The role of sustainability in the relationship between migration and smart cities: A bibliometric review

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Abstract:

Purpose: Smart cities attract efficient and profitable economic activities, contribute to the societal welfare of their citizens, and foster the efficient use and conservation of natural resources. Developing smart cities has become a priority for many developed countries but, since they are preferred destinations for migrants, this raises sustainability issues. They attract people who are seeking a better quality of life, smart services and solutions, a better environment and business activities. The purpose of this article is to review the state of the art on the relationship between smart cities and migration, with a view to determining sustainability.

Design/methodology/approach: A bibliometric review and text mining analyses were conducted on publications between 2000 and 2019.

Findings: The results determine the main parameters of this research topic in terms of its growth, top journals, and articles. The role of sustainability in the relationship between smart cities and migration is also identified, highlighting the special interest of its social dimension.

Originality: A bibliometric approach has not previously used to investigate the link between smart cities and migration. However, given the current relevance of both phenomena, their emergence and growth, this approach is appropriate in determining the state of the art and its main descriptors, with special emphasis on the sustainability implications.

Keywords: sustainability; smart cities; migration; bibliometric review; text mining.

Article classification: Review. Literature review.

1. Introduction

The emergence of phenomena such as urbanization and the digital revolution, together with the increasing importance of sustainability, has led governments and cities planners in several countries to transform major cities by offering better services and living conditions to their residents and visitors.

Over the last decade, this transformation of urban areas has evolved from solely focusing on technology development, to incorporating new perspectives such as improving service delivery for urban residents and offering a better quality of life through adoption of new technologies, thus fostering the emerging concept of the smart city (Visvizi and Lytras, 2018).

In general, smart cities are described as innovative cities that rely primarily on information and communication technologies to improve the efficiency of urban services and operations, competitiveness, and quality of life, while guaranteeing the economic, social and environmental needs of present and future generations (ITU, 2016). Within this, what Elkington (Elkington, 1998) describes as the triple bottom line of sustainability emerges, these being i) social equity in all aspects relating to people, societal welfare and individual well-being ii) environmental integrity for aspects relating to the planet and the efficient use and conservation of its natural resources and iii) economic prosperity for those aspects related to the long term effectiveness and profitability of companies.

Accordingly, smart cities have received considerable attention in recent years for their ability to attract investment, enhance economic growth, and improve sustainability. They provide safer places with better services, an innovative environment that facilitates creative solutions, thus creating more jobs and reducing inequality. Smart cities contribute to a powerful cycle that not only provides social and economic wellbeing but also ensures the proper usage of resources to secure the quality of life in the long term (World Bank, 2017). Consequently, smart cities have become powerful destinations that attract people to live there, in search of present and future social, ecological, and economic benefits.

Research that relates smart cities and migration is still in its early stages, and there are no bibliometric or text mining studies covering the characteristics and growth of publications in the field. Only two bibliometric pieces of research cover smart cities and international migration, but not their relationship (Hassan et al., 2019; Li, 2019). Given the current relevance of these phenomena and their emergence and growth, especially in the social and economic sphere, a significant number of studies have started to appear, which suggests the main aim of this study, that of bibliometric research.

Bibliometric research and "science mapping" analyses and visualizes i) bibliometric networks conducted on a specific field (Hérubel, 1999), ii) the main contributions of previous studies and iii) the principal themes in case of new topics (Gonzales-Bustos and Hernández-Lara, 2016). In the research that analyses the links between smart cities and migration, the role of sustainability emerges as a cornerstone, because it is one of the factors that explain why migrants move to smart cities and can itself be affected by migrant movements. Thus, how to deal with the effect of migration emerges as a key challenge for smart cities to assure their sustainability dimensions.

The present study aims to provide a bibliometric review of the publications that address smart cities and migration in addition to their relationship with sustainability. We respond specifically to two bibliometric research questions:

- What are the main descriptors of the research on smart cities and migration, in terms of growth, top journals, and publications in the field?
- What is the role of sustainability in the relationship between smart cities and migration?

This bibliometric review contributes from an academic and practical perspective, determining the state of the art on the topic and its main descriptors, the relevance of sustainability issues among the most frequent keywords and topics discussed, the dimensions of sustainability that have attracted the most attention (as well as those that remain unexplored), to point out future research directions and make recommendations mainly intended for researchers.

2. Smart Cities and Migration: Sustainability Issues in Focus

As yet, there is little agreement on the definition of smart cities. They are described by some scholars as "intelligent cities", "digital cities", or "ubiquitous cities", since there is no clear description and perception of their meaning (Angelidou, 2015; Caragliu et al., 2011; Chourabi et al., 2012; Hollands, 2008; Marsal-Llacuna et al., 2015; Navarro et al., 2017).

Most of the definitions of smart cities include the notion of relying on information and communication technology to improve infrastructure operations, and proper and effective communication between business organizations, institutions, and individuals. To these, they add the role of public government, and environmental issues, such as waste management and energy production.

In general terms, cities are geographical areas that facilitate communication and exchange between a range of societal stakeholders (Zhuhadar et al., 2017). As cities grow over time and increase in area and population, they turn into megacities that are described as urban agglomerations. Urban agglomerations are characterized by a continuous built environment, having one or several city centres and sub-urban areas, connected economically and functionally, and inhabited by millions of people (Safari et al., 2016). During their development and growth, they may encounter risks, but also challenges and opportunities that should be addressed to avoid losing attractiveness for citizens and investors (Kemeny and Cooke, 2017; Visvizi et al., 2017; Visvizi and Lytras, 2018). Accordingly, the role of turning urban cities into smart cities lies in the territory of public government, and its capacity and ability to influence and drive smart city implementation based on the creation of public infrastructure (Dameri, 2013).

Dameri (2013) underlined four components of smart cities; including the land or geographical area where the projects are proposed; the citizens to whom the smart initiatives are addressed; the technologies required to realize quality infrastructure, services, and governance processes; and the government or public powers to rule the public space (Dameri, 2013). This author also concluded that the confusion in the notion of smart cities comes from its nature, as a bottom-up phenomenon, which begins with the application of technology to urban problems, linking different actors in the urban arena. Among these, universities, research institutions and hi-tech companies are especially relevant actors since they work to produce projects and initiatives that implement smart solutions in these cities. However, these projects must be part of a comprehensive smart city vision developed by the city government, whose crucial activity is to facilitate the success of smart initiatives, focusing individual activities towards a common vision and goal, with citizens in the heart of the whole phenomenon.

Similarly, Angelidou (Angelidou, 2015), describes smart cities as the utilization of human and technological capital to conceptualize and develop urban models, emphasizing the role of information and communication technologies to achieve effectiveness, competitiveness, and prosperity. Marsal-Llacuna, Colomer-Llinàs and Meléndez-Frigola (Marsal-Llacuna et al., 2015) underline the relevance of information technologies in enhancing urban performance, monitoring and enhancing infrastructure, increasing collaboration and cohesiveness between varied economic and productive actors, encouraging private and public sector businesses innovation, and providing efficient services to city residents. Navarro, Ruiz and Peña (Navarro et al., 2017) consider two main dimensions of the notion of smart city, the "urban future" dimension associated with the impact of new technologies in advancing the city development in the long term and, on the other hand, the "knowledge and innovation economy" dimension focused on knowledge management in the city's framework. Hollands (Hollands, 2008) stresses the role of human capital and citizens rather than believing that only technology can transform normal cities into smart cities. He remarks that such cities are communities that enhance the quality of life, business prosperity, and government efficiency, by harnessing technology to transform services and physical systems. Therefore, a smart city entails more than automation fostered by new technologies, it also entails linking varied networks and systems, to gather data and provide the information necessary for the transformation (Hariharan, 2016). To achieve the best outcome, in addition to investing in information and

communication technologies, investments in social and human capital are essential for assuring sustainable economic growth and a high quality of life (Caragliu et al., 2011).

Even given these definitions, the notion of a smart city is not yet clear, since there are overlaps between similar concepts (for example, between megacities and smart cities), whose definitions conceptually complement each other. The debates on megacities stressed the existence of infrastructure planning, services for inhabitants, and government policies, strategies, and decisions that aid in overcoming threats and challenges, including unattractiveness to citizens and investors (Dameri, 2013; Meerow, 2017). The smart cities debate, however, stressed the role of information and communication technologies in overcoming challenges and generating added value through services for citizens, businesses, and institutions relying on well-established infrastructures, smart citizens, and government decisions (Angelidou, 2015; Khatoun and Zeadally, 2016). The conceptual relationship between the two was addressed by Visvizi and Lytras (2018); who underlined that megacities seek efficiency and growth of urban areas by focusing on infrastructure design and planning, while smart cities seek sustainability and citizens well-being by focusing on information and communication technology enablers.

What is certain is the continuous movement of people towards cities generates increasing urban problems such as traffic congestion, waste management, pollution, and poverty (Caragliu et al., 2011). Smart cities are no exception and globally there is an increasing shift towards smart cities. According to the Networked Society City Index (Ericsson, 2016), European cities recognized as connected and cohesive cities for sustainable development include, among others, London, Paris, Reykjavík, Amsterdam, Berlin, Copenhagen, Stockholm, Vienna, Helsinki, Rome and Oslo. In the United States of America, even before the notion of smart cities became trendy, cities such as San Francisco, San Diego and New York City were recognized for their highly developed information technologies (Hollands, 2008). In Asia, China has a plan to develop 277 smart cities (Riva Sanseverino et al., 2018), while India plans to develop 100 (Pathak, 2020). Arab countries, such as Qatar and the United Arab of Emirates are following the same path (Virtudes et al., 2017).

In this global trend towards the creation of smart cities, a well-known example is that of the city of Barcelona. In 2011, the city council launched an advanced and innovative information technology strategy, aimed at improving social welfare and economic growth through improved operations and management of the city. Seven years later, in 2018, the number of tourists in Barcelona reached more than 19 million, an increase of 8 million from 1990 (Forte, 2020). Additionally, in 2017, the information and communication sector generated 8.1% of gross added value in Barcelona, ranking it among the fifteen top cities in the world in terms of its digital equipment, technological maturity, social cohesion, and institutions focused on sustainable development goals (Barcelona City Council, 2018).

These examples signal smart cities as being powerful attractors of investment, development based on technology, social wellness, wealth generation engines, and loci for attracting visitors and new residents.

One of the phenomena associated with the rise of smart cities is their influence on migration, in which people move to settle temporarily or permanently in a new country or region. Indeed, internal and international migration to cities started long before the emergence of the smart city concept. Reports from the Organization for Economic Co-operation and Development (OECD) indicate that, in 2018, permanent migration flows to the OECD countries rose by 2% which represents 5.3 million permanent migrants. In 2017, an additional 4.9 million workers migrated to these countries through temporary migration programs. Smart cities are mostly located in the developed countries. The phenomenon of migration especially impacts cities and urban areas in which, according to World Bank data, 54% of the world's population is already concentrated, this being expected to increase by 50% (6 billion people) by 2045 (Ritchie and Roser, 2020).

Developing smart cities is a key to offering a better quality of life, raising investor's interest, and ensuring sustainability. But do smart cities attract more people than other cities? There used to be no clear answer to this question. Figure 1 offers data that at least exhibit the relevance of smart cities as attractors of migrants. It derives from the top 27 world smart cities rank provided by Joss et al. (2019)—this being based on 10 dimensions of smart cities migration data (IOM, 2019; MDP, 2019;

OECD, 2020; UN DESA, 2019). Four indicators were utilized to assess migration to smart cities—those were the percentage of international immigrants in the total population, the total immigrant population within the country, the population residing in urban areas, and the foreign-born percentage within a smart city. Since there are no data available for internal migrants, international data and foreign-born population within the same country and city were utilized. For example, in 2019, 43.2% of foreign-based immigrants were registered in Berlin, while Germany reported 15.7% of immigrants in its total population. Similarly, it is estimated that almost half of foreign-born immigrants who moved to Denmark are living in Copenhagen, while only 12.5% of the total population of Denmark are international immigrants. From this, it is concluded that the mean percentage of international migration in the countries included in this study is 16.75%, while the mean percentage of foreign-born population within their smart cities is 39.36%, signalling the relevance of smart cities for attracting foreign migrants.

Insert Figure 1

The confluence of the two phenomena gives rise to a need for research to understand the determinants and consequences of the relationship between smart cities and migration, and several studies have analysed these links. Some of these, address the city profile as a reason for migration, and the smart city's role in relation to the consequences of these migrant movements. Good examples are the studies of Alakshendra (Alakshendra, 2019) on the profile of Patna in India, and Todd (Todd et al., 2019) on Dar al Salam in Tanzania, both being cities with a smart city mission or programs. These studies discuss how a city's development and policy initiatives deal with the expansion in infrastructure and services to accommodate the influx of people.

Some studies address the migration of youth to smart cities (Suciu and Florea, 2017; Contreras Pinochet *et al.*, 2019), analysing the main attractive attributes and the perceived value of these attributes. Specifically, the study of Suciu and Florea (Suciu and Florea, 2017) on Romanian migrant youth concludes that the main attractions are the acquisition of more skills, knowledge, education and core competencies. The study of Pinochet et al. (Contreras Pinochet et al., 2019) discusses the perceived values that lead young people to migrate to smart cities, finding that traits such as smart economy, smart mobility, smart environment, smart governance, smart living, and smart people, significantly affect the perceived usefulness of these locations and act as attractors for relocation.

Other scholars discuss why smart cities attract qualified workers and the factors that affect their migration (Betz et al., 2016; Buch et al., 2017; Zheng, 2016). For example, the study of Betz, Partridge and Fallah (Betz et al., 2016) find that qualified workers are attracted to denser labour markets to cope with an increasing labour market uncertainty. They also highlight the influence of the growth of smart industries for attracting highly educated workers, although this effect is not constant over time. Likewise, Buch et al. (Buch et al., 2017) and Zheng (Zheng, 2016) underline the influence, not just of labour market conditions, but also of city amenities in attracting highly educated people, these attractors differing for highly qualified workers as opposed to the rest of the workforce. These scholars highlight the positive influence of some traits of smart cities and their attraction for qualified workers, such as wage levels, employment growth, business environments, availability of advanced infrastructure, but also lower population density, more educated and racially diverse residents, lower inequality, or cultural diversity.

From the analysis of previous research, it can be concluded that the role of sustainability in the relationship between smart cities and migration needs further attention because sustainability is at the very core of the notion of smart cities and generates an open debate about how to deal with the effects of their strong attraction for migrants. This study conducts a bibliometric review and text mining analysis on studies that link smart cities and migration, not addressed by previous research, in order to map the field, determine its main descriptors, as well as the role of sustainability in the relationship between smart cities and migration.

3. Methodology

We followed the review methodology proposed by Tranfield et al. (Tranfield et al., 2003) in the management field based on the phases of planning, conducting, and reporting the results in a systematic review. Due to their relevance as academic bibliographic databases, we used the WOS (Thomson Reuters) and Scopus (Elsevier) platforms to extract the data. In WOS, the research categories were limited to educational research, economics, management, social sciences, political science, and public administration. In Scopus, the subject areas were limited to social sciences, business, and economics.

In both platforms, the query "smart city" or "smart cities" and "migration" (or related forms) was carried out on the topic. We used this option instead of the title or keywords to broaden the search and include the highest number of related documents.

As result of the search, 53 articles from Scopus and 24 articles from WOS were retrieved, the first article on the topic being published in 2007.

In the first stage, each publication retrieved from either database was treated separately to identify its main bibliographic information, such as authorship, citations, publishing journals, keywords, research topics, and main contents. In the second stage, we aimed to correct discrepancies and standardize entries between the WOS and Scopus platforms which could affect the outcome of the results. In the third stage, fine-tuning of the data was conducted; 18 Scopus and 3 WOS articles were excluded from the database as not meeting the research indicator criteria. It was also noticed that 8 articles were included in both WOS and Scopus. Those were named as common articles and treated separately and analysed once to avoid duplication. After these modifications, the final number of articles subject to study was 48, 13 exclusively WOS articles, 27 exclusively Scopus articles, and 8 common articles. At the last stage, only articles meeting the research criteria were extracted to create the bibliometric network analysed using the VOSViewer software. This software allows bibliometric and distance base visualizations to be created from the extracted files (van Eck and Waltman, 2019).

3. Bibliometric analyses: Results and Discussion

3.1. Main descriptors of the research topic: Evolution, top journals, and articles

The first article analysing the relationship between smart cities and migration was published in the "Architektura A Urbanizmus" journal by Moučka in 2007 (Moučka, 2007). However, as can be seen from Figure 2, the topic did not become significant until 2016, when many countries around the world initiated plans and actions to develop smart cities. The number of publications increased from an average of 2 publications (4.17%) per year between 2011 and 2015 to an average of 9 (18.75%) in 2016 and 2017. In 2019, the publications on this topic increased to 15 (31.5%). In addition, whereas half of the publications in 2016 were conference papers, which is related to the novelty of the topic, and the emergence of conferences as precursors of future interest by academic journals, in 2019 most of the publications were already peer-reviewed journal articles.

Insert Figure 2

Regarding the top journals published in this field, "Urban Book Series" had the highest number of publications (three), although their impact was low (only three citations). Three other journals, as shown in Table 1, received a much highest number of citations, despite having each only published two papers on the topic. They are "Journal of Regional Science", whose articles received the highest number of citations (277), followed by "Papers in Regional Sciences" with 36 citations and "Journal of Science and Technology Policy Management" with 35 citations.

Insert Table 1

The analyses of the six most cited articles are given in Table 2. At the top of the list, the article entitled "Why Are Smart Cities Growing? Who Moves and Who Stays", published by Winters in 2011

(Winters, 2011a), headed the list. This article is indexed in both platforms and received 127 citations on Scopus, an average of 14.11 citations per year, and 122 citations on WOS with an average of 13.55 citations per year. It was published in the "Journal of Regional Science" and discussed the reasons for migration to smart cities establishing that, in the first place, migration occurs due to student enrolment in higher education programs, and afterwards, that those students usually stay on after completing their studies. The second article of Visvizi and Lytras (Visvizi and Lytras, 2018) entitled "Rescaling and Refocusing Smart Cities Research: From Megacities to Smart Villages", published in the "Journal of Science and Technology Policy Management" received 127 citations in less than two years and discussed smart cities at three levels namely: macro, mezzo, and micro. In 2017, Yassine, Singh and Alamri (Yassine et al., 2017) published an article entitled "Mining Human Activity Patterns from Smart Home Big Data for Health Care Applications", where they established that migration is increasing in smart cities, and smart homes are becoming a valuable source of data that could be used to enhance services. The authors proposed a model that utilizes smart home data to analyse and discover human activity patterns for health care applications. This article received 65 citations in two years, and it was published in the "IEEE Access" journal (Table 2).

The remaining papers in the field received significantly fewer citations—they mostly explored the reasons why smart cities attract knowledge workers (Betz et al., 2016; Miguelez and Moreno, 2014) and the migration-related challenges and opportunities for cities and urban systems motivated by irregular migratory flows generated by unplanned circumstances such as the movement of refugees (Visvizi et al., 2017).

Insert Table 2

These analyses and the bibliometric information retrieved do not, however, allow us to determine the role of sustainability in the relationship between smart cities and migration. Further bibliometric analyses and text mining analyses on the keywords and most discussed topics are necessary to respond to our second research question.

3.2. The role of sustainability in the relationship between smart cities and migration

Additional bibliometric and text data analyses allow us to determine the most frequent keywords and their length strength. This information determines the most frequently occurring topics in the field, which is helpful in determining if sustainability is included among them. Table 3 shows the results.

Insert Table 3

WOS papers used 40 keywords, 25 (60.9%) appeared more than once, while in the Scopus database we found 49 keywords, 37 of which appeared more than once (74.5%). More specifically, as Table 4 shows, in WOS only 10 keywords appeared more than twice (24.4%), 7 more than three times (17.07%), and 3 five times or more (7.32%). In Scopus, 15 keywords appeared more than twice (32%), 7 more than three times (14%), and 5 keywords five times or more (1%). These results confirm the variety of keywords, but also the sparsity of the most frequent ones, the publications thus using multiple and varied keywords with low repetition. This trait is to be expected in new lines of research where different topics are being explored and there are not yet mature or consolidated topics.

The analysis of the occurrences of the most frequent keywords shows that smart cities, migration, productivity, amenities, creative class, United States, and sustainable development were the most frequent keywords in WOS. In regard to Scopus, there is some repetition, smart cities or smart city being the most frequent topics, followed by urban growth and planning, urbanization, climate change, urban population, energy utilization, India, the Internet of things, population growth, urban areas and development, waste management and smart power grids.

Among the major keyword occurrences, aspects related to sustainability issues emerge in both WOS and Scopus. This is the case for terms like sustainable development, energy utilization, waste management or smart power. The inclusion of these terms among the most frequent keywords highlights the relevance of the environmental dimension of sustainability and the relevance of

management and development plans for a sustainable approach in the relationship between smart cities and migration.

Table 4 also shows the total link strength of the keywords. This indicates the number of links of an item with other ones and the total strength of the links of an item with other items (Niñerola et al., 2019), which points to the relevance of a keyword in the field, a higher value meaning that it has been frequently linked with others. VOSViewer was used to represent the keyword network as shown in Figure 3. We restricted the VOSViewer algorithm to a minimum number of 2 occurrences of a keyword. The size of the nodes and words represents the weight of the keywords, i.e. their occurrences. The distance between two nodes reflects the strength of the relationship between them; a shorter distance implies a stronger relationship. The network connections show the keywords that appear together more frequently; a line between two keywords indicates their co-occurrence. The thicker the line is, the greater the co-occurrence frequency.

Insert Figure 3

In the WOS network, 4 clusters were created, the biggest nodes in the third and fourth cluster appearing for the smart cities and migration keywords. In the fourth cluster, the smart cities keyword is connected to the keywords "sustainable development" and "model". In the third cluster, the migration keyword is mostly linked to productivity and quality of life. These keywords appear, after the migration node, as having the biggest nodes in this cluster. The second cluster included keywords such as college, human capital, and graduate migration, connected with almost the same size. Finally, the first cluster included the creative class keyword as the centre node and was connected to amenities, economic growth, cross-section, and education, while internal migration was connected to education and internal migration. For the Scopus network, the first cluster included only the skilled labour and human capital keywords. The second cluster included smart city as the biggest node connected to urbanization, sustainability, urban planning, and climate change, among other topics. The third cluster included also smart cities connected to waste management, economic and social aspects, as well as the information and data management items. Finally, the fourth cluster included keywords related mostly to smart management of power and energy.

From the analysis of the keywords network, it can be concluded that the literature shows that there is a strong connection between the two phenomena under study, smart cities and migration. Also, the relationship of sustainability and smart cities is clear and keywords related to both co-occur frequently, pointing to the relevance of the notion of sustainability in the very concept of the smart city (Marsal-Llacuna et al., 2015; Navarro et al., 2017), as well as the impact of urban management planning for attaining sustainability objectives (Butsch et al., 2017; Marsal-Llacuna et al., 2015; Pollalis, 2016; Yigitcanlar and Kamruzzaman, 2015). Smart cities are also connected with different dimensions of sustainability, for example with the ecological and environmental dimension (Akcin et al., 2016; Alagoz et al., 2016; de Amorim et al., 2019; Hernandez Uribe et al., 2015; Maksimovic, 2019; Santhiyakumari et al., 2017; Turkane et al., 2019), as is evident from the frequency of keywords related to waste management, smart power, energy consumption, etc. In addition, economic and social values appear in the keywords network analysis and constitute relevant aspects related to smart cities (Hariharan, 2016), which highlights the relevance of social dimensions such as the happiness and wellbeing of the population (Visvizi and Lytras, 2020), safety (Visvizi and Lytras, 2020), government issues (Tan and Taeihagh, 2020; Yigitcanlar and Kamruzzaman, 2015), and economic aspects like, for example, entrepreneurship (Hollands, 2008). In the research on smart cities and migration, the focus on migration mostly highlights economically sustainable aspects such as those related to the attraction of educated and high skills workers and human capital (Betz et al., 2016; Buch et al., 2017; Chen and Rosenthal, 2008; Miguelez and Moreno, 2014).

Besides the bibliometric analyses carried out on the keywords, some text mining analyses were conducted on the most discussed topics. To do so, the content of each paper was examined to identify the topics, the different categories under consideration were as shown in Table 4.

Insert Table 4

Seven topics attracted the most research attention in terms of the number of publications. These were “Planning for smart cities”, “City development and infrastructure projects”, “Smart city and development opportunities”, “Educated workers migration”, “Electrical efficiency”, “Technological services” and “Waste management”. The topic “Planning for smart cities” was at the top of the list with eight (18%) publications, although they received only 19 citations. However, they all are quite recent publications, which determines that this can be considered a "hot" topic in current research. These articles discussed the plans in smart cities before or during the establishment of this label. Other topics such as “Educated workers migration”, “Reasons for migration” and “Smart cities and health care from data”, appeared in a lower number of publications, but nevertheless were significant for research given their high number of citations, 64 (10.66 citations per year), 249 (27.66 citations per year) and 65 (21.66 citations per year), respectively. It should be noted that none of the publications addressed as main topics the effect of smart cities on businesses and societies, effectiveness and efficiency of organizations, and migrant's perception of, or integration in, smart cities.

The connection of sustainability and smart cities is evident since they are also known as "sustainable cities" (Tan and Taeihagh, 2020). Sustainability in smart cities entails a transportation infrastructure, water and waste management, green spaces, energy, and food (Pollalis, 2016; Yigitcanlar and Kamruzzaman, 2015), as well as citizen's security, well-being, safety and happiness (Visvizi and Lytras, 2020). So, different aspects of the triple bottom line of sustainability (Elkington, 1998; Wheelen et al., 2017) emerge when studying the relationship of smart cities and migration. We conducted an analysis to determine the relevance of each of the three economic, societal, and environmental attributes.

Insert Table 5

As Table 5 shows, most of the publications on smart cities and migration addressed one or more attribute of the sustainability bottom lines. The social dimension was addressed the most, and appeared 44 times (90%) in publications, followed by the economic and ecological dimensions of sustainability with 25 publications each (52%).

5. Conclusions

Although many smart cities are being developed around the world, and the migration towards these cities have increased in the last decade, research on smart cities and migration is still in its early stages and needs further development. This article aims at providing a bibliometric review and text mining analysis on smart cities and migration and has two main objectives. Firstly, this research outlines what has been done so far by identifying the evolution of the topic, the main journals, and the most relevant and cited articles. Secondly, our research sheds some light on the most frequent keywords and discussed topics, thus determining the role of sustainability in the field, pointing out its relevance and the specific dimensions of sustainability addressed by the research on smart cities and migration. The purpose of this review is to identify the principal themes in this new topic, and the role of sustainability as an implicit factor within the concept of a smart city. We also identify the connections between sustainability and the migration phenomenon, a smart city being an attractor of migrants, and the effects on sustainability of massive population movements.

Our results on the main descriptors of the topic confirm its novelty, the first research on smart cities and migration appearing in 2007 (Moučka, 2007), and the still scarce but growing attention that it is raising among scholars, as evidenced by the doubling of the number of papers in 2019 over previous years. There are still few academic journals that have shown a clear interest in this topic, which is another sign of its novelty—until 2016 most of the publications were in conference proceedings rather than academic journals. This situation is now changing, especially in research areas related to regional science, urban policy, and technology. Despite there being relatively little work in the field, some scholars are beginning to be recognized for their contributions, especially those investigating the main reasons that explain the attraction of smart cities for a valuable human capital workforce (Winters, 2011a; Miguelez and Moreno, 2014; Betz, Partridge and Fallah, 2016).

Our results on the most frequent keywords and topics discussed also highlight the relevance of sustainability to the relationship between smart cities and migration, this being implicit within the concept of smart city (Marsal-Llacuna et al., 2015; Navarro et al., 2017). The findings show that the literature emphasises the impact of urban management planning on achieving sustainability objectives (Butsch et al., 2017; Marsal-Llacuna et al., 2015; Pollalis, 2016; Yigitcanlar and Kamruzzaman, 2015), as well as the connection of smart cities with different dimensions of sustainability: the ecological dimension (Akcin et al., 2016; Alagoz et al., 2016; de Amorim et al., 2019; Hernandez Uribe et al., 2015; Maksimovic, 2019; Santhiyakumari et al., 2017; Turkane et al., 2019), with the emergence of frequent topics like waste and energy management; the social dimension, with topics like happiness and wellbeing of the population (Visvizi and Lytras, 2020), safety (Visvizi and Lytras, 2020), or government issues (Tan and Taeihagh, 2020; Yigitcanlar and Kamruzzaman, 2015); and the economic dimension with analyses on organizational innovation and entrepreneurship (Hollands, 2008). Considering the relevance of the three dimensions or attributes of the triple bottom line of sustainability, the importance of the social dimension is clear from the number of academic works that have included it in their analyses.

This study has certain limitations. The bibliometric review has allowed us to determine the main themes of this novel topic, applying a systematic perspective that points out the bibliometric networks in the field. However, this review could be complemented with a content review that would allow us to better determine the main debates occurring in the field, the emergent challenges, and the discussion around them. The novelty of this research topic and its expected growth would also suggest repeating systematic reviews in the future to provide a more holistic picture of its evolution.

As migration is expected to increase in the coming years, studying and prioritizing problems that affect people, the planet, and organizations' profitability are essential in benchmarking and developing solutions for the future, including those applicable to smart cities. Our study seeks to contribute from an academic perspective, determining the state of the art in the topic and its main descriptors, the relevance of sustainability issues, and the dimensions of sustainability that have attracted most attention (and indeed those still unexplored), in order to underline future research directions. Specifically, new studies should address how to encourage sustainability and sustainable practices in smart cities. The focus until now has been mostly on the social aspects, but the ecological and economic dimensions are also important and have been less analysed. Another interesting topic that remains mostly unexplored is related to the role of the different actors and stakeholders. As Dameri stated (Dameri, 2013), high technology and academic institutions are the main actors in the smart city model. The first is proactive in introducing innovative smart products and services to enhance citizens' well-being and serves their self-interest and goals. However, academic institutions and researchers are still to some extent reactive, their approach to smart cities research has not transcended the generic (i.e. waste management, pollution, workers migration, city development, etc.), and is frequently linked to the broader concept of the smart city, but remains unempirical and non-quantifiable in terms of the effect on ecological, economic and social dimensions. Social science and business researchers should address this topic with data-based studies on the impact of smart cities on organizational performance, and the effects of that on the social, ecological, and economic dimensions of sustainability.

Besides companies and research institutions, citizens and government constitute the intellectual backbone of smart city development. They play a role in developing cities and applying sustainable practices that reflect positive results on the above dimensions. Taking into account the cultural and economic characteristics of urban and suburban areas academic researchers should play a role in bridging the gaps between these two parties, by playing a mediating role in understanding citizens' needs in cities, at the micro, macro and mezzo levels, and reflecting the intentions of practitioners and governmental authorities on smart initiatives and supporting policies. Thus, academic institutions should strive to make this vision more concrete and to identify outcomes involving the needs, rights, duties, and scope of all actors and stakeholders, and the effects of their implementation on Society, the Economy, and the Environment.

To date, these issues have hardly been analysed—in our opinion, they constitute the future of this field of research.

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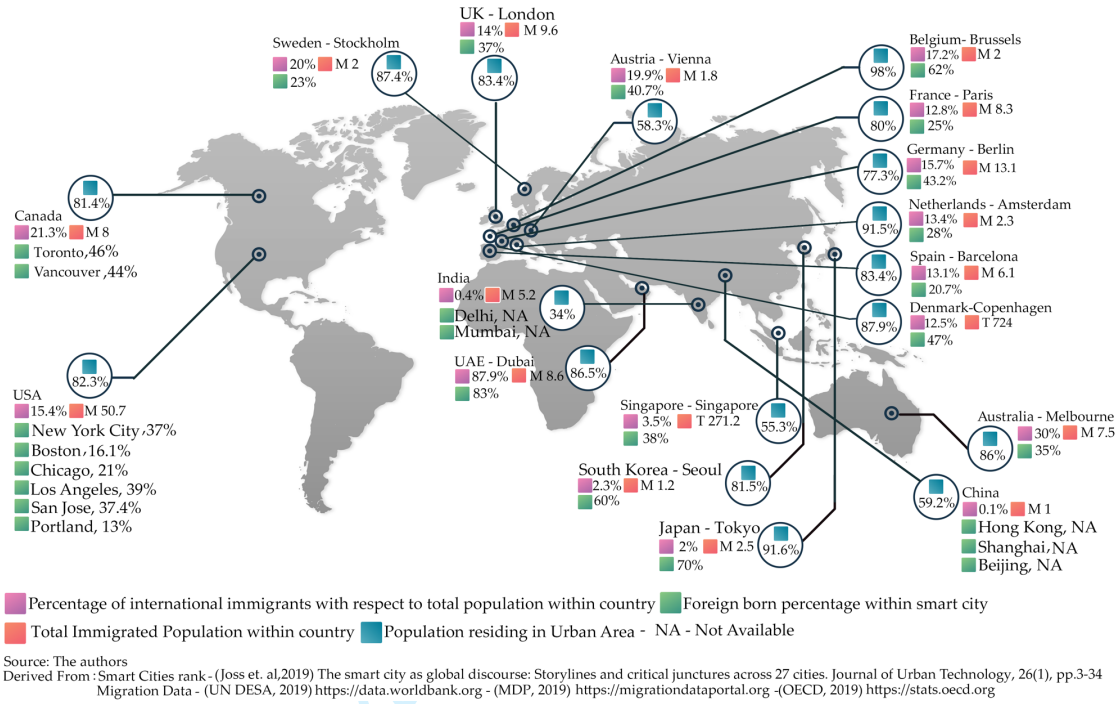
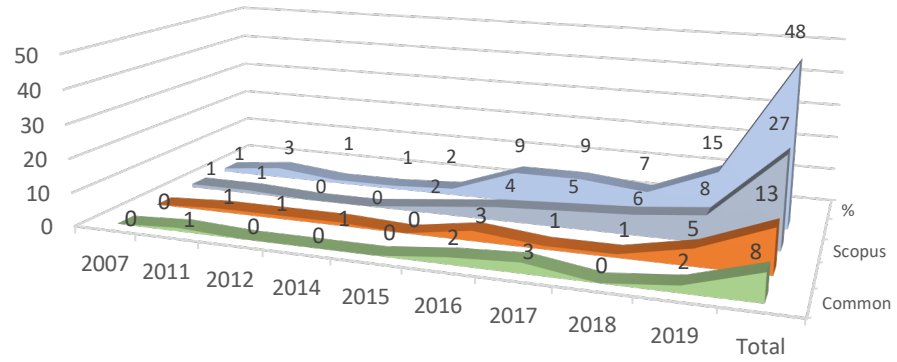


Source: The authors
Derived From : Smart Cities rank - (Joss et. al,2019) The smart city as global discourse: Storylines and critical junctures across 27 cities. Journal of Urban Technology, 26(1), pp.3-34
Migration Data - (UN DESA, 2019) https://data.worldbank.org - (MDP, 2019) https://migrationdataportal.org -(OECD, 2019) https://stats.oecd.org

Figure 1. Facts on smart cities and migration



	2007	2011	2012	2014	2015	2016	2017	2018	2019	Total
Common	0	1	0	0	0	2	3	0	2	8
WOS	0	1	1	1	0	3	1	1	5	13
Scopus	1	1	0	0	2	4	5	6	8	27
Total/ Year	1	3	1	1	2	9	9	7	15	48
%	2,08%	6,25%	2,08%	2,08%	4,17%	18,75%	18,75%	14,58%	31,25%	100,00%

Figure 2. Evolution of research on smart cities and migration

Table 1. Top publishing journals in the field.

Journal name	Articles	Citations
Urban Book Series	3	3
Journal of Regional Science	2	277
Papers in Regional Sciences	2	36
Journal of Science and Technology Policy Management	2	35

Table 2. Most cited articles.

Article	Authors and Year	Journal	Bibliometric information
Why Are Smart Cities Growing? Who Moves and Who Stays?	(Winters, 2011a)	Journal of Regional Science	Scopus 127 citations Q1 IF: 1.43 CPY: 14.11 WOS 122 citations Q2 IF: 2.83 CPY: 13.55
Rescaling and refocusing smart cities research: from mega cities to smart villages	(Visvizi and Lytras, 2018)	Journal of Science and Technology Policy Management	Scopus 73 citations Q3 IF: 0.3 CPY: 73 WOS 54 citations Journal Not Ranked In WOS
Mining Human Activity Patterns from Smart Home Big Data for Health Care Applications	(Yassine et al., 2017)	IEEE Access	Scopus 65 citations Q1 IF: 0.6 CPY: 21.66
What Attracts Knowledge Workers? The Role of Space and Social Networks	(Miguelez and Moreno, 2014)	Journal of Regional Science	WOS 28 citations Q2 IF: 2.38 CPY: 4.66 Scopus 31 citations Q1 IF:1.4 CPY:5.16
Smart Cities and Attracting Knowledge Workers: Which Cities Attract Highly Educated Workers in the 21ª Century?	(Betz et al., 2016)	Papers in Regional Science	Scopus 15 citations Q1 IF: 1.19 CPY: 3.75 WOS 10 citations Q2 IF: 1.99 CPY: 2.5
Irregular Migratory Flows: Towards an ICTs" Enabled Integrated Framework for Resilient Urban Systems	(Visvizi et al., 2017)	Journal of Science and Technology Policy Management	Scopus 20 citations Q3 IF: 0.305 CPY: 6.66 WOS 15 citations Q: NR IF: NR CPY: 5
Human Capital and Population Growth in Nonmetropolitan Us Counties: The Importance of College Student Migration	(Winters, 2011b)	Economic Development Quarterly	WOS 15 citations Q3 IF: 1.77 CPY: 1.66

Q refers to journal quartile - IF: Journal Impact factor - CPY: Citation Per Year – NR: Not Reported.

Table 3. Keyword co-occurrence.

WOS			Scopus		
Keyword	**Occurrence**	**Link Strength**	**Keyword**	**Occurrence**	**Link Strength**
Smart Cities	10	30	Smart Cities	10	36
Migration	9	52	Smart City	10	42
Productivity	5	33	Urban Growth	5	28
Amenities	4	26	Urban Planning	5	27
Creative Class	4	22	Urbanization	5	19
United-States	4	28	Climate Change	4	25
Sustainable Development	4	13	Urban Population	4	12
Economic-Growth	3	23	Energy Utilization	3	13
Growth	3	12	India	3	21
Quality-Of-Life	3	18	Internet of Things	3	5
Cities	2	8	Population Growth	3	16
City	2	13	Urban Areas	3	12
College	2	19	Urban Development	3	21
Cross-Section	2	18	Waste Management	3	13
Education	2	15	Smart Power Grids	3	12
Graduate Migration	2	19	Big Data	2	9
Human Capital	2	19	Economic and Social Effects	2	6
Impact	2	5	Economics	2	4
Internal Migration	2	17	Electric Power Transmission Networks	2	9
Localization	2	13	Energy Efficiency	2	9
Model	2	3	Future Challenges	2	7
Preferences	2	11	Governance Approach	2	17
Technology	2	12	Human Capital	2	5
Universities	2	13	Information and Communication Technologies	2	7
Urbanization	2	5	Population Statistics	2	9
Sustainability	1	4	Pune	2	11
Immigration	1	4	Resilience	2	5
Internal Migration	1	3	Rural-Urban Migration	2	12
Migration and Refugee Crises	1	5	Skilled Labour	2	5
Migration Choice Model	1	3	Sustainability	2	17
City Amenities	1	3	Traffic Congestion	2	11
City Development Concept	1	5	Urban Economy	2	5
Policy Instruments	1	5	Immigration	2	8
Policy Making	1	5	Sustainable	2	10
Population Growth	1	4	Planning	2	12
Transport	1	2	Policy Instruments	2	10

Smart Assets	1	6	Transportation Energy	2	6
Smart Cities Framework	1	6	Internal Migration	1	3
Smart City	1	3	Labour Migration	1	6
Smart Governance	1	2	Migration and Refugee Crises	1	5
			Migration Patterns	1	11
			Self-Sustaining Village	1	4
			Smart Assets	1	6
			Smart Cities Framework	1	6
			Smart City Technologies	1	4
			Smart Economy	1	6
			Smart Energy	1	5
			Smart Homes	1	9
			Smart Village	1	4

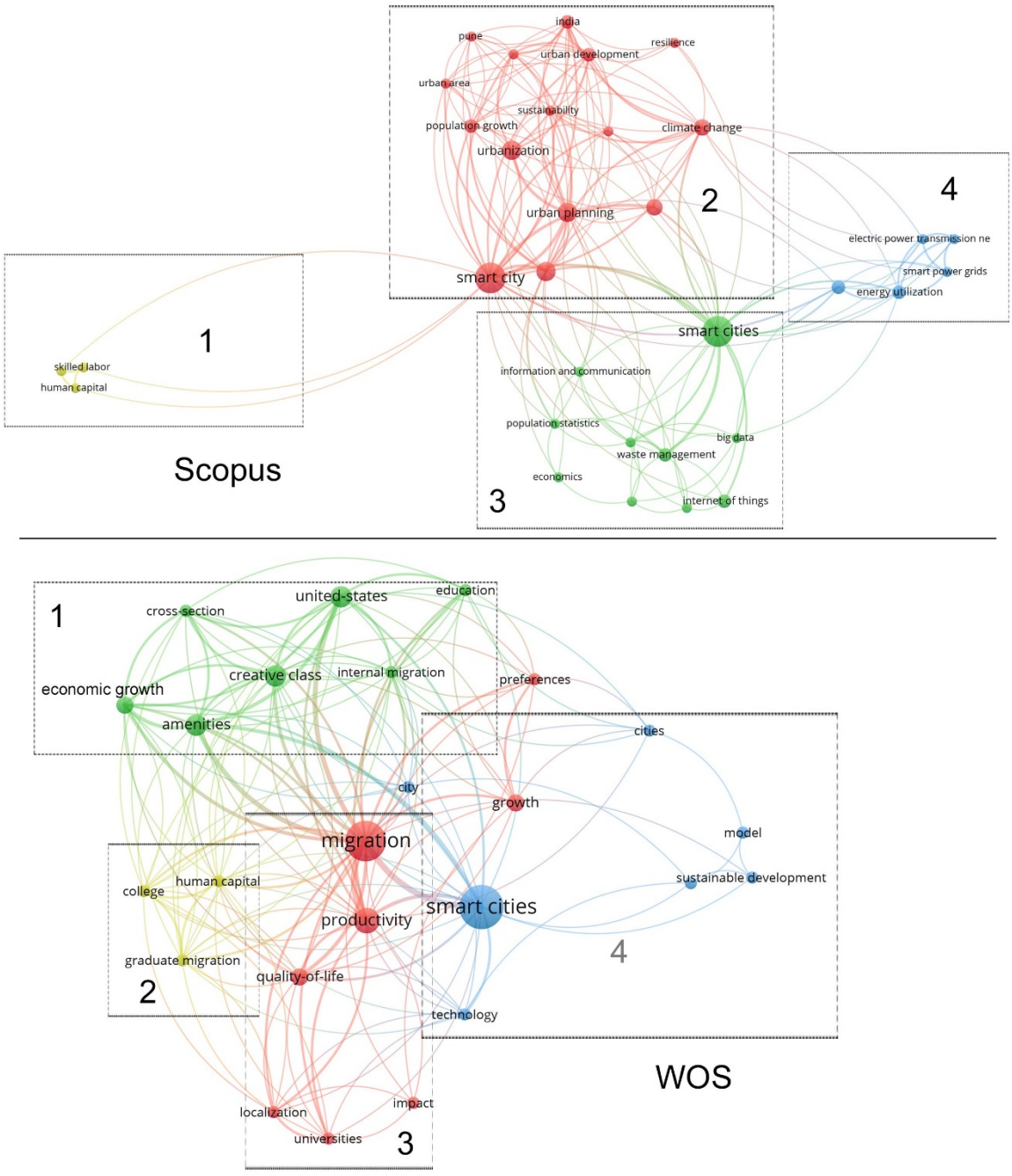


Figure 3. Keywords network

Table 4. Topics discussed in smart cities and migration research.

Topic	N	%	Citations	Number and years of publications
Planning for Smart Cities	8	18	19	2019(3), 2018(3), 2017(2)
City Development and Infrastructure Projects	5	10	0	2019, 2018(2), 2017, 2016
Smart City and Development Opportunities	4	8	3	2019, 2018, 2017, 2016
Educated Workers Migration	3	6	64	2016 (2), 2014
Electrical Efficiency in Smart Cities	2	4	10	2016 (2)
Technology Services in Smart Cites	2	4	11	2019, 2016
Waste Management	2	4	0	2019 (2)
Border Smart Security for Migrants	1	2	5	2011
City Development and Economic Evolution	1		0	2019
Connecting Citizens to Transportation Service Delivery	1	2	1	2016
Food Security	1	2	4	2019
Future Problems for Smart Cities	1	2	0	2019
Irregular Migratory Flow to Smart Cities	1	2	15	2017
Land Use and Smart Cities	1	2	19	2012
Migration of Qualified Workers	1	2	4	2017
Migration and Smart Economy	1	2	0	2019
Military Protection for Migrants Using Smart Data	1	2	0	2018
New Ethical Standards	1	2	0	2019
Productivity of Educated People in Innovative Environment	1	2	1	2016
Reasons for Migration to Smart Cities	1	2	249	2011
Researchers Migration Behaviours	1	2	1	2019
Skilled Workers Migration	1	2	7	2017
Smart Cities and Health Care from Data	1	2	65	2017
Smart City Expansion	1	2	0	2007
Smart Phones to Improve Transportation Systems	1	2	4	2015
Student Migration	1	2	15	2011
Thermal Energy Control	1	2	4	2015

Water Management	1	2	7	2017
Youth Migrations	1	2	0	2019

N refers to the number of publications – In the column "Number and years of publications" the number appears in brackets.

Table 5. Sustainability dimensions in research on smart cities and migration.

Sustainability dimensions	**N/%**	**Year of publication**							**Total**
		2007	**2011**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Ecological dimension	N	1	0	0	2	5	5	1	11	25
	%	2.08	0.00	0.00	4.17	10.42	10.42	2.08	22.92	52.08
Economic dimension	N	0	1	1	0	6	7	0	10	25
	%	0.00	2.08	2.08	0.00	12.50	14.58	0.00	20.83	52.08
Social dimension	N	1	3	1	2	7	9	1	20	44
	%	2.00	6.00	2.00	4.00	14.00	18.00	2.00	40.00	90.00
Total	N	1	3	1	1	9	10	1	22	48
	%	2.08	6.25	2.08	2.08	18.75	20.83	2.08	45.83	100.00

N refers to the number of publications – % refers to the percentage of publications.