

A preliminary reflection framework of sustainability, smart cities, and digital transformation with effects on urban planning: A review and bibliometric analysis

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Abstract. This study aims to identify high-impact articles and citations involving urban planning based on a systemic approach to sustainable practices, digital transformation, and smart cities to propose a preliminary construct to support the sustainable performance of urban planning focusing on the Brazilian reality. In this context, a theoretical essay was carried out based on the systematic review of current articles on the database Scopus. To achieve the objective, firstly, a systematic literature review (RSL) was carried out using the Biblioshiny tool developed in the R software. Then, an analysis of descriptive statistics of the main bibliographic metrics was presented. A Sankey Diagram was generated relating different bibliographic factors (countries, journals, and keywords). Furthermore, a word cloud and a Co-citation network were proposed through bibliographic coupling analysis using simple centrality algorithms. Finally, a study was carried out on a sample of 86 scientific articles to identify the relationship between the topics of interest. Therefore, it requires a version of a systemic approach of parameters and criteria commonly accepted in its dimensions, seeking to broaden and deepen the themes once the analysis made it possible to identify a relative scarcity of scientific research on the subject and its dissemination in Brazil. As a result, in addition to RSL, it was possible to propose a preliminary construct to support the sustainable performance of urban planning considering a systemic approach.

Keywords: Sustainable practices, Smart cities, Digital Transformation, Urban Planning.

1 Introduction

The impacts caused by rapid urbanization demand that sustainable practices be incorporated into urban planning. Lessons from past and future challenges can help to identify practices for each situation, also considering the Triple Bottom Line, formed by the economic, social, and environmental dimensions. Planning and make sustainable strategic decisions to motivate the transformation of cities into more friendly or intelligent

environments. The smart city as a concept provides a potential approach to finding solutions to the various sustainability issues arising from rapid urbanization [1].

Smart City is a theme that involves many areas of research converges and is considered a social and economic phenomenon driven by environmental and human well-being issues [2]. The smart city paradigm is strictly connected to sustainability aspects, and local context influences the implementation of smart cities [3, 4]. As depicted in the Sustainable Development Goal 11 of the United Nations is important that of building safer, more resilient, sustainable, and inclusive cities [5]. This will necessitate a step change in performance goals and tangible solutions [6]. The smart city industry plays a key role not only in the sustainable city, but also in the growth of the national economy, the reduction of environmental impact of urban activities, the optimized management of energy resources, and the design of innovative services and solutions for citizens [4, 7]. Is a concept that has multiple definitions that vary based on the elements that a city needs to be seen as smart, the resources it needs, its characteristics, objectives, purpose, and scope [8].

A large volume of relevant work has been published in different directions, proposing solutions, services, frameworks, and applications based on these technologies. The bibliometric analysis indicates that Smart Cities are emerging as a fast-growing topic of scientific inquiry, and much of the knowledge generated about them is uniquely technological [2]. But in the analysis of the available systematic reviews of the literature, the gap was identified that the studies do not pay attention to the links between the concepts of sustainability, smart cities, digital transformation and urban planning.

In this context, the aim of the study is a theoretical essay was carried out, based on the systematic review of current articles on the database Scopus. The study found in a preliminary way that the proper functioning and the effects and impacts between the variables are much more complex. Therefore, it requires a vision of a systemic approach of parameters and criteria that are commonly accepted in its dimensions, seeking to broaden and deepen the themes, since public policies actions, and initiatives are still very incipient. The analysis made it possible identify a relative scarcity of scientific research on the subject and its dissemination in Brazil.

2 Background

It is not today that there is a need for an urgent break, facing the challenges of sustainability, because we need, according to [9], to understand that the breach is in the relationships, in the way of thinking, and not only in the technology. That without natural resources, business will not survive, and that we need to get out of our comfort zone and understand that ethical behavior brings economic gains. Aware that this cannot be done just for financial reasons, but for the awareness of man's existence and survival. Research must seek solutions or innovations for the problems and needs of the current society [10].

Understanding that there is still much to do realize that the environment is not something that serves only to exploit and generate wealth. Therefore, organizations implement various strategies, according to the interests of their stakeholders and best

practices to make their processes environmentally efficient and socially and economically viable [11].

The aim of sustainable urban development is to increase the quality of life of citizens through sustainability-oriented innovations (SOIs) [1]. All in all, a connection between the smart city concept, sustainability and urban development exists on several levels, and there is a need to further increase our understanding of the linkages between the various components of sustainability-oriented innovation in this context to enable systemic urban development in cities using digital transformation. It is needed to interact directly with the community where it operates, through products or services of any nature [12].

The socio-economic impacts on cities caused by rapid urbanization demand that sustainable practices be incorporated into urban planning [5] and develop management knowledge to start dealing with internal and external uncertainties [13]. Transformative changes are required for a 21st century sustainable urban planning transition involving multiple interconnected domains of energy, water, transport, waste, and housing and capability based on learning allows to adapt to changes in the economic and social context and technology [14, 15]. According to [16] Smart city technologies have recently become the subject of extensive research and development in the literature.

The concept of "smart city" has several definitions: knowledge city, sustainable city, and digital city. Until the 1990s, "digital cities" was the most used term, today, the most frequent is "smart cities"[17]. It is a recent concept, but it is already consolidated in the debates about sustainable development and technological solutions. According to the European union, Smart Cities are systems and people interacting and using energy, materials, services, and finance to catalyze economic development and improve quality of life. A characteristic situation of these process changes in organizations is quite visible [18]. [19] also talks about the systemic effect of processes on the sustainability of institutions.

These interaction flows are considered smart because they make strategic use of infrastructure and services and of information and communication with urban planning and management to respond to the social and economic needs of society. [20] says that a smart city has some characteristics that differentiate it from others, such as: (i) the use of network infrastructure to improve economic and political efficiency and enable social, cultural and urban development [21]; (ii) it has an underlying emphasis on business-led urban development [21]; (iii) a strong focus on the goal of achieving social inclusion of various urban residents in public services [22]; (iv) an emphasis on the crucial role of high-tech and creative industries in long-term urban growth [22]; (v) deep attention to the role of social and relational capital in urban development [22]; and (vi) social and environmental sustainability as an important strategic component [22].

With innovative technologies, companies must keep up with rapid technological evolution and offer innovative and increasingly sustainable products, ensuring a competitive advantage [23]. Digital transformation comprises more than the set of technologies usually addressed in the literature [23]. Can boost sustainable development strategies, providing opportunities to accelerate change [24]. In timeliness, the companies also face internal and external pressures on sustainable development practices [25]

The digital transformation process of smart cities has different aspects [26] and other publications highlight the digital components and architectures of smart cities [27, 28]. The digital transformation of cities is ecosystem specific [29, 30] and its pace varies according to the ecosystem: it evolves quickly in energy and transport and is slower in the housing and traditional industry sectors [31].

The high variability of options in the digital transformation process enforces a higher complexity level in configuring and setting up objectives and goals based on cities' needs; hence, a systematic approach is required to assist decision-makers in better and more sustainable transformation [32]. Additionally, enterprise architecture fosters digitalization towards achieving system alignment and data integration in cities to support the urban environment as they digitally transform services provided to citizens [31].

3 Method

A systematic review of the literature starts by defining appropriate keywords and the appropriate database for the research topic [33]. For this study, the Scopus database was used as a source, as it is considered a reliable database by many researchers [33, 34, 35]. The chosen keywords were used in the sequence shown in (Fig. 1), with the strategy of starting with words that generated the most comprehensive results to the least comprehensive ones.

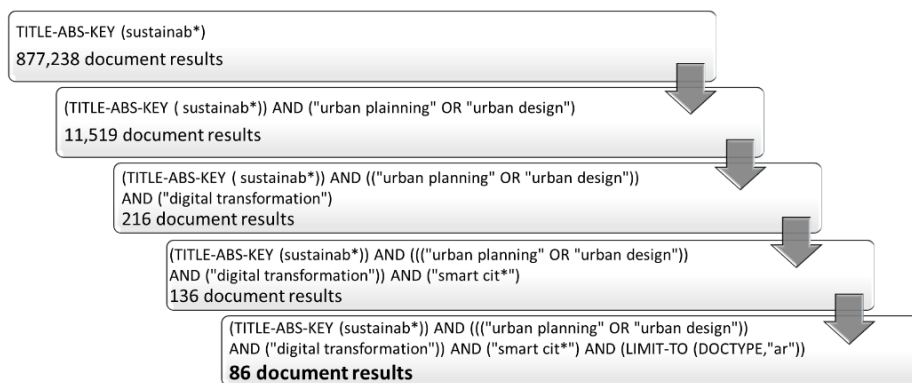


Fig. 1. Sequence of keywords and number of documents.

Bibliometric analysis techniques are based on a quantitative approach designed to identify, describe, and evaluate published research [36]. The use of transparent and reproducible search and review processes increases the reliability of the results and reduces the subjective bias of literature reviews [37, 38]. Bibliometrics can reliably connect publications, authors, or journals, identify research sub streams, and produce maps of published research [39]. For data visualization and analysis, the Bibliometrix package in R was used. Table 1 presents the main data of the sample of articles.

Table 1 - Main information about data

Description	Results
Period	2016:2023
Sources (Journals, Books, etc)	49
Documents	86
Annual Growth Rate %	16,99
Document Average Age	1,84
Average citations per doc	12,84
References	9026
DOCUMENT CONTENTS	
Keywords Plus (ID)	502
Author's Keywords (DE)	391
AUTHORS	
Authors	335
Authors of single-authored docs	10
AUTHORS COLLABORATION	
Single-authored docs	10
Co-Authors per Doc	4,05
International co-authorships %	33,72
DOCUMENT TYPES	
Article	86

In **Table 1**, it is possible to identify that the database has 86 articles, distributed among 49 peer-reviewed journals. Ten articles were published by a single author. The sample had a total of 345 authors, which generates an index of authors per article of 4,05, obtained by dividing the number of authors (345) by the total number of articles in the sample (86).

4 Observations and analysis

The following section presents the metadata analysis and insights, has done based on 86 of current articles on the database Scopus.

4.1. Metadata analysis

This section presents the descriptive statistics based on the metadata of 86 papers. The metadata analysis contained publication of 86 papers by years, institutions, countries, journals, keywords, and co-citation network.

Publications by year

Fig. 2 shows that publications have grown since 2020. Moreover, the trend line also indicates an increasing pattern, which implies that the literature on Smart Cities and other keywords applied in this study is still growing.

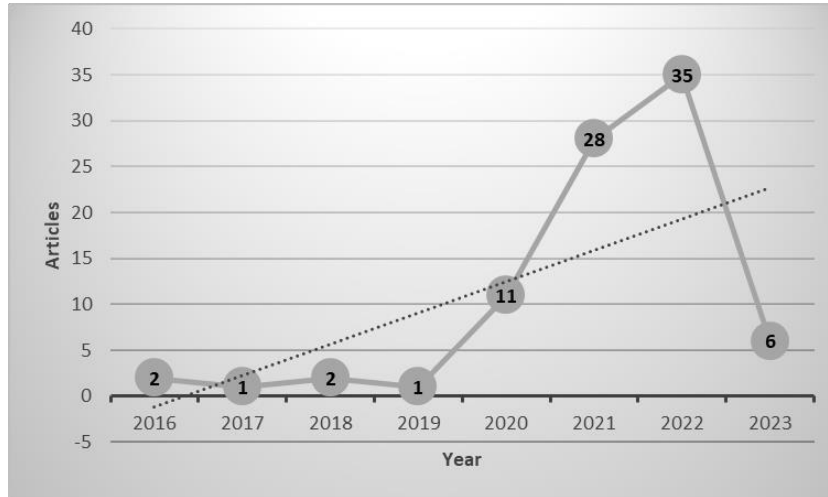


Fig. 2. Articles by year.

For example, in the year 2021, 28 papers were published, which is significantly the highest number of documents as compared to previous years. This concludes that there are increasing concerns and interests in the Smart Cities topic, parallel with sustainability issues, digital transformation, and urban planning.

Publications by institutions

Fig. 3 illustrates Smart Cities and other keywords publications by authors' affiliations, considering the top ten list of the institutes. The figure shows that Aristotle University of Thessaloniki in Greece, published the highest number of papers in the Smart Cities literature.

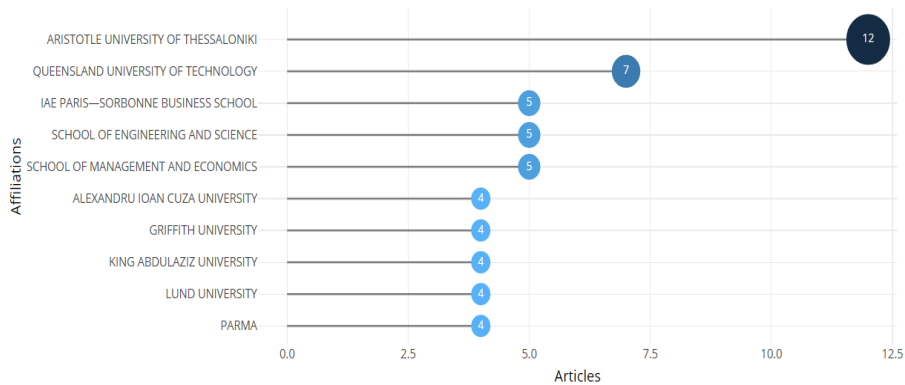


Fig. 3. Articles by affiliations.

Sankey Diagram – countries x, key words, and journal

The Sankey diagram (Fig. 4) is considered an advanced graphical way to display bibliometric data of the characteristics of related articles [40, 41], and presents the proportions of three analyzed topics [42].

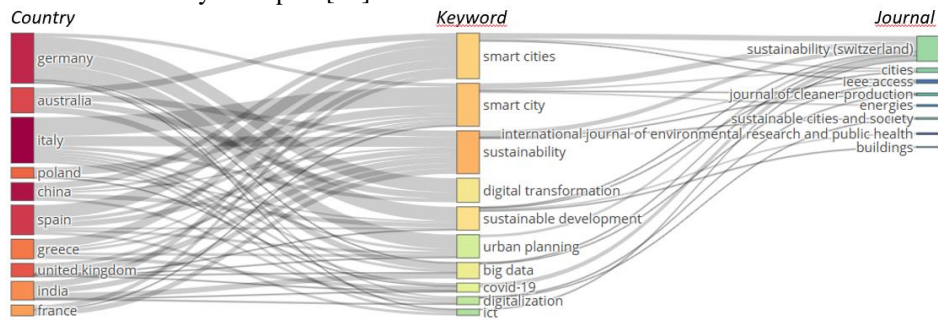


Fig. 4. Sankey Diagram.

From this diagram, a 3-field graph was generated among the 10 most important countries, 10 most important keywords, and 10 most important journals. The figure demonstrates that the Germany has the largest proportion of publications on the theme “digital transformation”, with 16 works published in the sample. The “smart cities” and “smart city” themes are cited in all 10 countries and the journal that publishes the most on the themes is “Sustainability (Switzerland)”.

Most common keywords used.

It is found that the most common word used in keywords is Smart City, showing 30 times, followed by 'sustainability,' 'urban development,' 'urban planning,' and so on. Fig. 5 represents the word cloud derived from the software “Biblioshine”, highlighting the most common words in bigger fonts while other relatively fewer common words appear in smaller fonts. This word cloud is straightforward for identifying common words in a complex environment [43]. Thus, it can identify the most common theme and keywords used in publications.



Fig. 5. Word Cloud.

Contribution by Co-citation Network

Academic research depends on prospecting to retrieve the most relevant research studies and establish links with authors from key international research groups [44]. The existence of co-citation of 2 articles occurs when these 2 articles are cited in a third one [45].

Fig. 6 shows the clusters identified by different colors, composed of four groups of articles and 33 nodes. The selected layout was Multi-Dimensional Scaling, on which the more significant the dimension of the circle, the greater the frequency of co-cited reports. Louvain's heuristic algorithm was used to make the grouping seeking to maximize the modularity in the network. This clustering method is agglomerative if the input is a weighted network with "N" vertices [46].

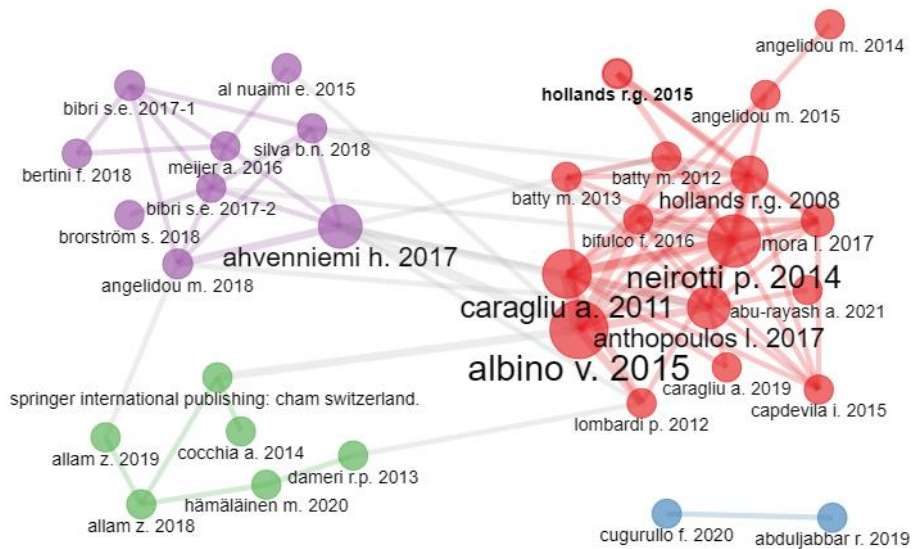


Fig. 6. Co-citation Network.

In the picture is easy viewings to notice the cluster with the highest frequency of co-cited articles is identified by the red color (upper right side), composed of 16 documents, followed by the purple collection (upper left side), with nine articles. The two smaller ones are written of six items in green color (bottom left) and two pieces in blue color (base right), respectively.

A conceptual framework for Smart Cities

After analyzing the existing literature on the possible relationships between the theme's sustainability, smart cities, digital transformation, and urban planning, it is possible to explore and deepen studies on the articles and the potential relationships between the variables.

In this sense, Fig. 7 presents the proposal of a conceptual framework for analyzing the variables using a systemic approach to study the possible relationships and

interactions that may or may not happen between the variables used in the smart city's context. Finally, we identify some hypotheses (H1 and H2) and suggest that they be evaluated in future studies.

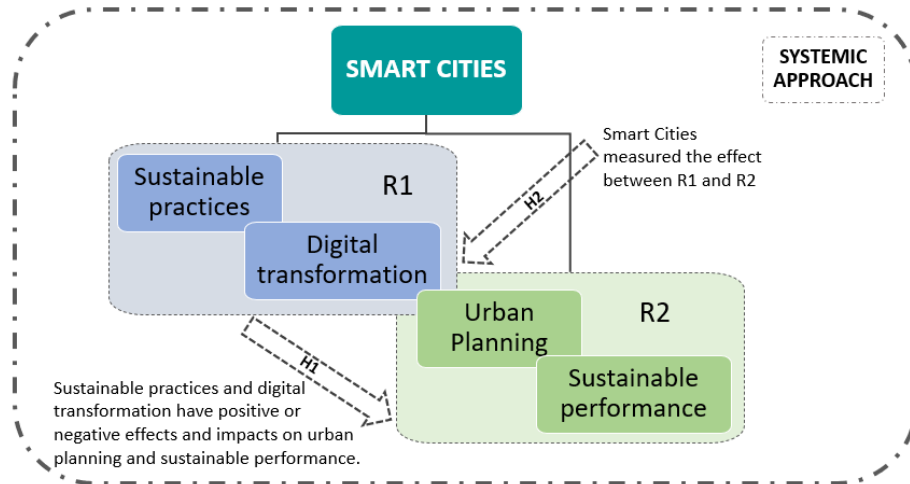


Fig. 7. Conceptual framework for smart cities.

H1: Sustainable practices and digital transformation have positive or negative effects and impacts on urban planning and sustainable performance.

H2: Smart Cities measured the effect between relation R1 (Sustainable practices and digital transformation) and relation R2 (urban planning and sustainable performance).

5 Conclusions and future research potentials

The paper systematically reviews the extant literature and presents a descriptive analysis based on metadata analysis as well as offers insights based on content analysis. The data has been collected from remedies databases. Metadata analysis reveals influential authors, popular journals, publications by year, and top contributing countries and institutions.

This study tells that Aristotle University of Thessaloniki in Greece is the most published institution about Smart Cities. Moreover, Sustainability was the most popular journal regarding its: impact and the number of papers it publishes in this area. The study also reveals that Germany and Italia dominate this discipline in many publications. Additionally, the study finds that the business management discipline holds a large share of the literature on Smart Cities.

One limitation of this paper is that using the Scopus database only. Scopus is an extensive database of management and science journals [34]. However, the collection does not contain all peer-reviewed articles; as a result, a few important papers may have been missed.

In addition to the literature review, we proposed a conceptual framework based on the research themes and identified some hypotheses that can be tested in future studies, intending to investigate the possible relationships between the variables that were part of the literature analysis.

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