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DESENVOLVIMENTO SUSTENTÁVEL DE SMART CITIES BASEADA NO CONTEXTO DO TRIPLE BOTTOM LINE: UMA REVISÃO SISTEMÁTICA DE LITERATURA

SUSTAINABLE DEVELOPMENT OF SMART CITIES BASED ON THE CONTEXT OF THE TRIPLE BOTTOM LINE: A SYSTEMATIC LITERATURE REVIEW

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Resumo: O objetivo do estudo foi realizar uma revisão sistemática sobre desenvolvimento sustentável e smart cities, para entender a relação entre ambos no contexto da ferramenta Triple Bottom Line (TBL). Realizamos uma revisão sistemática usando os bancos de dados ScienceDirect, Scopus e Web of Science no período entre 2003 – julho/2020, resultando na análise completa de 33 artigos. Apresentamos a evolução do conceito ao longo dos anos, periódicos e países mais influentes deste conceito. Este artigo realizou as seguintes técnicas de análise: análise de citações, coocorrência de palavras-chave e autores. Observou-se que para a efetiva implantação de um modelo de smart city, depende, além do planejamento urbano, do enfrentamento de barreiras que impactam no equilíbrio do TBL, como mudanças climáticas, falta de políticas públicas de incentivo para o uso de energia limpa, qualidade de vida da população, saneamento básico, entre outros fatores que são dificuldades encontradas principalmente nos países em desenvolvimento.

Palavras-chave: Sustentabilidade. Desenvolvimento sustentável. Smart city. Triple Bottom Line.

Abstract: The purpose of our study was to bring a systematic review on sustainable development and smart cities, to understand the relationship between both in the context of the Triple Bottom Line tool (TBL). We performed a systematic review using the ScienceDirect, Scopus and Web of Science databases for the period of 2003 – July/2020, resulting in the complete analysis of 33 articles. We presented the evolution of the concept over the years, journals and most influential countries in this tool thematic. This paper carries out the following analysis techniques: citation analysis, co-occurrence of keywords and authors. It was observed that for an effective implantation of a smart city model, in addition to urban planning, it depends on facing barriers that impact the balance of the TBL, climate change, lack of public policies to encourage the use of energy clean, quality of life of the population, basic sanitation, among other factors that are found mainly in developing countries.

Keywords: Sustainability. Sustainable development. Smart city. Triple Bottom Line.

Introduction

Actuality, natural resources have a potential impact on the global growth of the urban population, associated with the increase in industrial production and transport networks. Therefore, sustainability demands in part of a political characterization, due to the progressive advance to damages in the environment resulting in climatic transformations and in the fast urbanization process with the new customs evidenced in urban life (Ipsen, Zimmermann, Nielsen & Birkved, 2019).

The reduction of impacts on government systems in energy policy, based on fossil fuels and climate change on the planet, are among the main barriers to sustainable development, influencing the existence of natural resources and human health (Datta, 2012). The damage caused by cities to the environment, such as the emission of polluting gases for global warming (Angelidou et al., 2018) and the use of non-renewable energy (Villa-Arrieta & Sumper, 2019), are some examples.

In recent decades, several economic, environmental and social crises on a global level have considerably impacted the planet's population (Berquier & Gibassier, 2019). Between 1990 and 2020, the metropolitan region of large cities at a global level has committed to attitudes towards urban services and adequate infrastructure, seeking environmental, economic and social conditions as an attractive environment and encouraging competition between cities (Sahu, Shelare, & Sahale, 2020).

Since 1990s, Elkington (1994) developed the term “Triple Bottom Line” (TBL), covering sustainability in a new structure in the development of the three dimensions: environmental, economic and social. TBL seeks a balanced harmony of the three dimensions, the concept goes beyond traditional measures of return on investment and profit to include the environmental and social dimensions. According to Ahmad and Mehmood (2015), the term can also be defined by “3 Ps”, profit, people and planet.

Events like ‘Shanghai World Expo’ in 2010 and ‘Smart City Expo World in Barcelona’ in November 2015 were some incentives that expanded the concept of smart city. These events brought together representatives at a global level to discuss a more proactive vision of cities in the development of society focused on TBL (Cavada, Hunt, & Rogers, 2016).

In this way, smart cities have as their purpose the joint use of data in different sectors, for example, alternative and renewable energies (Villa-Arrieta & Sumper, 2019), learning processes (Wang, Ho, & Fu, 2019), health systems (Sarkar, 2018), knowledge transition processes and urban public policies (Sahu et al., 2020). Urban sustainable development and the TBL conceive a thought and reflection on production systems and the appropriate use of essential resources for the industrial sector, forms of commercialization and residential energy consumption (Zhang et al., 2019). Urban sustainable development encourages a process of commitment and adherence to the so-called smart cities, as a

way of accompanying the rapid expansion of the population that is overloading the natural resources of cities (Culwick & Patel, 2020).

Urban sustainable evolution in cities impacts on social, economic, political, cultural, ecological and institutional aspects, which results in the population's quality of life (Sarkar, 2018). The orderly growth of society, environment and economy, are fundamental to the success of productive activities in a city, showing differences according to the country, culture and regions (Tan & Taeihagh, 2020).

Some studies have carried out a systematic review of the concept of smart cities in an attempt to assess its importance for sustainable development, however, in a generalized way (Tan & Taeihagh, 2020; Wang et al., 2019). Considering that the concept of smart cities is broad with several applications, and no study has carried out an in-depth analysis of smart cities on environmental, economic and social advances, there is a research gap that requires in-depth investigations around the main characteristics of smart cities in the context of the Triple Bottom Line.

Based on this, this study is guided by the following research problem: (i) Which authors, countries and journals are most influential in the concept of smart cities? (ii) What are the main emerging characteristics of smart cities in environmental, social and economic aspects? The objective of this study was to analyze the scientific studies focusing on smart cities and sustainable development to understand the relationship between them in the Triple Bottom Line context. The methodology presents a systematic review of the literature in three databases: ScienceDirect, Scopus and Web of Science (WoS). To define the keyword group, symbols and boolean operators were used as follows: "environmental sustainability" OR "sustainable development" AND ("sustainable city" OR "smart city"). A bibliometric analysis was performed with filters used as exclusion criteria.

The study has significant academic and managerial implications. In academic implications, the study contributes with representative information on emerging environmental, social and economic factors in the field of smart city research, in addition to trends in the evolution of the concept, authors, journals and countries that have shaped the literature. When analyzing the evolution of smart cities in sustainable development, it indicates an increase in interest in scientific research on the topic addressed.

In managerial implications, the study contributes so that public policies and urban design are developed in smart cities based on environmental, social and economic dimensions, demanding the participation of stakeholders such as the community, corporate governance, universities, research institutions and public authorities (Schwach, Junior, Pereira, & Ribeiro, 2017; Worthington, 2009).

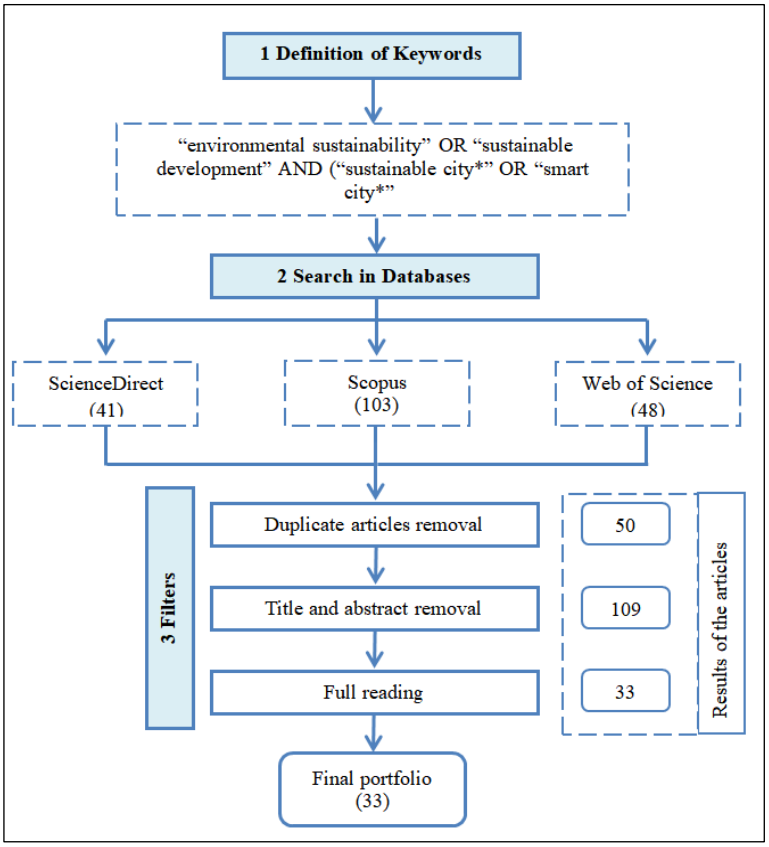
The next section describes the methodological procedure adopted for the study. The subsequent sections present the results discussed and enriched on the main trends of the concept of smart cities in sustainable development. The study ends with final considerations and suggestions for future research.

Methodology

A systematic literature review was conducted based on rigorous methodological procedures for defining the final portfolio. Figure 1 shows the summary of the literature review steps:

Figure 1

Summary of literature review steps



Source: Own Authorship (2020).

We used the ScienceDirect, Scopus, and Web of Science databases for research papers, without time period. To define the keyword group, symbols and boolean operators were used as follows: "environmental sustainability" OR "sustainable development" AND ("sustainable city" OR "smart city").

The Scopus and Web of Science databases were used because they are classified as the largest bibliographic reference bases by peer review in the multidisciplinary field of science. Both present basic and applied research with a wide coverage of high impact journals (Vieira & Gomes, 2009; Norris & Oppenheim, 2007). Due to the need to consider research involving smart cities and quality of life, the ScienceDirect database was selected, as it contains scientific research in the area of health and well-being (Elsevier, 2020).

The research was conducted within no time limit, given that the choice of focus this study was investigation in concept evolution of sustainable development and smart cities. After searching the

databases, a result of 192 articles was obtained, with the beginning of publications on the topic from 2003. Before this period no publications were found according to the keyword conditions mentioned.

Subsequently, 50 duplicate articles were excluded, resulting in a result of 142. With the application of the filter by titles, abstracts and full reading, the articles considered not applicable to the topic were excluded. Filtering by title and abstract was performed, eliminating those studies that did not address smart cities in the title (22 articles) and that did not present smart cities and sustainable development as the object of study in the summary (26 articles), thus obtaining 94 articles. After the complete reading, other 61 articles not aligned with the Triple Bottom Line concept were found and, therefore, 33 articles remained in the final portfolio.

After a rigorous bibliometric analysis methodology, the final portfolio comprised 33 articles related to the sustainable development of smart cities, based on the concept of the Triple Bottom Line. The 33 high impact articles were analyzed in the results section. In order to carry out the complete analysis of the final portfolio, some characteristics were taken into account. In addition to the year of publication, authors, country, journal, impact factor of the journal and number of citations, the other factors observed and evaluated were: main characteristics of smart cities in the environmental, social and economic aspects.

The articles were classified by environmental, social and economic aspects, according to the concepts of the Triple Bottom Line adopted by John Elkington. According to the main characteristics of the object of study, articles related to the maintenance of life and integration of the ecosystem as replaceable or renewable, were classified as environmental aspect. Articles related to human capital, health measures, education of society and equity to reduce inequality of resources, were classified as social aspect. Articles related to financial and intellectual capital, production activities and economic development, were classified in the economic aspect (Elkington, 2012).

We use some analysis techniques. Citation analysis was used, which involves different aspects of a research field, such as influential production in terms of year, periodicals and countries. It is an analysis in which the quote is considered as a measure of influence (Van Raan, 2003). The study also carried out the co-occurrence technique by keywords, allowing a mapping of words, through clusters of the concepts provided, helping to identify the main research trends. Finally, the co-authorship technique was used to analyze the relationship between the authors, through the formation of clusters (Castro & Frazzon, 2017).

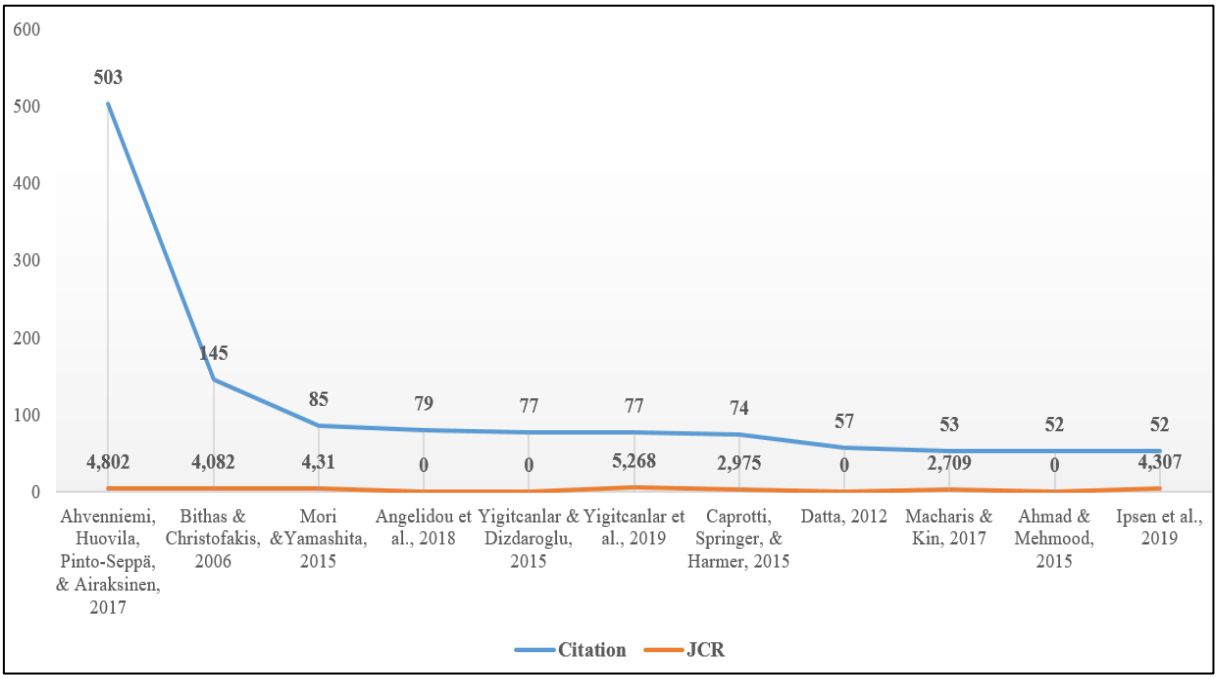
To perform this method, the software Mendeley, Jabref and Microsoft Excel were used to accomplish data entry. The visual maps of co-occurrence and co-authorship were constructed with the aid of the VOSviewer software. VOSviewer is a tool for building and visualizing bibliometric networks to facilitate interpretation (Van Eck & Waltman, 2009).

Results and discussion of the characteristics found in the studies

After going through the set of exclusion criteria, described in the Methodology section, the results are based on the final portfolio of 33 articles considered most scientifically relevant, according to the number of referenced citations, in addition to the respective impact factor (IF) classified in the Journal Citation Reports (JCR, 2019). To classify the greatest scientific relevance among the 33 selected articles, the authors establish the citation criterion > 50. Figure 2 presents an illustration of the articles that had a citation > 50 and the relationship with the JCR.

Figure 2

Characteristics of the assessed studies (number of citation and impact factor)



Source: Own Authorship (2020).

According to the criteria adopted, 11 articles are classified in descending order by number of citations. Of the articles analyzed, 35.5% received a citation> 50. The study by Bithas and Christofakis (2006), entitled “Environmentally sustainable cities: critical review and operational conditions”, shows that the natural and socioeconomic characteristics of urban planning are systematically considered to define environmentally sustainable development in smart cities. However, the authors criticize the lack of indicators that involve the well-being of the local community (social sustainability).

A common understanding about urban planning, also is shared by Ahvenniemi, Huovila, Pinto-Seppä, & Airaksinen (2017), in the study entitled “What are the differences between sustainable and smart cities?” portrays that urban sustainability structures contain a large number of indicators that

measure environmental and economic sustainability, however, smart city structures lack indicators that highlight social aspects.

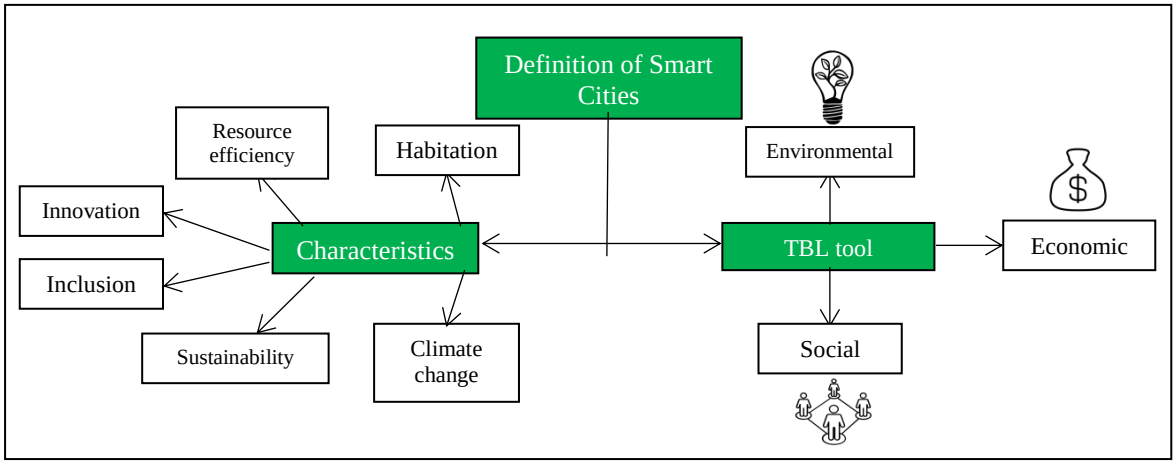
These two articles that were most cited, portray the topic of social sustainability as critical in the sustainable development of smart cities, presenting a connection between the studies. According to the authors, there was no evolution in terms of practices to improve social sustainability in urban planning systems (Ahvenniemi et al., 2017; Bithas and Christofakis, 2006). This observation can be confirmed in more recent studies such as Yigitcanlar et al. (2019), entitled "Can cities become smart without being sustainable? A systematic review of the literature", which obtained the highest JCR among the 11 most cited articles. The research shows similar results when evaluating indicators in urban planning systems. Studies on the poverty rate involve the categories of social sustainability (population's quality of life) and economic sustainability (development of the city's economy), appearing with less prominence among the studies evaluated by the authors.

Improvement practices are highlighted, for example, public policies for smart cities, being possible to confirm the benefits of applying sustainable practices from a holistic point of view focused on aspects of the Triple Bottom Line. It is important to develop cities recognized as sustainable, presenting objectives on the intelligent structural characteristics, being applied not only with a focus on economic and environmental aspects. According to Ahvenniemi et al. (2017), to show that a city is smart, investments need to involve human and social capital, in order to promote a high quality of life.

We developed a structural model of characteristics of the smart city concept based on the Triple Bottom Line tool, according to the concepts that we analyzed in the literature (see Figure 3).

Figure 3

Suggested smart city model with the TBL tool



Source: Own authorship based on the concepts of Martinez-Bravo, Martinez-del-Rio, & Antolin-Lopez (2019), Ahvenniemi et al. (2017), Bithas & Christofakis (2006) and Elkington (1994).

The TBL in the environmental dimension constitutes actions that reduce or eliminate negative environmental impacts caused by economic activities (Elkington, 1994). In the concept of smart cities, themes such as climate change, renewable energy and resource efficiency stand out. Research shows that climate change is marked by a process of transformation of the economic model. With the use of resources for renewable energy, there is an increase in energy efficiency. In smart cities, urban planning projects go through the process of urban energy transition to the use of renewable energy and reduction of energy consumption in buildings, with solar and wind energy being the main sources (Martinez-Bravo et al., 2019; Villa -Arrieta & Sumper, 2019; Zhang et al., 2019).

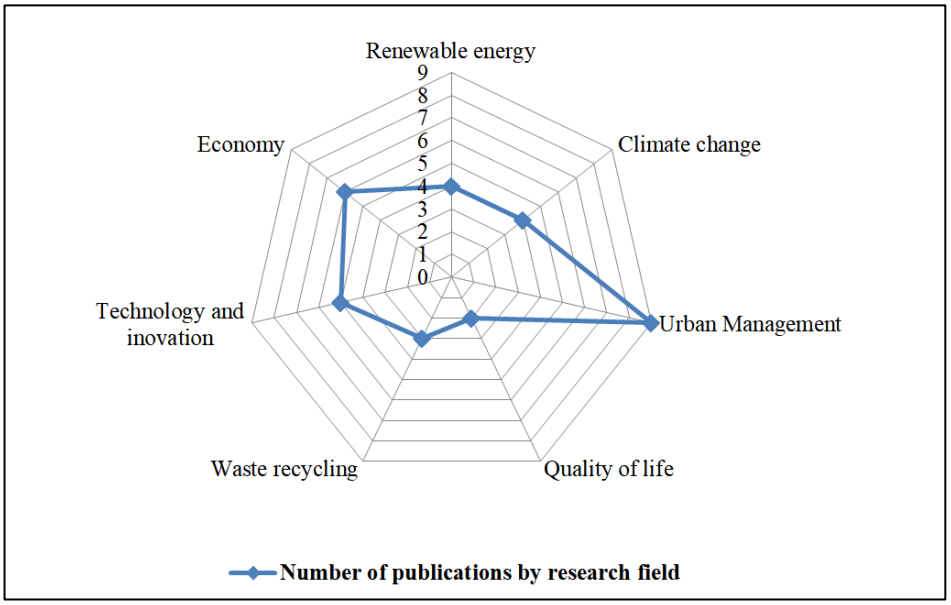
In the TBL tool, Elkington (1994) and Bithas & Christofakis (2006) highlight the economic dimension as being profit combined with projects that promote environmental practices and people's quality of life. According to Hu (2015), to measure the economic dimension of the population and job creation, it is necessary to evaluate the assumption that the attraction of inhabitants and workers in cities is not motivated only by the economy. Factors considered to be non-economic are fundamental to the functioning of the city, such as, for example, the sustainable environment that promotes quality of life.

The social dimension involves the business sector and society in general. Actions considered socially sustainable present an environment conducive to healthy work relationships, in addition to providing the individual and collective development of the population (Elkington, 1994; Villa-Arrieta & Sumper, 2019; Ahvenniemi et al., 2017). Currently, global commitments highlight the need to achieve sustainable growth and the equality of society. Therefore, for the implementation of smart cities it is essential development of the fair and sustainable society (Martinez-Bravo et al., 2019). Research shows a growth in population associated with an increase in demand for basic services and housing. The main challenge is the difficulty in meeting this growing need for services and housing, which in countries like South Africa, for example, is compounded by the lack of access to water, electricity and sanitation (Culwick & Pater, 2020; Chatfield & Reddick, 2016).

The main research fields on the topic smart cities were identified, and the articles were classified according to their main research area, as shown in Figure 4.

Figure 4

Smart city research field (2003–2020) showing number of publications per theme



Source: Own Authorship (2020).

The themes "urban planning" and "economics" appear with the largest number of publications in the field of smart city research, with 27% and 18% of studies respectively. There is a greater concern with the environmental and economic dimensions; and few studies in the social dimension, for example, the theme quality of life appears with only 6% of publications. Ahvenniemi et al. (2017) emphasize that smart cities are those that have the capacity for economic growth combined with a broad quality of life for their population, generating efficiency in sustainable development. The concept of smart cities highlights the need to achieve sustainable growth in society. With population growth associated with a high demand for basic services and housing, the biggest challenge is the difficulty in meeting the demand for these changes.

Currently, a critical in the literature is that authors like Culwick & Pater (2020), Martinez –Bravo et al. (2019) and Nesti (2018), mention in the definition of the concept of smart cities, the characteristic of inclusion as part of this model of urban planning in contemporary society. Themes on socioeconomic inequality and unemployment are discussed as barriers to developing cities, however, these themes do not appear in the evaluated literature.

This suggests that in the social dimension, characteristics such as inclusion and quality of life may not be considered to a sufficient extent in the models of smart cities, which may indicate in the future some need for development in the social dimension to measure the performance of smart cities.

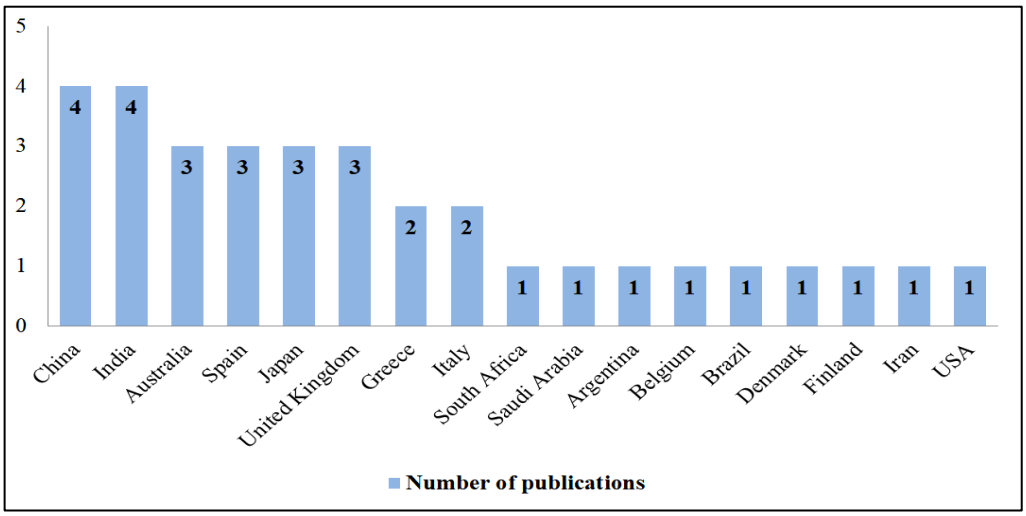
We carried out an analysis of the evolution of the concept, according to the year of publication and the number of articles. Between 2003 and 2012, the first concepts of smart cities in the field of

sustainability appear with a minimum number of publications (5 articles). Between 2015 and 2018, there is an advance in the publications of the concept (15 articles). In 2019 there was an increase in the number of publications until the current year (13 articles). Analyzing the publications until June 2020, there is a trend that the year 2020 would receive more publications compared to the previous year, which means that the topic has not been exhausted and there is a need for the continuation of scientific research.

Figure 5 shows the number of publications according to the country.

Figure 5

Number of publications per country



Source: Own Authorship (2020).

This research is presented globally because the studies were carried out in Asia, Europe, America, Africa and Oceania. The continent of Africa appears with little emphasis on the theme addressed, with only 3% of the articles evaluated. The Asian continent appears with greater prominence with 42%, followed by Europe with 36% of the articles evaluated. The data demonstrate the concern of developing countries with urban planning and smart cities. Research shows that developing countries are experiencing not only economic growth, but there is also a beginning of concern with the environment of cities, indicating a trend towards the adoption of the TBL tool in smart cities (Sahu et al., 2020; Mundoli, Unnikrishnanm, & Nagendra, 2017; Cenci & Schonardie, 2015; Zulaica & Tomadoni, 2015).

Among the countries that have published the most articles are China and India. Research shows that China dedicates significant political and economic investments to the development of new smart city projects, reflecting on goals for the country's government in building a society in harmony, in which

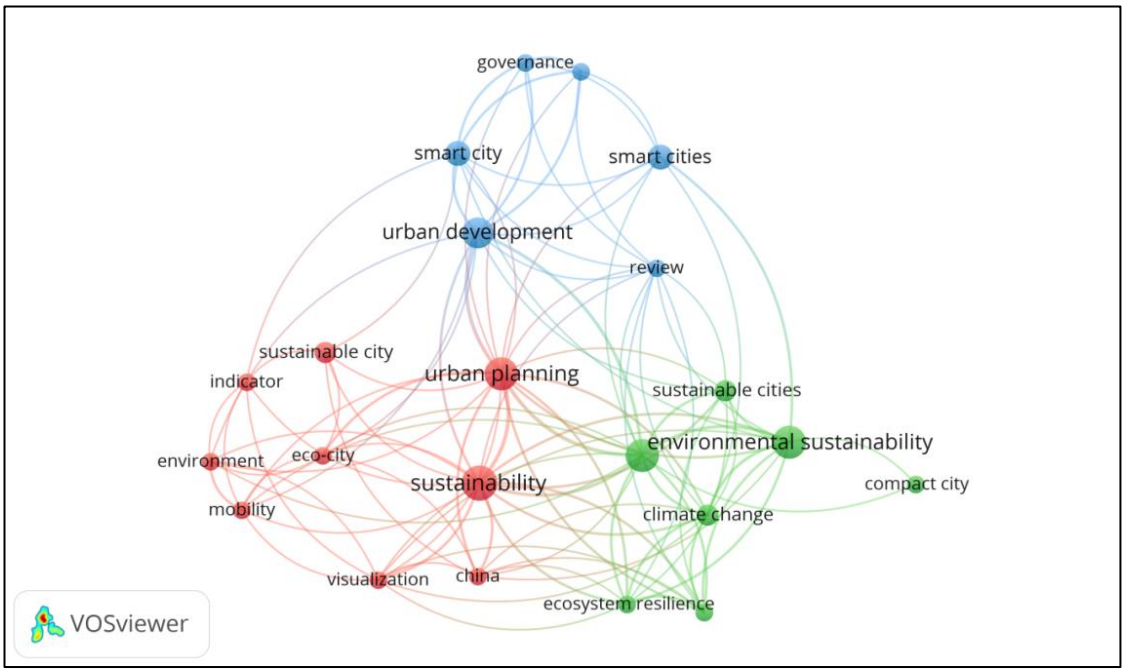
the environmental and social dimensions are mutually reinforcing (Zhang et al., 2019; Wang et al., 2019; Caprotti, Springer, & Harmer, 2015).

India presents a trend in the development of smart cities, the author Datta (2012) presents a study in Lavasa that is highlighted as the most planned city in India. However, critical factors are mentioned as barriers to continue the deployment of smart cities in India. Studies show that future smart cities in India are at risk of prioritizing the economic dimension over the environmental dimension, due to the lack of application of legislation and monitoring of environmental performance, presenting internal legal and political conflicts (Sahu et al. 2020; Mundoli et al., 2017; Datta, 2012).

Using text data, a visual map was constructed considering keywords, complete counting method, with a minimum number of 2 occurrences, thus 23 keywords out of a total of 216 met the criteria, with 156 links total, as shown in Figure 6.

Figure 6

Co-occurrence of keywords from the final portfolio



Source: Own Authorship (2020).

According to the terms and their interrelations, it can be seen that the keywords that most appear in the literature were: “urban planning”, “sustainability” e “environmental sustainability”. In addition, the largest cluster (in red tone) consists of 9 related words. When we analyze the classification of these terms, it can be seen that studies on smart cities and sustainability stand out in the following themes: urban planning (Angelidou et al., 2018), urban mobility (Aletà et al., 2017) and eco-city (Caprotti et al., 2015; Yigitcanlar & Dizdaroglu, 2015).

Since 1970s, the term eco-city came about, partly due to the work developed by Richard Register, one of the greatest theorists in the field of ecological design and planning of cities. Among his most prominent works is the book *"Ecocity Berkeley: Building Cities for a Healthy Future"*, the American author states that no urbanized area can be utopian of actions such as recovery of green areas, alternative energies, recycling and urban mobility solutions (Caprotti et al., 2015; Datta, 2012; Register, 1987).

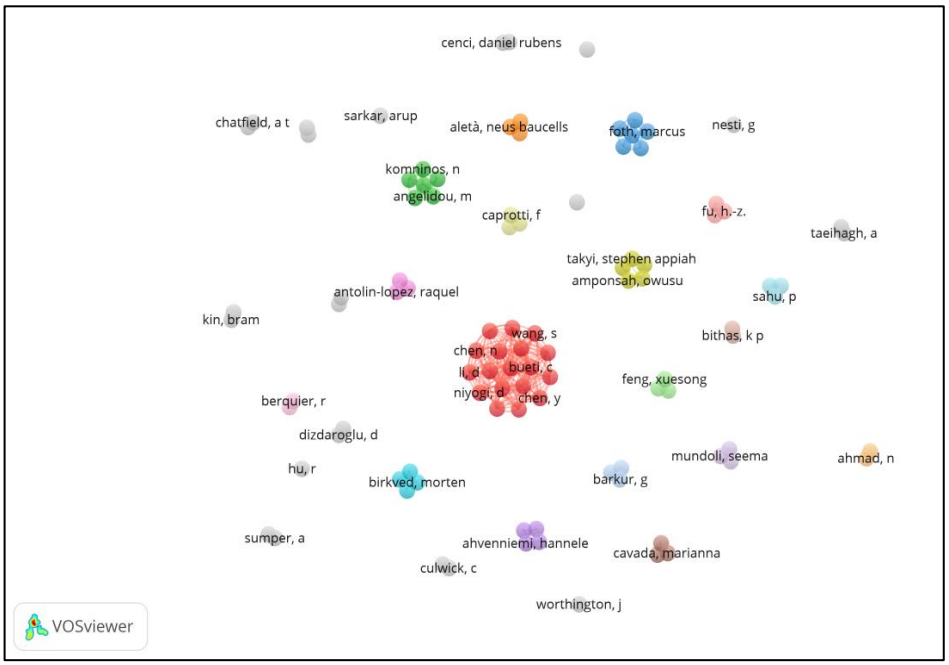
Only in 1990, events on the ecological planning of cities were motivated at a global level, with emphasis on countries such as Spain, China, the United Kingdom and Australia, which began to systematize the design of cities with the quality of life of the population and environmental preservation, supporting theories like "Garden City "and" Broadacre City ", and later influencing other trends such as" Eco-city "and" Healthy City ", which culminated in the concept of" Smart City "(Aletà et al., 2017; Mundoli et al., 2017, Hu , 2015).

The second largest cluster (in green tone) consists of 7 related words, and analyzing the relationship of these terms, there is an emphasis on studies involving climate change (Nesti, 2020) and ecosystem resilience (Cavada et al., 2016). Ecosystem resilience has been a concept that has become known since the 1970s, when Canadian ecologist called Crawford Stanley Hollin published his work entitled "Resilience and stability of ecological systems". The concept of resilience relates to the ability to restore a system (Wang et al., 2019). The main goal of Hollin (1973) was to develop models to understand changes in the structure and function of ecosystems. Depending on the degree of destruction of the ecosystem, it cannot be restored to its original form. Research shows that the concept of resilience has been highlighted in the last few years, both in theoretical application and practical decision-making in the development of smart cities (Zhang et al., 2019; Azunre, Amponsah, Peprah, Takyi, & Braimah, 2019; Mundoli et al., 2017).

Figure 7 shows the co-authorship map, it was based on bibliographic data, type of co-authored analysis, unit of analysis by authors and complete counting method. The network found was made up of 100 authors and co-authors, with the formation of 33 clusters (authors who carried out together studies) with 244 ties.

Figure 7

Co-ocurrence of authors



Source: Own Authorship (2020).

The largest cluster (in red tone) consists of 16 authors, the results of the study by Zhang et al. (2019), show the smart city theme and the challenges of urban drought as part of achieving the goals established in five of the Sustainable Development Goals (SDGs). In regards to this gap in research, the current literature on urban drought does not show enough emphasis to achieve the SDGs in 2030, mainly on SDG 6 'clean water and sanitation', SDG 11 'sustainable cities and communities', SDG 12 'responsible consumption and production', SDG 13 'climate action' and SDG 15 'life on land', becoming a barrier to the development of smart cities. In the study of Zhang et al. (2019), it is identified that there is a partnership relationship between countries, as it presents authors from China, Australia and the USA.

We conducted a survey of the potential benefits of urban planning in the smart city model, according to the TBL tool (Table 1).

Table 1

Potential benefits of urban planning in the smart city model according to the TBL

TBL tool in Smart Cities		
Environmental	Social	Economic
Reducing environmental impacts (Tan & Taeihagh, 2020; Ahvenniemi et al., 2017)	Renewable energy in rural regions (Culwick & Patel, 2020; Tan & Taeihagh, 2020; Nesti, 2020)	Promote sustainable consumption and a sustainable industrial policy (Culwick & Patel, 2020)
Circular economy in the construction industry (Nesti, 2020; Bithas & Christofakis, 2006)	Sustainable education in schools (Worthington, 2009; Bithas & Christofakis, 2006)	Construction of ecological buildings (Tan & Taeihagh, 2020; Yigitcanlar et al., 2019; Bithas & Christofakis, 2006)
Separating garbage produced in the city (Tan & Taeihagh, 2020; Yigitcanlar et al., 2019)	Planning to meet the demand for population growth (Culwick & Patel, 2020; Yigitcanlar et al., 2019; Aletà et al., 2017)	Public policies to reduce interest rates with the use of clean energy (Ipsen et al., 2019)
Decrease in the use of fossil fuels (Yigitcanlar et al., 2019; Feng, Fujiwara, & Zhang, 2008)	Awareness for the responsible use of water (Tan & Taeihagh, 2020; Zulaica & Tomadoni , 2015)	Environmental Management System (EMS) with continuous improvement between the relationship of industrial processes and the environment (Tan & Taeihagh, 2020; Yigitcanlar et al., 2019; Bithas & Christofakis, 2006)
Reduce energy dependence on water sources (Tan & Taeihagh, 2020; Martinez-Bravo et al., 2019; Bithas & Christofakis, 2006)	Encouraging the use of public transport and bicycles (Bithas & Christofakis, 2006)	Attractive environment for customers and investors (Tan & Taeihagh, 2020; Cavada et al., 2016; Bithas & Christofakis, 2006)
Use of organic waste for energy generation (Culwick & Patel, 2020; Tan & Taeihagh, 2020; Bithas & Christofakis, 2006)	Improvement in public lighting (Sarkar, 2018; Bithas & Christofakis, 2006)	Making public transport economically viable for the population (Ahmad & Mehmood, 2015; Bithas & Christofakis, 2006)
Minimisation of emissions of polluting gases (Berquier & Gibassier, 2019; Yigitcanlar et al., 2019)	Use of technological tools that help to monitor public services (Culwick & Patel, 2020; Yigitcanlar et al., 2019; Hu, 2015; Bithas & Christofakis, 2006)	Increase in green construction industries, and consequent increase in jobs (Tan & Taeihagh, 2020; Yigitcanlar et al., 2019; Datta, 2012; Bithas & Christofakis, 2006)
Preservation of urban green areas (Wang et al., 2019; Bithas & Christofakis, 2006)	Production of performance indicators that are useful for measuring and improving public policies (Ipsen et al., 2019; Bithas & Christofakis, 2006)	Integration of information in public administration (Yigitcanlar et al., 2019; Yigitcanlar & Dizdaroglu, 2015)
↘ ↓ ↙		
Sustainable development in cities		

Source: Own Authorship (2020).

In the environmental dimension, the sustainable creation of smart cities requires interventions for the development of human capital and the economy for the preservation of the environment. Sustainable development demands the awareness of the population in their proper attitudes, such as the use of organic waste for the generation of energy. The new way of managing smart cities favors

sustainable and low-impact management, such as encouraging public transport. The smart city model limits the emission of CO2 into the atmosphere and promotes the reuse of water (Culwick & Patel, 2020; Tan & Taeihagh, 2020; Yigitcanlar et al., 2019).

In the social dimension, sustainable cities must establish new standards of society to govern future cities. Smart cities promote the social insertion of diverse urban dwellers in public services and social sustainability as a fundamental strategic component (Sarkar, 2018; Bithas & Christofakis, 2006). The proximity of people with different incomes, cultures, ages and professions, contributes to the development of social capital and sustainable economic growth. Through proper management of natural resources, it is possible to combine participatory governance and reduce social inequality (Aletà, Alonso & Ruiz, 2017; Worthington, 2009; Bithas & Christofakis, 2006).

In the economic dimension, the use of the circular economy in smart cities encourages economic principles for the use of materials and energy, restricting the entry of resources, polluting gas emissions, food and energy waste (Culwick & Patel, 2020; Yigitcanlar et al., 2019; Pinto-Seppä, & Airaksinen, 2017). Investments in human and social capital in the traditional communication and transport infrastructure stimulate sustainable economic growth and the development of quality of life, with intelligent management of natural resources, through participatory public policies (Cavada et al., 2016; Ahmad & Mehmood, 2015). Smart cities show important characteristics in the development of network infrastructure to improve economic and political efficiency, permitting cultural, urban and social development (Yigitcanlar et al., 2019).

The relationship between the studies brought results of different forms of management in cities, such as public policies of smart cities, in addition to the verification of the benefits in the use of sustainable practices from a holistic point of view focused on aspects of the Triple Bottom Line. The development of cities identified as sustainable shows objectives on intelligent structural models applied in the environmental, social and economic dimensions.

Final considerations

This article presented a systematic review of the literature on the sustainable development of “smart city”, based on the context of the Triple Bottom Line. Using the methodology employed, a bibliographic portfolio was built to select the authors, countries and journals most influential in the concept of smart cities and to find out what are the main characteristics emerging from smart cities in environmental, social and economic aspects.

In order to meet the proposed objectives, a bibliographic portfolio with 33 articles was obtained, and the authors with scientific prominence who obtained the most cited article were Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., and Airaksinen, M. (with 403 citations published in Journal

Cities), and with the most cited article and with the greatest impact factor were Yigitcanlar, T, Kamruzzaman, M., Foth, M., Sabatini-Marques, J., da Costa, E., and Ioppolo (with 77 citations and JCR 5,268 published in Journal Sustainable Cities and Society). Among the countries that most published articles are China and India, both with a total of 24% of the articles analyzed.

Regarding the main characteristics emerging from smart cities in environmental, social and economic aspects, it was possible to identify that for an effective implantation of a smart city model, in addition to urban planning, it depends on facing barriers that impact the balance of the TBL, climate change, lack of public policies to encourage the use of energy clean, quality of life of the population, basic sanitation, among other factors that are found mainly in developing countries.

The results of this research in the theoretical contributions conclude that the environmental aspect in smart cities is the most referenced, mainly as an incentive for actions to minimize the negative environmental impacts generated by economic activities. In the economic aspect, the most discussed issue was the inclusion of topics such as the population's quality of life combined with the growth of employment and productive activities. Regarding the social issue, there was an emphasis on discussions about healthy work relationships, providing the collective and individual development of the population. It was observed that in the studies of smart cities there is a greater concern with the environmental and economic aspects, with few studies in the social aspect.

The results of this research in practical contributions conclude that in the environmental aspect, climate change, renewable energies and resource efficiency demand greater attention, with climate change being marked by a process of transformation of the economic model. In the economic dimension, with the profit generated in projects, it encourages the quality of life of society and environmental practices. Job creation is not the only parameter to be assessed as attractive to inhabitants and workers. In the social dimension, the population increase associated with a high demand for basic services and housing is the biggest challenge to meet these changes. In view of the above, the engagement of public policies, companies, the population and other stakeholders is important for the effective implementation of a smart city model, easing the issues that the government does not solve alone.

In the suggestion for future work, the authors recommend the use of other combinations of keywords to develop research on the gap found in smart cities in the social aspect. It is recommended that future pieces of research address the results of smart cities initiatives that impact the needs of the population and how the resources promoted are transformed into benefits for society. It is also recommended for future studies, to use the concept “eco-city” for the ecological planning of cities.

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