovic and Ostergaard (2018)<br>Reichert and Sturker (2017) |
| Renewable **energy** sources | Trombadore (2017)<br>Krneta et al. (2019)<br>Di Leo and Salvia (2017) |
| Waste | Di Leo and Salvia (2017)<br>Popescu et al. (2016)<br>Konovsek et al. (2017) |
| Solar | Nemes et al. (2018)<br>Goricki et al. (2017) |
| Radiation | Djuric et al. (2016)<br>Nemes et al. (2018) |
| **Smart Governance/24** | |
| (Good, Participatory, Open) **governance** | Verheijen et al. (2015)<br>Rink et al. (2014)<br>Chirlesan (2015)<br>Soomro et al. (2017)<br>Rasic et al. (2018) |
| Internet of Things | Lucic et al. (2018)<br>Milenkovic et al. (2017)<br>Zdraveski et al. (2017) |
| E-government | Pinteric (2017) |
| Innovation | Danaiata et al. (2014)<br>Verheijen et al. (2015)<br>Andreea and Ioana (2015)<br>Catalin et al. (2015) |
| Change management | Casalino et al. (2014)<br>Verheijen et al. (2015) |
| ICT adoption | Verheijen et al. (2015)<br>Casalino et al. (2014) |
| (Electronic, Smart) **services** | Danaiata et al. (2014)<br>Casalino et al. (2014) |
| Sustainable development, sustainability | Elena (2018)<br>Catalin et al. (2015) |
| (Public) participation | Pipan (2018)<br>Klimovsky et al. (2016) |
| **Smart Living/15** | |
| (e-)**Health** | Cripps et al. (2012)<br>Vucetic et al. (2011) |
| Internet of Things | Sofic and Barakovic Husic (2016)<br>Vrabie (2018)<br>Grasic et al. (2018) |
| Urban development | Vrabie (2018)<br>Sofeska (2017) |
| Sensors | Trilar et al. (2019)<br>Trilar et al. (2018)<br>Fortuna and Grobelnik (2012)<br>Mohorcic et al. (2013) |
| Family-centred design | Trilar et al. (2019)<br>Trilar et al. (2018) |
| **Infrastructure** | Niculescu-Dincă (2018)<br>Sofic and Barakovic Husic (2016)<br>Mohorcic et al. (2013) |
| **Smart Mobility/10** | |
| Smart **transport** | Pokric et al. (2014)<br>Avdic et al. (2017)<br>Baucic et al. (2017) |
| (Freight, Railway) **transport** | Cossu (2016)<br>Popovic et al. (2017) |
| (Smart, Urban) **parking** | Avdic et al. (2017) |

(*continued on next page*)

**Table 2** (*continued*)

| SC themes, SC sub-themes and keywords/Number of papers within the theme | Author(s) |
|---|---|
| | Saric et al. (2017)<br>Farkas and Lendak (2015) |
| **Smart People/6**<br>(Political, digital) **participation** | Hafner and Oblak Crnic (2014)<br>Oblak-Crnic (2016) |

### 3.2. Smart environment

A smart environment refers to the city's natural resources and waste management; water management, energy efficiency, monitoring, and pollution management are just some of the smart environment topics where changes can be made by utilising new technologies and practices (Giffinger & Gudrun, 2010). There are a significant number of publications falling under this theme (30 %). The most popular sub-theme is related to energy, which is the central keyword of the smart environment in the SEE, as 9 out of 15 papers contain 'energy' as a keyword along with either efficiency, management, or renewable. Trombadore (2017) presented the MEETHINK Energy research project that will result in a platform focusing on three priority areas (energy efficiency in buildings and districts, renewable energy sources, and distributed energy generation and energy in urban mobility). The aim of the project will be achieved by sharing activities through networking, learning and best practices and by assessing the training needs of the participating municipalities in terms of energy-efficiency planning and a capacity building strategy for public authorities at different levels of government (ibid). Reichert and Sturker (2017) outlined a smart city energy management platform that integrates some of the components from the Internet of Things and offers decision support systems for different market actors involved in the energy system. By following their proposed benefit evaluation framework based on open data API services and privacy protection mechanisms that enabled the distribution of required data, the authors identified and categorised several benefit types on different levels (ibid). As the energy management tool is implemented in two pilot cities in Croatia and Bulgaria, they expect further valuable insights into the created value of the system.

The importance of raising the awareness of renewable energy resources (RES) and energy efficiency (EE) is well documented in the paper of Krneta, Dragicevic, Pester, and Rojko (2019), where a particular focus is on the smart applications that can be used for raising the awareness of young citizens in the local community. The paper describes the possibilities of online experiments (remote and virtual) in which the learning outcomes are related to RES, EE, the online monitoring of energy consumption and the RES potential in the local community. In addition, the paper proposes the development of an innovative web-based platform for improving energy efficiency and the possibilities of using RES through consumer understanding, engagement and behavioural changes (ibid). Bacekovic and Ostergaard (2018) made a comparison between two different 100 % renewable energy scenarios: for the design of a future energy system in Zagreb, Croatia, a smart energy system approach and a non-integrated renewable energy system approach. With EnergyPLAN simulations, both scenarios were modelled as isolated systems; the smart energy system demonstrated lower energy consumption and comparable annual costs, while the traditional non-integrated renewable system utilised unsustainable amounts of biomass (ibid). Resource efficiency remains a challenge, particularly in the SEE region, where local authorities need to develop and implement policies for enhancing the quality of life in cities, while also ensuring a reduction of resource extraction, energy consumption, and waste generation (Di Leo & Salvia, 2017). In a RE-SEE-tied project, eight partner cities, including ones from Croatia, Macedonia, and Slovenia, were helped in their efforts to tackle the energy and waste management challenges and worked simultaneously on data and methodologies, available technologies, policymaking tools, incentives, and awareness-raising initiatives. The goal was to enhance the policy-making and strategic planning competencies of municipalities (in the area of capacity building, technology, and knowledge support) and to incorporate the knowledge into local strategies and action plans in the field of energy efficiency, renewable energy sources, and waste valorisation (ibid).

The objective of the study of Popescu et al. (2016) was to analyse the current waste management system (collection, storage and recycling of the waste in the campus) at the University of Oradea and to develop strategies incorporating the use of smart technologies (through reducing the waste and encouraging recycling), to improve the existing system. Konovsek et al. (2017) presented a project designed for the useful utilisation of waste heat in the steel industry and in which modern technology and innovative system solutions were used for the integration of a smart and sustainable heating and cooling system. The use of the system resulted in energy savings and air quality improvements (ibid).

The aim of smart city development is to create an environment that is sustainable in the long term and that is economically justifiable. As one of the sunniest European countries, Croatia has significant solar potential. For analysing the solar potential of a pilot locality in Croatia, the paper of Goricki, Posloncec-Petric, Franges, and Bacic (2017) describes a procedure in which a digital surface model (DSM) based on the data available from the national Meteorological and Hydrological Service is used. The large potential of solar energy use in Croatia is confirmed by the results of the study that showed that the installation of 19.6 $m^2$ of solar panels in each household could cover the annual requirements of the households in the analysed locality (ibid). Complementary, another regional study found that a solar resource investigation should be performed in accordance with clearness index probabilistic features, as identifying the resource potential is an important requirement for solar system planning and operation (Nemes, Ciobanu, & Rugina, 2018). The study assessed the degree of the clearness index in Iasi, Romania and used solar radiation database information recorded for four years and a statistical analysis to derive the probability density distributions. The computational results showed that the probability density function that gives the lowest values of statistical tests is the Bendt function (ibid). In the paper of Djuric et al. (2016), the authors tested the use of a wireless sensor-based monitoring network (Serbian Electromagnetic Field Monitoring Network) for the advanced low-frequency EFM monitoring for a future smart cities environment; in the test results, the scores were below the Serbian prescribed reference levels.

Not presented in Table 2 due to its unique keywords, the paper of Ceh, Pirs, and Jereb (2018) presents an examination of CO2 production in private and public vehicles and concludes that with better traffic management in the cities, significant changes in CO2 emissions produced by transport can be made.

### 3.3. Smart governance

Smart governance characteristics and factors can be divided into the following (Giffinger & Gudrun, 2010): participation in decision-making, the provision of public and social services, the development of transparent governance and political strategies and perspectives. Smart governance refers to the strengthening of the connections between the government and its stakeholders (citizens, businesses, and other organisations of the civil society) by using new methodologies (e.g., co-creation or crowdsourcing) or by implementing innovations (Beesmart, 2019). In a survey conducted by Chirlesan (2015), Romanian citizens answered that they perceive good governance through the quality of public services, national security and the state's efficiency at the economic, political and administrative levels. Smart governance is a highly discussed topic in the smart city domain in the SEE region, as 30 % of the reviewed papers cover sub-themes, such as governance, e-government, change management and innovation. Verheijen, Bhatti and Kusek (2015) presented a technology-driven and citizen-centric

Smart Proactive Government model that uses smartphones and dashboard technologies in improving the effectiveness and quality of public sector governance. Smart governance is needed not only when cities are growing but also in the opposite cases; similar to the consideration of a solution when cities are growing, the in-depth consideration of a 'smart shrinking' solution when cities are decreasing should be pursued. In examining the reaction of four cities to urban shrinkage, Rink et al. (2014) found out that the primary reaction of urban governance to urban shrinkage is non-acceptance or ignorance of this fact and an attempt to reverse shrinkage into regrowth.

In the study of Soomro, Khan, and Ludlow (2017), the possibility of using ICT in participatory urban governance was tested in three applications in four pilot cities. One of the applications allowed urban planners to propose urban development and at the same time enabled the feedback of stakeholders; the second application was used to analyse the population and its mobility in the city. The third one simulated the different socio-economic activities linked to different planning scenarios. An understanding of these activities is an important input in the decision-making processes of local governments (ibid). Rasic, Milenkovic and Vojkovic's (2018) paper presented the results of a survey of Croatian citizens who according to the results, are interested in participating and being a part of decision-making processes but are not familiar with instruments required for participation, as the local governments do not provide citizens with the plans and tools needed.

The topic of the Internet of Things (IoT) is highly promoted and researched by scholars but is researched even more by practitioners. It is analysed in the context of electronic communications, since the strict application of data protection and e-privacy might negatively affect the roll-out of IoT and smart city solutions; therefore, national regulations in Croatia were examined and described (Lucic, Boban, & Mileta, 2018). Public-Private Partnerships (PPP) are discussed by Milenkovic, Rasic, and Vojkovic (2017), where the role of local government was shown to be to evaluate implementation plans of the concessionaire, while as they were viewed as having the know-how, the private partner's role was considered to be to develop, finance and operate the facilities. Zdraveski, Mishev, Trajanov, and Kocarev (2017) presented a smart city dashboard that obtains and processes data from various sensors and enhances the ISO 37120 standard for city services and quality of life in terms of adding new indicators. Pinteric (2017) explored the reasons for the poor implementation of e-state tools that could improve the administration processes. Leading the author to conclude that a lack of motivation will block any reform attempt, the results of the survey from Slovenia showed a general ignorance of technology potential and security threats by the citizens (ibid).

The study of Danaiata, Margea, Hurbean, and Artene (2014) confirms that a significant improvement of (local) e-government can be made by delivering qualitative information on services, implementing user-centred orientation regarding information and services and responsively approaching local public government. To test the changes in the productivity of the region, Andreea and Ioana (2015) studied the effects of Romanian clusters on regional development and growth based on innovation and branding. Catalin, Andreea, and Oana-Maria (2015) discuss the challenges of the cities' and regions' parallel development involving innovative mechanisms for both urban and regional governance through planning strategies. In terms of new and innovative governance practices, Casalino, Ciarlo, and Lombardo (2014) demonstrated the process of designing a smart public registry that by facilitating the offering of new smart services, the optimisation of public spending and the improvement of the coordination of all stakeholders, tends to enable a more transparent governance of European infrastructures.

In the context of a knowledge society, Elena (2018) lists the strengths and deficiencies of Romanian cities that pursue the implementation of the principles and practices of sustainable development. Pipan (2018) explores interactive tangible planning support systems (PSSs), which by making digital spatial data more accessible when trying to reach consensus among stakeholders in the decision-making process, tend to improve the urban planning and participation methodologies. The impact of public participation when governing smart cities is evident also in the study results of Klimovsky, Pinteric, and Saparniene (2016), which show that people are reluctant to use technology above the level of their needs and show little interest in participating in matters of governance. This reluctance and lack of interest prevents smart cities from developing in reality.

### 3.4. Smart mobility

Smart mobility solutions are designed to increase the efficiency of urban transportation (Giffinger & Gudrun, 2010) and to encompass the following: local accessibility, (inter)national accessibility, the availability of ICT infrastructure, and sustainable, innovative, and safe transport systems. Examples of smart mobility can be found in new forms of transportation, such as electric vehicles, autonomous vehicles, e-scooters, or in new mobile applications for car and bike-sharing. Mobility as a theme gained the moderate attention of researchers, as 15 % of the papers are linked to different forms of mobility, but most are focused on public and freight transport and parking.

Pokric, Krco, and Pokric (2014) described end-to-end solutions with complete system setup and user experience aspects based on IoT devices and in which, using smartphones and augmented reality technology, citizens can access information about bus lines or tourist landmarks. Baucic, Jajac, and Bucan (2017) used big data from the telecom company to analyse the transport demand and transport needs of the tourists in Split, Croatia. Cossu (2016) shared the results of urban freight transport testing conducted with soft measures and newly developed C-LIEGE tools; the aim of the testing was to identify ways to reduce freight traffic and operating costs, energy consumption, and negative environmental impacts. In their paper, Popovic, Lazarevic, Vukicevic, Vilotijevic, and Mirkovic (2017) provided a list of measures supporting the idea of the increase in the volume of railway transport in Serbia, as the increase in volume might reduce the negative environmental consequences.

Avdic, Avdic, Marovac, Kajan, and Ljajic (2017) explained in general the process of efficient parking in a smart city and presented the architecture of possible parking solutions for smaller cities. Saric, Mihaljevic, and Marasovic (2017) proposed a new model for the emergent properties' introduction through integrating existing smart city subsystems that are already in use in the city of Dubrovnik, Croatia (smart parking). Farkas and Lendak (2015) presented a case study of a crowd-sensing based application for parking in a city in Serbia. Cinac (2018) presented the perks of implementing the park and ride system in the capital city of Bosnia and Herzegovina.

### 3.5. Smart living

The topic of smart living refers to the quality of living and is viewed through the prism of cultural facilities, health conditions, individual safety, housing quality, education facilities, tourism, and social cohesion (Giffinger & Gudrun, 2010). This theme attracted a moderate attention of the researchers, as 23 % of papers were sorted within this theme, which covered different sub-themes, ranging from sensors and related technologies to health.

In a case study in Slovenia, Electronic health (smart) cards are discussed by Cripps, Standing, and Prijatelj (2012), who note the health smart card's benefits, such as easier tracking of prescriptions, insurance refunds and similar items, while the disadvantages include poor data quality and patient data security concerns. Vucetic, Uzelac, and Gligoric (2011) presented the design, architecture, and strategies to develop in Serbia a health information system that will be based on e-health records. A performance evaluation was conducted to test each attribute, such as system and information quality, user satisfaction and the individual and organisational impacts, of the new information system (ibid).

Compared to the results from the traditional approach, the results from this new approach showed an increase in performance (ibid).

As a basis for decision-making processes, IoT is discussed within smart governance, while IoT within the smart living dimension focuses on better living conditions for citizens. A general consideration of how IoT networks and services can contribute to the development and living in smart cities is given by Vrabie (2018). Sofic and Barakovic Husic (2016) emphasise the crucial role of IoT in the communications sector and highlight essential factors to consider when planning communications infrastructure for new IoT solutions. The goal should be to use fast Internet technologies to achieve the sustainable economic and social benefits of the digital market Internet(ibid). Using open IoT data, Grasic, Kos, and Mileva-Boshkoska (2018) classified the incoming calls of 112 public safety systems in the capital city of Slovenia. The main contribution of the paper was the classification of the incoming calls as a basis for further work on improving the prediction, i.e., the in-advance classification of incoming calls in order to provide predictive information to the relevant smart city public safety system. Sofeska (2017) demonstrates the vital role of smart cities in creating opportunities for the liveable future of cities where municipal system services allow the urban structure to function.

As a sub-theme of smart living, sensors are presented as the basis for different complex ICT solutions. Trilar, Kos, Jazbinsek, Jensterle, and Duh (2018) presented the prototyping and testing approach (their conclusions are based on survey data and conducted interviews) before starting to develop ICT solutions for families that in order to promote a healthier lifestyle, connect sensors through different activities (sensor-based testing). In a further study of a family-centred design approach model (Trilar et al., 2019), an ICT solution was tested on all generations in a family to see if their needs were met and to address the identified limitations. There are more research papers on sensors, but they focus on the technical side: Fortuna and Grobelnik (2012) present the generic pipeline for the analysis of sensor data comprising the test results in two cities in Slovenia. To understand smart urban environments, Mohorcic, Smolnikar, and Javornik (2013) present the role of a LOG-a-TEC sensor network in experimentally driven research and development.

### 3.6. Smart people

The smart people dimension denotes the social and human capital described by level of qualification, affinity to lifelong learning, social and ethnic plurality, flexibility, creativity, cosmopolitanism/open-mindedness and participation in public life (Giffinger & Gudrun, 2010). Only three papers have been identified as representing the smart people theme, and there were no common links in the keywords.

In their paper, Cabrilo, Nesic, and Mitrovic (2013) present empirical research on human capital across Serbian industries; they identify gaps related to the innovation performance of employees and which form the basis for the creation of more effective innovation strategies/policies. To make the most of human capital, the priority is to identify the relevant gaps between the value drivers in human capital and the innovation goal scenarios of the companies. Kadar (2016) shows the results of an EU-funded project where to create a better learning and teaching environment, three universities collaborated to enhance people's skills and competences for the development of smart city applications within the university curricula of Applied Electronics, Computer Science and Environmental Engineering specialities. Velciu, Grecu, and Zamfir (2014) present an overview of the national features of the dropout phenomenon in six European countries and the best practices identified to address different phenomena, such as school dropout, absenteeism, school failure, and more. In the context of finding measures that can be used against school dropout and other phenomena in the new economy, the goal is to identify the educational/counselling/theoretical approach, the results achieved, and the opportunities for the transferability of the best practices. Previously described studies point to different aspects of a smart people theme, while public and digital participation is the only theme recognised as important by two studies. Hafner and Oblak Crnic (2014), and Oblak Crnic (2016) discuss the predictors of digital political participation in Slovenia, with a special focus on young citizens and their digital culture.

## 4. Positioning smart city research in SEE to frameworks and level of user involvement

### 4.1. Smart city research reflected in the stages of the plan-do-check-act cycle

The plan-do-check-act (PDCA) framework or the Deming cycle is a practical tool widely adopted for achieving continuous improvement in different sectors. This never-ending cycle is comprised of four stages (EPMM, 2000, p. 156): 1) the plan stage, which involves studying the current situation, gathering data and planning for improvement; 2) the do stage, in which the plan is implemented on a trial basis; 3) the check stage tests if the trial plan is working and if further problems or opportunities have been discovered; and 4) the act stage consists of implementing the final plan. The act stage is not the end of the cycle, as this stage leads back to the plan stage for further diagnosis and improvement. The PDCA framework emerged as a useful tool for assessing the research advances related to smart cities in the SEE region, as it is still a young and fast-developing area with many conceptual and theoretical contributions and an area in which the research has been less empirical, as already presented earlier. Here, the aim was to use a known framework to try to determine the prevailing level of the development phase of smart city research. The results of the mapping are presented in Table 3. The view is that all 74 papers have described the current situation of the problem and brought forth a concept, which is the starting point of every research study (the plan stage). In the next stage (do), it is possible to select 25 papers (34 %) where the trial plan or pilot research is reported and described. For example, Albania is implementing a proactive government model for offering multi-services in a one-stop-shop issuing documents and permits (Verheijen et al., 2015). Skopje in North Macedonia is another example, where the pilot dashboard platform with existing online public services is being implemented (Zdraveski et al., 2017). In the third stage (check), where the results of the pilot studies are reported and discussed, there are 8 papers (11 %). This stage can be illustrated by using the example of a MyFamily web application, where to provide new insights and ideas for the change of the family-centred design approach model, extensive testing of the prototype solution was done along with user interviews (Trilar et al., 2019). The study stops at the point of obtaining the users' feedback; therefore, it does not satisfy the criteria for the next stage. In the final stage (Act), the implementation of smart city solutions is researched and presented in only 1 paper. This implies that final smart city concepts and solutions are neither implemented nor tracked by the research studies on the SEE countries. Considered here for the act stage, the study (by Soomro et al., 2017) included field research conducted by evaluation questionnaires given to the stakeholders of three urban ICT applications. In this way, the researchers gathered inputs and propositions that will be implemented in the final version of the application and in its updates - progressing thereby again towards the planning phase.

### 4.2. Stakeholder's perspective in the SC research

Another important selected papers' classifier was assessed to be the perspective taken, in the context of whether it reflected the dominant point of view of the following most important smart city actors: individuals (citizens), businesses and government. When analysing the level of ICT adoption, which is an important prerequisite for SC implementation, these actors are the three main groups of stakeholders (The Global Information Technology report, 2016). The analysis (presented in Table 4) revealed that the government was the main focus in 68 % of the papers, followed by issues relevant to individuals in 28 % and issues

**Table 3**
SC research in SEE reflected in the stages of the plan-do-check-act cycle.

| SC themes | Paper count | Plan | | Do | | Check | | Act | |
|---|---|---|---|---|---|---|---|---|---|
| | | f | % | f | % | F | % | f | % |
| Smart Economy | 3 | 3 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Smart Environment | 16 | 16 | 100 | 6 | 37.5 | 2 | 12.5 | 0 | 0 |
| Smart Governance | 24 | 24 | 100 | 4 | 16.67 | 2 | 8.33 | 1 | 4.17 |
| Smart Living | 15 | 15 | 100 | 9 | 60 | 3 | 20 | 0 | 0 |
| Smart Mobility | 10 | 10 | 100 | 5 | 50 | 1 | 10 | 0 | 0 |
| Smart People | 6 | 6 | 100 | 1 | 16.67 | 0 | 0 | 0 | 0 |
| Grand Total | 74 | 74 | 100 | 25 | 33.88 | 8 | 10.81 | 1 | 1.35 |

**Table 4**
SC research in SEE depending on the stakeholder's perspective.

| SC themes | Paper count | Individuals | | Businesses | | Government | |
|---|---|---|---|---|---|---|---|
| | | F | % | f | % | f | % |
| Smart Economy | 3 | 0 | 0 | 1 | 33.33 | 3 | 100 |
| Smart Environment | 16 | 1 | 6.25 | 3 | 18.75 | 12 | 75 |
| Smart Governance | 24 | 9 | 37.5 | 5 | 20.83 | 20 | 83.33 |
| Smart Living | 15 | 3 | 20 | 3 | 20 | 9 | 60 |
| Smart Mobility | 10 | 4 | 40 | 3 | 30 | 4 | 40 |
| Smart People | 6 | 4 | 66.67 | 1 | 16.67 | 2 | 33.33 |
| Grand Total | 74 | 21 | 28.38 | 16 | 21.62 | 50 | 67.57 |

relevant to businesses in 22 % of the papers. The study by Milenkovic et al. (2017) discusses both the business and the government perspective and provides recommendations for both groups of stakeholders when discussing public-private partnerships; however, it places a stronger focus on the government's role. Klimovsky et al. (2016) tested how citizens in Slovenia and Slovakia used technology—considering the individuals' perspective, the authors found issues that present a serious obstacle in implementing smart city solutions.

### *4.3. User involvement in the SC research*

New research envisions citizens becoming co-creators and co-producers (Vázquez & Vicente, 2019) and emphasises their new and active role in shaping public services and in public decision-making. Considering the fact that as described in the previous paragraph, the perspective of individuals was underrepresented in the selected papers, in papers discussing smart cities in the SEE region, further analysis was done to examine the extent of user (citizen) involvement in any manner (physically or electronically). Only 26 % of the papers show evidence of user involvement, which included asking for the users' opinions (Rasic et al., 2018) or feedback after the users had tested the applications or other types of solutions (Trilar et al., 2019).

## 5. Synthesis of smart city research per country

A summary of the selected papers per country is presented in Table 5. Again, the total number of reviewed papers is 74, but since some of the studies cover examples from multiple countries in the SEE region, the total is 81. In respect to the number of papers, most of the papers deal with SC themes in Romania (25), followed by Slovenia (16), Serbia (14), and Croatia (12). The SEE region includes 4 EU member countries (Bulgaria, Croatia, Romania and Slovenia) and 4 non-EU members (Albania, Bosnia and Herzegovina, North Macedonia and Serbia); all of these countries are very different in size. In the table, a country population row is added to illustrate the differences in the size of the countries. Countries such as North Macedonia and Romania cannot be compared easily in terms of the number of published papers, as North Macedonia has approximately 2 million inhabitants and Romania has over 19 million (World population review, 2019). For this reason, when discussing the research advances in one country compared to those in another country, the number of papers cannot be interpreted as an isolated number.

Topics falling under the smart environment and smart government themes are investigated in almost all countries in the region (except for Bosnia and Herzegovina), while the smart economy and smart people are the least investigated in all countries, except Romania.

To obtain a better insight into differences between and among the countries and the overall position of the SEE countries in respect to the SC level of development, available city or country ranking tools should be consulted as well. One relevant list is the 2018 Smart Sustainable Cities rankings (Akande et al., 2019), where three thematic areas are evaluated: the economy, the environment and society. Four SEE region cities, which are capitals of the EU-countries included in this analysis, hold the lower part of the ranking list: Zagreb, Croatia (ranked 23 out of 28 EU cities), Ljubljana, Slovenia (ranked 24), Bucharest, Romania (ranked 27) and Sofia, Bulgaria (ranked 28). The 2019 Quality of Living city rankings (Mercer, 2019) monitors the overall quality of living and evaluates factors, such as recreation, housing, economic environment, consumer goods availability, public services, transport, political and social environment, natural environment, socio-cultural environment, school and education, and medical and health considerations. The

**Table 5**
SC research in SEE per country and theme.

| Country | Population | SC theme | | | | | | Number of papers per country |
|---|---|---|---|---|---|---|---|---|
| | | Smart Economy | Smart Environment | Smart Governance | Smart Living | Smart Mobility | Smart People | |
| Albania | 2.8 M | | 1 | 1 | 1 | | | 3 |
| Bosnia and Herzegovina | 3.3 M | | | | 1 | 1 | | 2 |
| Bulgaria | 7 M | | 1 | 1 | 2 | 1 | | 5 |
| Croatia | 4.1 M | 1 | 5 | 3 | | 3 | | 12 |
| North Macedonia | 2 M | | 1 | 2 | 1 | | | 4 |
| Romania | 19.5 M | 2 | 5 | 12 | 3 | | 3 | 25 |
| Serbia | 8.8 M | | 5 | 2 | 2 | 4 | 1 | 14 |
| Slovenia | 2 M | | 4 | 3 | 6 | 1 | 2 | 16 |
| Total | 49.5 M | 3 | 22 | 24 | 16 | 10 | 6 | 81 |

rankings of the 8 countries from the SEE region (out of 230 countries) are as follows: Ljubljana, Slovenia (ranked 74), Zagreb, Croatia (ranked 98), Bucharest, Romania (ranked 109) and Sofia, Bulgaria (ranked 116) are on the upper half of the ranking list, while the Serbian, Bosnian, Macedonian and Albanian capitals are ranked 139, 156, 161 and 175, respectively. The digital performance and competitiveness of EU member states is tracked with the previously mentioned DESI index. The leading position in SEE regions is Slovenia (ranked 16), which is followed by Croatia (rank 20). The end of the ranking is concluded with Romania and Bulgaria, which have the lowest ranks in the EU (ranked 27 and 28). Although most research studies of the region belong to Romania, this is not evident in the position of ranking lists formulated by European and worldwide institutions. This could be explained with the results of the PDCA cycle, which positions the Romanian research in the planning stage.

The e-government and e-participation indexes by UNDESA's office (UN, 2018) show the advancement of SEE countries every two years. The SEE countries' rankings, which are based on the E-government development index (EDGI) from 2018 (out of 193), are as follows: Slovenia 37, Bulgaria 47, Serbia 49, Croatia 55, Romania 67, Albania 74, North Macedonia 79 and Bosnia and Herzegovina 105. Considering that the SEE countries are in the upper half of the EDGI ranking list (except for Bosnia and Herzegovina), a slightly larger number of papers and interest in the smart governance theme in the region is explicable.

## 6. Discussion and future research

This section examines the findings and research opportunities in the smart city domain in the SEE region. Future research is diverse, as the smart city concept covers a broad range of research areas. As similarly done by Duan, Edwards, and Dwivedi (2019) in their paper, the research propositions for addressing opportunities are proposed and divided in 3 areas in order to have a clear perspective of each area. These areas consist of the following: 1) the conceptual and theoretical development of SEE's smart cities, 2) the implementation of SC solutions and, 3) the role of citizens and other stakeholders in SC.

Further investigation is needed to understand the differences between SEE's SCs and the leading SCs in Europe; therefore, the following propositions are prepared.

**Proposition 1**. Elaborating the themes researched, the research perspective and other investigated points of this study, a detailed comparison of Eastern and Western smart city advances is needed in order to determine the extent of the differences.

In addition, an analysis of the economic indicators of Eastern and Western Europe is needed to uncover the reasons for the differences in implementing and researching smart city initiatives. The topic can be investigated by comparing the size of the SC solutions' market, the investment in ICT in general, broadband market development, the citizens' digital skills, and the offering and the use of Internet (public) services as measured by the European Commission's Digital Economy and Society Index (DESI). These sub-themes correspond to the concept of the smart economy, which is a theme that has been identified by this review study as unexplored in all countries of the SEE region.

Although there are a number of conceptual concepts framing smart cities, the research in SEE lacks studies measuring what has been done so far (case studies). There are a limited number of SC implementation examples, and it is very important to study more and to study the details of what has been done. At the same time, it is necessary to identify not only strengths and good practices but also the challenges and barriers faced in the implementation process. As proposition 3 explains, pilot and other implementations of SC solutions should be investigated in detail in order to generate relevant lessons learned.

**Proposition 2**. An analysis and comparison of (successful) SC implementations (complete smart city solutions or different segments) will lead to the generation of key success factors.

Insufficient research from the business perspective has been noted as a finding and as a research gap in this study (22 % of articles reviewed included a business perspective), and logical solutions can be developed by intensifying the academic and business sector cooperation, which will lead to more SC implementations studies. Going a step forward, SC cannot be considered successful by measuring how much has been done. Potential pitfalls also need to be identified and measures need to be developed to mitigate these pitfalls, as they can negatively affect the development of SC (Lam & Ma, 2019).

**Proposition 3**. Measuring the impact of pilot studies and final SC solutions is very important. For that reason, there is a need to test (impact) indicators in order to ultimately measure SC benefits. The following proposition is a hybrid, as it includes elements of both areas: the implementation of SC solutions and the role of citizens in SCs.

**Proposition 4**. When implementing SC solutions from the planning to the implementation of selected SC solutions, it is necessary to explore the citizens' and other stakeholders' needs.

The exploration process should include receiving the feedback from end users after the implementation. This can lead to better SC solutions that better fit the needs of all user groups. In addition, greater acceptance of SC solutions and services is expected along with greater user satisfaction. End user involvement should be included in exploratory and case studies covering any SC project phase, ranging from planning to the upgrading of solutions/applications.

As a smart people theme is not investigated in countries in the SEE region, multiple propositions have been generated as part of the third future research propositions' area. In spite of the overall citizen-centric agenda of smart cities, this study identified the underrepresentation of the individuals' perspective in the SC context. As SEE research lacks comprehensive and systematic studies of people's ICT competencies, proposition 5 explains its importance.

**Proposition 5**. Conducting a systematic review and research on the ICT competencies of people working and living in smart cities is necessary. The findings would drive faster implementation and adoption of final solutions, which would create more prosperous and beneficial effects on the quality of life of the citizens.

**Proposition 6**. Conducting an analysis of higher education institutions (HEI) and curriculum offered to foster digital literacy is necessary. It is necessary to examine the HEI curriculum in order to identify possible improvements, as students (despite their chosen major) and teachers should be able to use ICTs to find, use, create, and share information.

**Proposition 7**. An examination of skills and traits is needed for smart city managers and/or Chief Information officers (CIO) governing smart cities. It would also be very useful to see how many cities in the SEE region have this important work position installed in their city organisational structure and if the individuals in these positions are separately placed in an organisational structure or are heads of departments. It would be interesting to see if these departments are part of IT departments and strategy department or if they stand independently.

**Proposition 8**. Investigating the SC users' personal traits, education and understanding of SC will significantly affect the use and success of SCs.

Larger studies in smart cities should be conducted in order to see the profile of citizens using SC solutions, to identify the reasons and to drive such usage. The results could be used to identify part of population not using the solutions and at the same time to develop the measures that will encourage the rest of city population to join.

## 7. Conclusion

Aiming to present the current state of smart city research in Southeast Europe, this descriptive literature review followed a systematic process of searching, filtering, and classifying research papers (King & He, 2005). The researchers exploring different topics in the area of smart cities have shown significant interest in studying smart city governance and smart environment—approximately 54 % of the total papers that were selected and reviewed fall under the two smart city themes. The focus on governance can be explained with the top-down approach that local governments take up in introducing new city initiatives in the evolution towards smart cities. In the context of Croatia, when implementing smart city applications, strategic factors were noted as the most challenging ones in the long-run (Cukusic, Jadric, & Mijac, 2019). This observation is noted throughout the whole SEE region, where the importance of governance and e-government has been recognised for a while now and has been reflected in the increasing EDGI rankings. A strong focus on environmental topics by researchers from the SEE region is another understandable result that this review unravelled. Different forms of energy efficiency have been the subject of the studies in the past, although the focus has shifted slightly, especially now with the advancement of new technologies such as IoT and artificial intelligence (AI). The review clearly shows that there is a lack of papers focused on the smart economy and smart people. This presents a serious problem, as successful transformations into smart cities and research advances in this domain are not possible without people. There are numerous studies related to links between human capital and the economic potential; however, these are not tailored to smart city development requirements or the specificities of the region.

The mapping of the research studies to the PDCA cycle provides an important insight, as it outlines the state of the research advances in the region. The findings suggest that the scholarly research in SEE coped successfully with the initial planning stage and that pilot studies are progressing (34 %), but more advanced stages, such as those in which the results of pilot studies against the plans are checked and those in which the final solutions and corrections or the updates to final solutions are implemented, are of low appearance. More attention should be placed on obtaining the response from the stakeholders and into implementing complex, working solutions. The same conclusion is made in regards to the user involvement in the SC domain, as a very low percentage of research studies include and involve any type of end-user involvement, even though people should be in the centre of all initiatives and the topic of people in smart cities should be crucial (Albino et al., 2015; Chourabi et al., 2012).

This paper fills the gap in understanding the research advances in SEE related to smart cities. In the process, it became apparent that the region has not brought forth and analysed a significant number of successful implementation examples (either as a complete smart city solution or as different segments of it, i.e., smart city services). It was surprising, since the population of the region comprises almost 50 million people and the papers were searched and analysed for eight different countries, each having different (smart city) development strategies and policies. However, there might be more relevant studies and cases that were not included in this analysis, as only Scopus and the Web of Science databases were used as document sources. Therein is the important limitation of this study, as there is a possibility that relevant SC studies in the region were not indexed in these databases. In addition, the comparison between countries is limited to a single classification of the SC themes, while social, political and economic implications are not analysed in this research. In addition to tackling the social, political and economic differences and implications within and for the region in the future, another research direction can be to compare and test the differences between Eastern and Western Europe. The comparison could be made with respect to the analysis of the economic indicators in order to uncover the reasons for the differences in implementing and researching smart city initiatives. The studies presented in this review are focused on planning and implementing the pilot projects, while future studies should focus on examining the data generated by pilot solutions and particularly by the users (citizens). Another important future research proposition refers to conducting a systematic review and research around the ICT competencies of people working and living in smart cities. The findings would drive a faster implementation and adoption of final solutions, which would lead to more prosperous and beneficial effects on the quality of life of the citizens in smart cities.

## Declarations of interest

None.

## CRediT authorship contribution statement

**Ivana Ninčević Pašalić:** Conceptualization, Methodology, Investigation, Data curation, Writing - original draft, Writing - review & editing. **Maja Ćukušić:** Conceptualization, Methodology, Investigation, Writing - review & editing, Supervision. **Mario Jadrić:** Conceptualization, Methodology, Investigation, Writing - review & editing.

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