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Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments

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Abstract: This study starts by questioning what smart cities are and how they are being planned for the future of the population. Faced with a wide range of information, the coexistence of multiple definitions, and differences between the theoretical concept and what is being carried out in the real world, it is recognized that entrepreneurs and public managers require more clarity regarding the essential attributes that need to be considered in the initiatives of a city that aims to be classified as smart. This study strives to identify and synthesize essential information, helping managers to define and develop projects and initiatives within the context of smart cities. Through a literature review, six widely cited and commonly used groups of indicators are selected, and the most frequent themes, indicators, and keywords are identified. The results are the essential elements founded and synthesized in a single visual scheme. Although this study has a practical purpose, it is also necessary to promote new policies focused on incentives for local initiatives to support and complement them due to the new decentralized and anthropocentric approach to smart sustainable cities.

Keywords: smart sustainable cities; indicators; strategy; planning

Citation: Schiavo, F.T.; Magalhães, C.F.d. Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments. *Smart Cities* **2022**, *5*, 994–1024. https://doi.org/10.3390/smartcities5030050

Academic Editors: Véronique Flambard, Sadia Benamrouz-Vanneste and Abir Karami

Received: 11 July 2022
Accepted: 11 August 2022
Published: 17 August 2022

1. Introduction

The world's population is growing rapidly and becoming concentrated in urban areas (Figure 1). By 2050, more than two-thirds of humanity may live in urban areas [1–3]. Nations are dealing with both rapid digital transformation and severe environmental impacts. How to adapt life on the planet in the face of these challenges has been broadly discussed.

In this context, the reflections on the development of cities, however, are not recent and have been on global agendas for some decades, anchored in world debates and forums. Consequently, international reports guiding worldwide policies and actions in different nations have been produced (Figure 2).

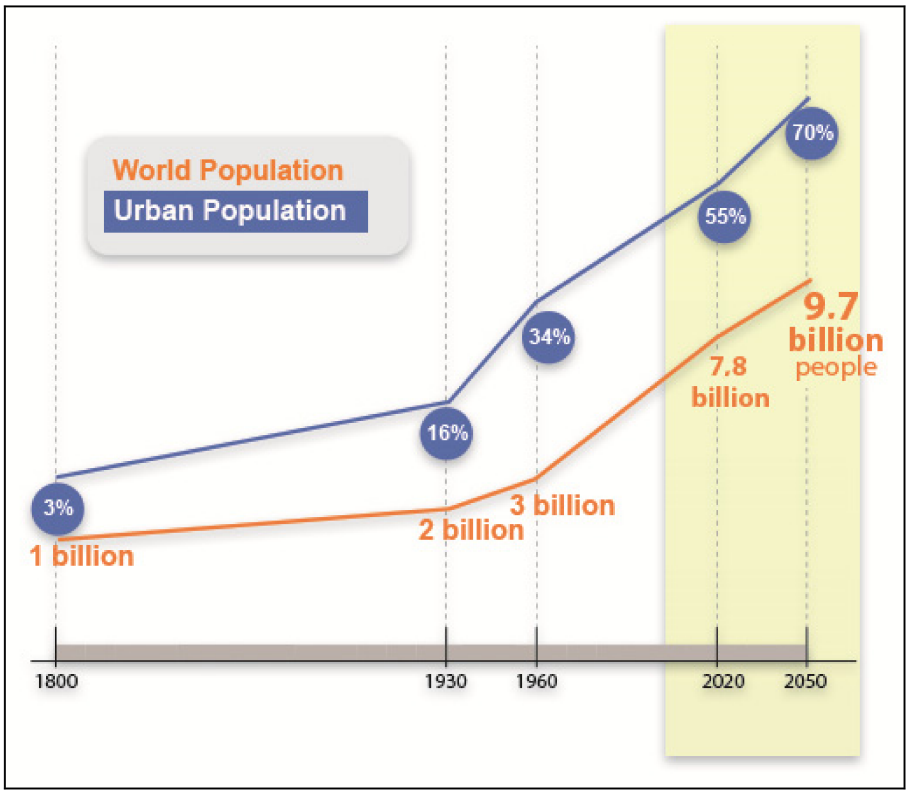

Figure 1. World population (past–present–future projections) Source: [4]. Adapted by the author.

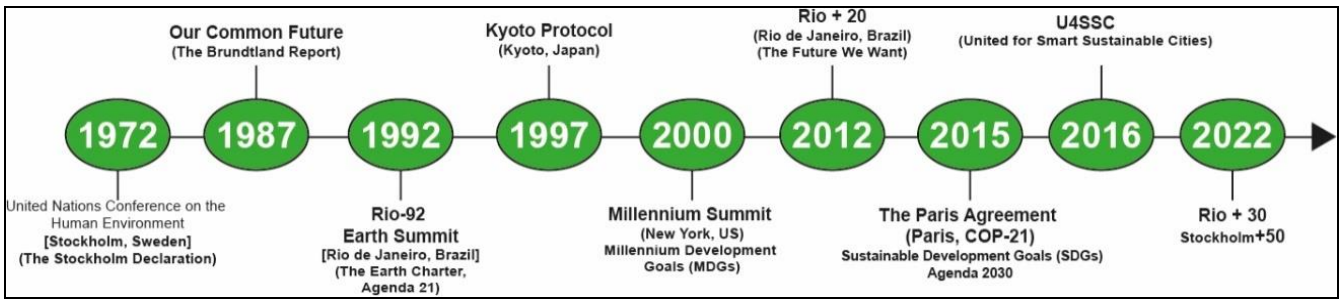

Figure 2. World summits and documents concerning the future we desire. Elaborated by the author, based on [5].

One example is the Brundtland Report, entitled "Our Common Future" [6]. It was published in 1987 by the United Nations (UN) through the World Commission on Environment and Development, chaired by Gro Harlem Brundtland. The report assumed a critical view on the development model adopted by the industrialized nations and reproduced by developing countries. It emphasized that economic and social progress cannot be based on indiscriminate exploration and nature degradation. Likewise, it indicated that poverty in the global southern countries and extreme consumerism in the countries of the north would be the fundamental causes of the unsustainability of development and the environmental crises. Although the report did not present any easy guidelines toward action, it revealed an idea force that established an agreement between generations, being used as the consensus definition of sustainable development, that is, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs [6]".

During the Earth Summit held in Rio de Janeiro in 1992 and led by the United Nations Conference on Environment and Development, also known as Rio-92, the leaders of 179 countries agreed upon and signed the Global Agenda 21. This was an action program

based on one document of 40 chapters, which, until that moment, could be considered the most embracing attempt to promote a new pattern of development on a planetary scale. "Agenda 21" was a term used in the sense of the desired development model for the 21st century. It could be defined as a planning tool for building sustainable societies in different geographical localities and reconciling methods of environment protection, social justice, and economic efficiency.

In 2000, during the Millennium Summit promoted by the UN in New York, the leaders of 191 countries signed a pact aiming for a peaceful, just, and sustainable future until 2015 and defined the Millennium Development Goals (MDGs). The agenda included eight MDGs, detailed in 18 targets and 48 indicators.

The current Sustainable Development Goals (SDGs) have succeeded and updated the MDG. SDGs' construction began in 2012 after the Rio + 20 Conference. The process was completed in 2015 during the United Nations Summit for Sustainable Development when 193 UN members agreed on the proposed agenda entitled "Transforming Our World: The 2030 Agenda for Sustainable Development". Known also as Agenda 2030, it consists of 17 SDGs, 169 targets, a section concerning the means of implementation, a renewed partnership world, and a mechanism for evaluation and follow-up [7,8].

The 17 SDGs must guide policies and activities for international cooperation until 2030 and are a global call to action to end poverty, protect the planet, and ensure that by 2030, all people enjoy peace and prosperity. SDG 11 aims to make cities and communities more inclusive, safe, resilient, and sustainable.

To support the implementation of the Agenda 2030 and to help the achievement of the SDGs, especially SDG 11, the UN launched the United for Smart Sustainable Cities initiative (U4SSC) in 2016. It is coordinated by the International Telecommunication Union (ITU), United Nations Economic Commission for Europe UNECE, and UN-Habitat. It is a global platform for the advocation of public policy and encourages the use of information and communication technologies (ICT) to facilitate and ease the transition to smart sustainable cities [9].

As can be seen, plans for better futures are not new: the intentions and designs of desirable cities have been objects of debate for decades on a global scale. Table 1 synthesizes some of these plans, from the Brundtland Report to the initiative for smart cities.

Table 1. Initiatives and documents that make evident the desire for and design of better futures. Elaborated by the author, based on [5–9].

Document/Initiative	Description
Our Common Future (Brundtland Report)	It was introduced in 1987, providing a view of sustainable development.
Agenda 21	A document with 40 chapters elaborated during the Earth Summit (1992) to guide the planning of sustainable societies.
Kyoto Protocol	In 1997, during the United Nations Climate Change Conference in Kyoto, this international protocol was signed, aiming to reduce 5% of greenhouse gas (GHG) emissions.
8 Millennium Goals—MDG	In 2000, during the Millennium Summit, promoted by the United Nations in New York, leaders from 191 countries signed a pact aiming at a peaceful, just, and sustainable world until 2015.
Paris Agreement	In 2015 during the COP-21 in Paris, 195 countries signed this agreement to reduce the consequences of global warming.
17 Sustainable Development Goals—SDGs (Agenda 2030)	The process was initiated after the Rio + 20 Conference (2012) and completed in 2015 at the United Nations Summit for Sustainable Development in New York. SDGs shall guide national policies, activities, and international cooperatives after the ODM until 2030.
United for Smart Sustainable Cities (U4SSC)	A UN initiative created in 2016, coordinated by ITU, UNECE, and UN-Habitat and supported by 14 other UN bodies. It provides an international platform for information exchange and partnership building to guide cities and communities in achieving the UN SDG, especially goal 11.

Among these discussions, what is unprecedented is the rapid technological advance combined with digital transformations, the high amount of data and information generated, and the environmental concern at a global level. Additionally, these are frequent themes when talking about smart cities, a concept that has been developed in relation to both the increase in urbanization rates and to the growing use of ICT. In recent years especially, there has been a significant increase in the interest in smart cities (Figure 3) [10–12]. However, what are smart cities and how are they being planned for the future of the population?

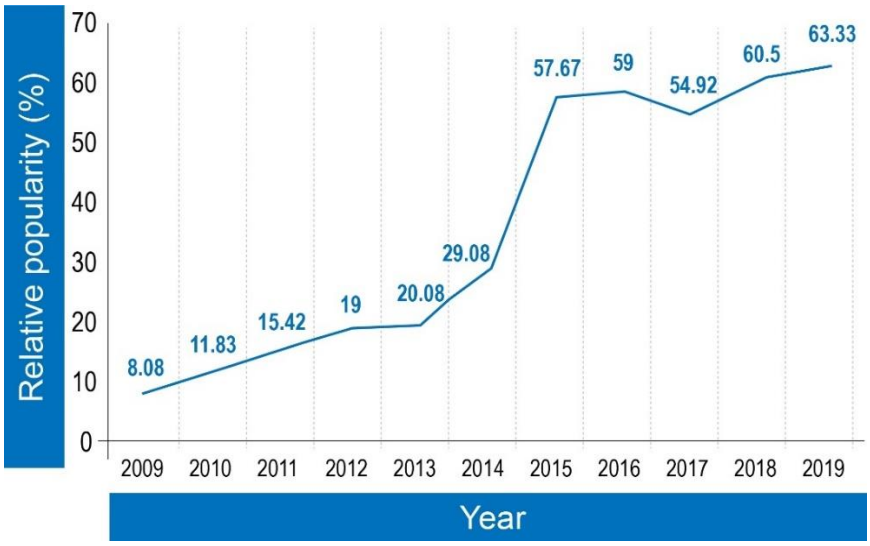

Figure 3. Volume of publications on smart cities (2009–2019). Source: [10]. Adapted by the author.

Based on this question and given the diversity of information currently available, this research focuses on identifying and presenting in a simple and synthetic manner the essential attributes that must be included in the projects and initiatives of a smart city to facilitate the action of entrepreneurs and government officials. The goal of this study is to contribute scientifically, bring new knowledge to the identified gaps, and enable collaboration with managers, who may have more clarity regarding what to take into account when planning initiatives aimed at smart cities.

The document is organized into six sections. The introduction presents the problematization, culminating in the research question. The Section 2 presents the literature review and previous studies. The Section 3 describes the methodology used. In the Section 4, the results obtained from the research carried out are presented. The Section 5 discusses the results, and the sixth contains the conclusion and recommendations.

2. Literature Review and Previous Studies

Some authors claim that the concept of smart city, together with the first academic publications on the subject, emerged in the 1990s [13,14]. In line with the process of searching for better places to live, Cocchia [14] attributed the development of this concept to the signing of the Kyoto Protocol in 1997, which motivated cities to seek "smart projects" to fulfill the signed agreements. These projects explored ways in which new information and communication technologies (ICT) could contribute to sustainable development [15,16].

Until 2008, the literature focused more on the conceptual aspects of smart cities, and "digital cities" and "information cities" were the most frequently mentioned terms. The term "smart city" appeared in the late 1990s [17] but became relevant in terms of the number of publications from 2010 onwards. Until then, the focus was on technological aspects. From 2012 onwards, the studies began to adopt a more holistic view, expanding the aspects addressed, especially those related to people in cities [18]. This differentiation of aspects, moving from a technocentric view to a more holistic perspective, can also be observed depending on the origin of the publication: North American publications tend

to have technology as a basis, and European publications utilize a broader perspective encompassing different dimensions, such as human, ecological, technological, and governance aspects [13]. Currently, there are two mainstream approaches to this concept: the technology and ICT-oriented approach and the people-oriented approach [19,20]. More recently, it has been argued that cities cannot be truly smart without being sustainable [21].

Regarding the classification of the city in terms of its smartness, the terminology has been evolving since the beginning of the 1990s, along with some other categories of cities that essentially have coincident missions and purposes, such as virtual cities, web cities, cities of knowledge, broadband cities, digital cities, mobile or wireless cities, green or ecological cities, sustainable cities, cities for people, and alive cities [11,22].

Regarding the concept of smart cities, although the term has gained prominence in recent years, there is still no single, widely adopted definition [12,18,19,23–33]. The use of the term shows some confusion regarding its meaning and application, which is evident when comparing definitions and practical implementations [2,34].

In recent years, the definition suggested by Giffinger [35], which focuses on the European model of smart cities, and the one adopted by the U4SSC, have been recurrently used. The first is recurrent in academic publications and proposes that a smart city must perform well in six dimensions (governance, economy, people, life, environment, and mobility) and is built from the "smart" combination of talents and activities of self-determined, independent, and conscious citizens [35]. The second, present in documents of global guidelines focused on practice and regulation [36,37], understands that "a smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects" [38].

Complementarily, in an analysis of 84 definitions of smart cities [18,21,23,39], and regardless of the breadth and diversity of concepts, some words remain recurrent: quality of life, services, citizens, and ICT.

The coexistence of more than one definition and the fact that the concept is still diffuse [40] are probably influenced by the difficulty of tracing a pattern that fits all cities. Needs, political structures, histories, socioeconomic profiles, habits, and cultures shape cities, making them unique and different from one another [23,41]. However, even in the face of the lack of consensus regarding a definition for the term, one objective remains common: to improve the quality of urban life [2,42].

In general, it can be perceived that, until recently, the concept of smart cities was closely linked to technologies. Ideas and themes related to ICT and the Internet of Things (IoT) were very present as mediators of the planning, development, implementation, and evaluation of urban transformation processes. Currently, the concept remains linked to technologies, which should aim to raise the quality of life so that it represents the primary component (Figure 4) [43]. In other words, in smart cities, only those technologies that improve human well-being are considered relevant.

In recent years, however, the discussion about smart cities has moved beyond their being techno-centric or life-centric. It has been argued that technology is not enough if the citizen cannot use it or perceive its applicability [44]. There is no point in making significant investments in technology if the citizen is unwilling to adopt it. This discussion corroborates a more current view of smart cities, which is no longer driven by a largely techno-economic approach but has shifted towards a decentralized, anthropocentric approach focusing on ways by which to foster collaboration and community involvement [24,45].

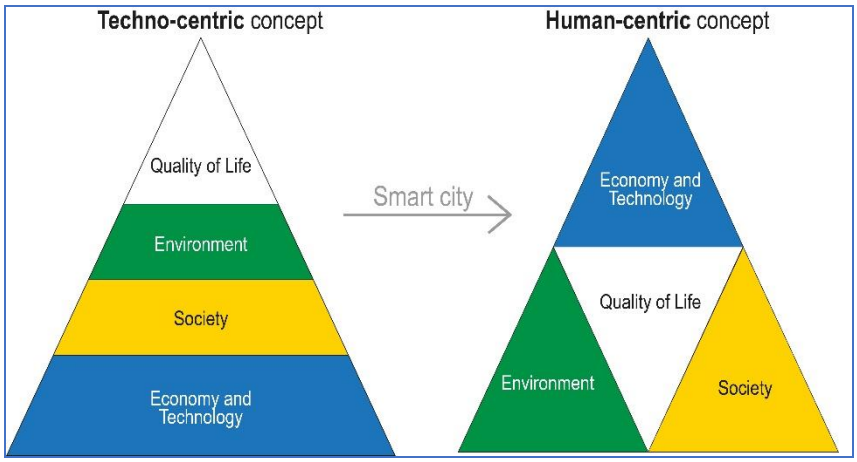

Figure 4. The concept of the smart city from the traditional techno-centric conception to a human-centric conception. Source: [9]. Adjusted by the author.

Likewise, the concern with the scarcity of natural and productive resources, energy resources, and urban density provokes stimuli to processes of change so that the emergence of intelligent and engaged cities, governments, and citizens is possible. Concern about environmental and climate issues, in particular, has been growing in recent years. Companies, governments, and individuals have adopted more conscious attitudes in their activities. Additionally, a better understanding of the role of technology in smart cities allows it to enable social, environmental, economic, and cultural progress [18,46]. From this point of view, sustainability and improving the quality of life are the main objectives of smart cities, more so than the technology itself [16,47–50]. Thus, sustainable cities may be understood as integrating socio-cultural, economic, and environmental aspects and could function as an umbrella, where other concepts, such as the smart city, are located below it. The primary goal of these would be to improve the sustainability of cities through the application of ICT, the collaboration of key stakeholders, and the integration of different themes [2].

It is understood, therefore, that the use of technologies, the concern with sustainable development, and the search for quality of life are recurring factors in the different concepts. Thus, within the scope of this research, a smart city is not considered a final destination, but an approach, or culture, that uses available technologies as a tool that may improve the quality of life in cities in a socially, environmentally, and economically sustainable manner (Figure 5).

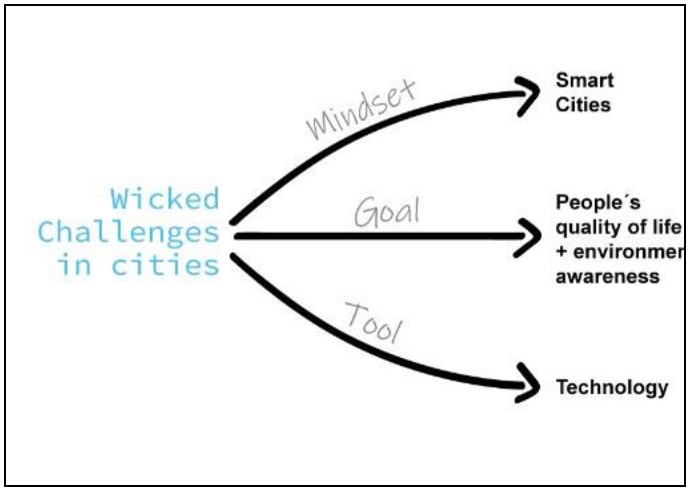

Figure 5. The essential of the smart city's concept.

Although the discussions are comprehensive and cover the primary objectives for cities—including the unprecedented presence of the use of ICT, the digital transformation that the world is experiencing, the amount of data produced, and the growing environmental awareness—it is not clear in the literature how to classify whether or not a city is a smart city. Although it is clear that cities have their own characteristics, those that call themselves smart cities lack universality or standardization [23]. Even though many studies have focused on smart cities, knowledge about the criteria that can be used to define a city as smart or to measure its degree of smartness remains limited [10].

According to the literature review focused on the assessment of smart cities, the benefits of such assessments can be of use to authorities, investors, funding agencies, researchers, and citizens and can include the following: performance monitoring; investment attraction; the identification of strengths and weaknesses; a better understanding of socio-environmental and technical implications of projects; benchmarking analysis for learning; stimulating discussions; the prioritization of funding allocation; the identification of new business opportunities; the development of studies to increase performance; the simplification of the complexity of the concept; public awareness of the benefits; the development of skills to make decisions about future investments; and the promotion of citizen engagement [2,35,51–59]. However, it is unclear which attributes should be considered and prioritized to structure a smart city project.

Previous studies about models or frameworks to help plan projects for smart cities are mostly restricted to a specific theme or territory. Mobility [60–63], data [64–68], urban planning [69–72], energy [73–75], security [76–79] and economics, partnerships and innovation [80,81] are examples of prevalent themes in articles about smart city's projects. A significant number of studies combine a theme and a specific region [82–93].

Some articles do not correlate smart city projects to a specific theme, instead keeping a broader vision, but the goal is to evaluate, scale or replicate projects and not to support a decision to start a new project [94–99]. Hearrshana, R. [100] points out how the conditions of governmental organizations may influence technology enactment in smart city projects, but the focus is on the adopter and not on the project's planning. Holzmann, V. [101] focuses on future managers that will plan a project for the city and not on the project's aspects.

Attaran [29] corroborates with the necessity of having a more general and integrated smart city model, comprehensively for a variety of purposes and applications. The proposed diagram connects the different themes, identifies the existing relationships, and is closely related to this study; however, it is based on the six dimensions of smart cities proposed by Giffinger [35], which focuses on the European model of smart cities, and sustainable development aspects of the city as a whole are under-represented. As a methodology, the authors analyze each of the six dimensions and then propose a model based on the conclusions. The study from Angelakoglou et al. [102] has the energy transition as a core focus. However, despite the specific theme, they provide a broad view of key performance indicators (KPI) related to smart cities that may contribute to the present study. Furthermore, different assessments were analyzed through an iterative approach that required the active involvement of various stakeholders. Therefore, the results are relevant to this study to promote comparability.

According to the review, there is a lack of knowledge regarding the starting point for planning a new smart city project. It is related to helping managers have a holistic view of the territory and perform suitable decisions on where to begin to face real-world problems, of a specific city, within the available resources.

Although the literature gap concerning how to design and implement strategies for smart city development represents an important line of investigation [31] in which researchers are investing significant efforts [56,103–110], the studies developed have not been able to fill the gap between theory and practice. Therefore, this study is focused on this line and has a practical purpose. It aims to identify and synthesize essential elements that should be considered to help prioritize and plan a smart city project. The result should be comprehensive for managers and entrepreneurs to act locally and maintain a global understanding of the city.

3. Methodology

The research began from the initial question, "what are smart cities and how are they being planned for the future of the population?" Based on a literature review regarding the definition of smart cities, it was concluded that there is no single and official definition for smart cities and that there is a diversity of information available. According to previous studies, a gap between theory and practice has not yet been fulfilled. This situation has led to confusion regarding the practical application of the concept in projects aimed at smart cities because there is a gap concerning the essential elements required to design a project for smart cities. The results of this step are presented in the literature review section of this article. Based on these findings, the current research question was elaborated as follows: given the diversity of the available information, what is essential when elaborating a smart city project? Our goal was to identify and present in a simple and synthetic way the essential elements that must be considered for the elaboration of projects and initiatives of smart cities, facilitating the action of entrepreneurs and governments. This study seeks to contribute scientifically, bringing new knowledge to the identified gaps, and to enable collaboration with managers, who may have more clarity on what to take into account when planning initiatives aimed at smart cities.

The definition of which groups of indicators would be analyzed was based on reviews of smart city indicators found in academic articles available from the Web of Science and Scopus databases [2,16,52,111–114]. This analysis included studies without thematic restrictions and those that were carried out from 2015 onwards.

According to the review of the literature, rankings and assessment studies of smart cities provide information on the characteristics of cities that make it possible to classify their smartness level. Moreover, the attributes present in them provide, in a practical way, guidelines for classifying a city as smart or not, as well as for indicating the resources they have or should have and, thus, contribute to medium- and long-term planning [111].

Huovila [115] carried out a comparative analysis of more than 400 indicators used in international documents to assess smart cities, and they identified a lack of balance between the different indicators, especially those related to sustainability and "smartness" [2]. This result may have implications for practical implementation and the reliability of comparisons between cities. It also highlights that the sets of indicators must be combined with the needs and objectives of the cities, thereby avoiding a poor evaluation of the city's development in cases where there is no alignment with the strategies devised by the managers.

An analysis of 16 indicators aiming to identify the similarities and differences of smart and sustainable cities [16] found that, although environmental sustainability is considered an essential aspect of smart cities, environmental indicators are under-represented. The author suggests that the use of indicators should not be limited to measuring the efficiency of smart solutions but should also include their impact and contribution towards the ultimate goals such as environmental, economic, or social sustainability.

An analysis of 34 sets of indicators [113] identified an imbalance in the distribution of indicators, a lack of attention paid to local contexts, and measures of engagement with key stakeholders, and that only a quarter of these tools link results to action plans. Subsequently, having found few analyses regarding the typology and structure of the evaluation schemes [114], 34 sets of indicators were analyzed again in order to provide better information to the end user for the evaluation process.

Based on this review, the selected sets of indicators for this research had the following criteria: rankings with evaluations of more than 100 cities from different countries and cultures; global standards applicable to any city, regardless of size and origin; academic publications containing indicators with high reach and recurring application; and material whose data are open for consultation. These criteria take into account the fact that there is no standardization of a single concept and the importance of considering the particularities of each city.

This research, therefore, covered the following six groups of indicators:

- The smart cities scheme proposed by Giffinger [35], composed of 6 themes and 34 indicators.
- The Cities in Motion Index (IESE) [116], composed of 9 themes and 101 indicators.
- The Connected Smart Cities ranking (Urban Systems) [117], composed of 11 themes and 75 indicators.
- ISO 37122 (International Organization for Standardization—ISO) [118], composed of 19 themes and 80 indicators.
- The Smart and Sustainable Cities Maturity Model (ITU) [119], with 3 dimensions, 19 themes, and 103 indicators.
- The Bright Cities ranking [120], composed of 10 themes.

The following step consisted of analyzing the selected groups, with the following as the units of research:

- Identification and selection of the most frequent themes in the field of smart cities.
- Identification and selection of indicators related to each of the selected themes.

A comparative analysis of the themes was carried out to identify the similarities and frequencies. The most frequently recurring themes were selected as essential.

The analysis for the selection of indicators was focused on those present in the selected themes. After processing the data, especially those concerning synonyms and the identification of key terms, the frequencies at which the words appeared in the themes were evaluated. Additionally, a word cloud was generated with the terms.

As a result, the essential information in the groups of indicators was identified.

The final step consisted of aggregating the results so as to present the essential information regarding the construction of projects aimed at smart cities.

Figure 6 contains a flowchart of the macro-steps of this study.

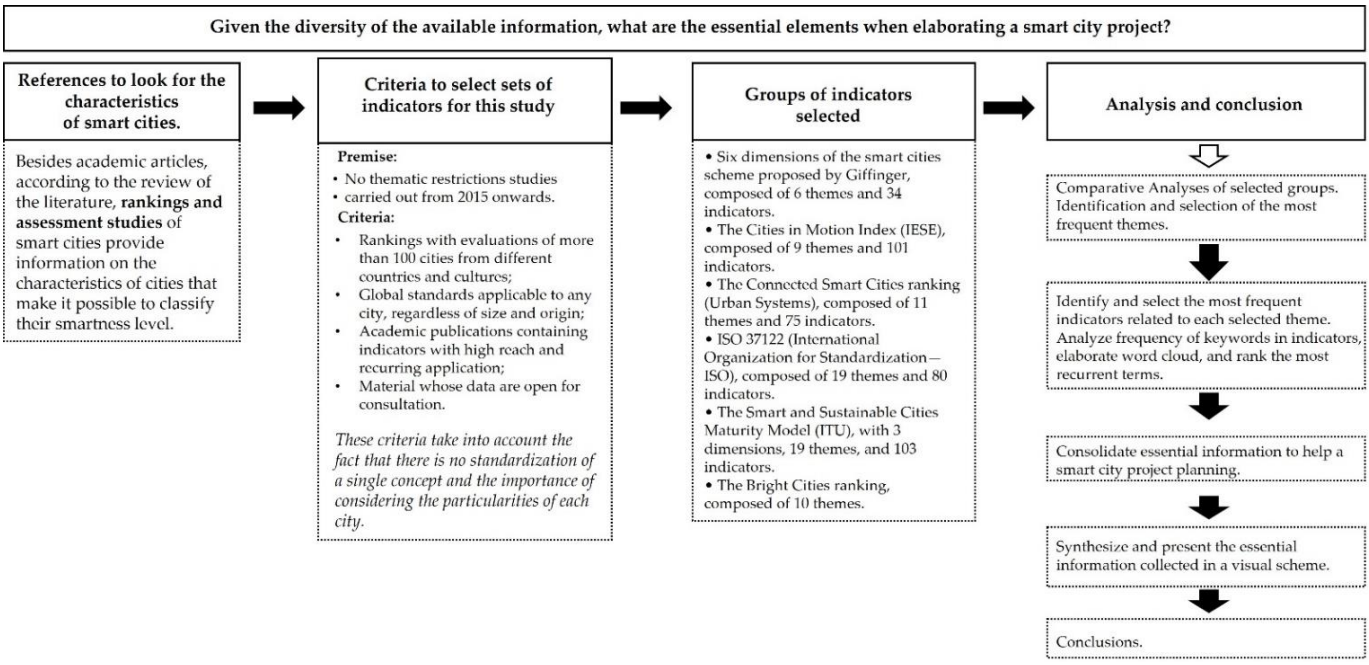

Figure 6. Study flowchart.

4. Results

4.1. Groups of Indicators Analyzed

Giffinger [35] mapped the six characteristics that he considered the most relevant and necessary to be present in cities for them to be considered smart (i.e., economy, people, governance, mobility, environment, and life) and also identified indicators for each of them. This model (Figure 7) was designed with medium and large European cities as parameters.

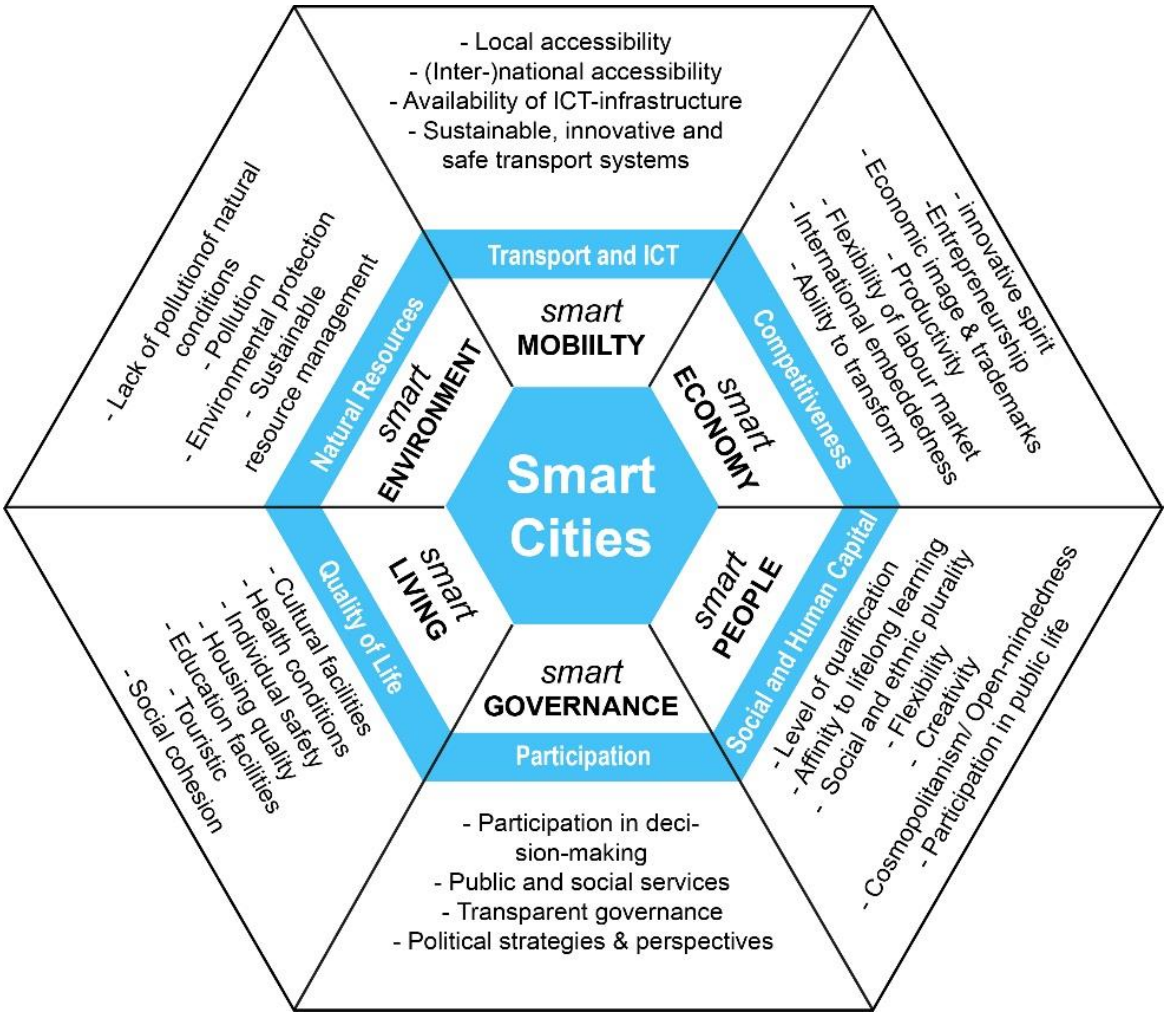

Figure 7. Smart cities' dimensions and indicators according to Giffinger. Source: [35]. Adapted by the author.

The IESE Business School of the University of Navarra has published the IESE Cities in Motion ranking since 2014 [116]. This ranking is present in practically all of the reviews consulted, and it compares cities of different origins (Figure 8).

These models would make sense if the solutions generated effectively provide a harmonious and balanced composition among all their dimensions and attributes. However, it is challenging to plan solutions that fit into just one of the themes. For example, the pandemic caused by COVID-19 had a high impact on governance, the economy, and people's lives, in addition to causing changes in other aspects: the failure of public safety management, which involves both lighting infrastructure and street policing, negatively impacts the image of a place, reducing the flow of tourists and resulting in economic losses and financial losses for the three sectors of society; the lack of basic sanitation and the deficiency in the management of residues imply an increase in expenses for the management of the consequences in public health; and the population's level of schooling is directly related to the fertility rate, indicating that there is a link between low education and an increase in childhood and adolescence pregnancies and all the related complications, including those referring to the increase in poverty levels. In other words, a holistic and systemic view is needed for these variables and for the solutions derived accordingly, which, thus, must be planned in an integrated manner.

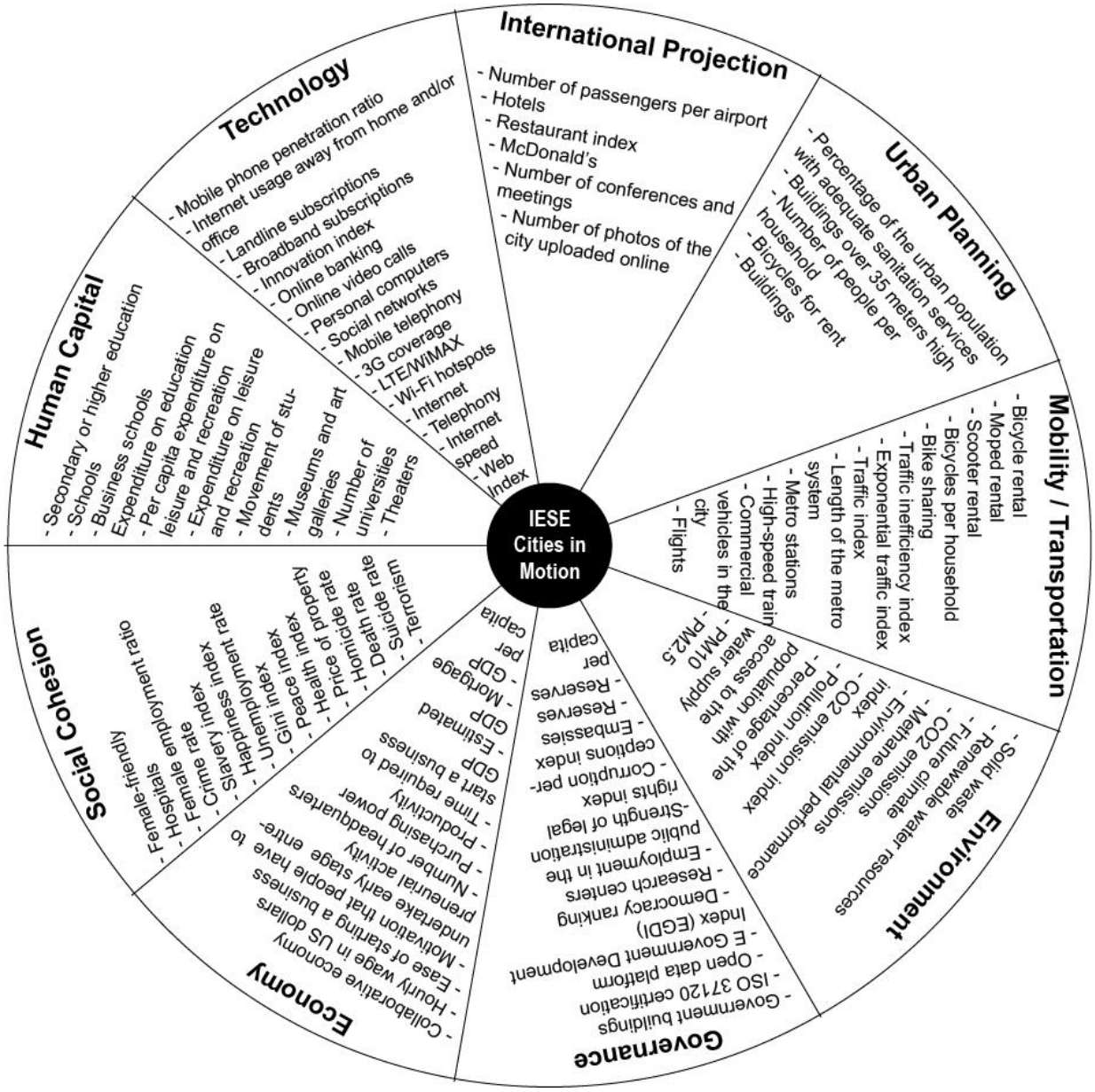

Figure 8. Cities in Motion ranking by IESE. Source: [116]. Adapted by the author.

The Connected Smart Cities ranking [117] has already analyzed more than 800 Brazilian cities with more than 50,000 inhabitants since 2015. To identify themes and indicators, this ranking takes into account, among other studies, the IESE Cities in Motion [116]; Innovation Cities, Innovation Cities Program [121]; ARCADIS Sustainable Cities Index [122]; the World Council on City Data [123]; ISO 37120—sustainable development of communities—indicators for city services and quality of life; ISO 37122—sustainable cities and communities—indicators for smart cities; and ISO 37123—sustainable cities and communities—indicators for resilient cities [118]. This ranking allocates variables in more than one theme, indicating their connections and allowing an integrated reading. Figure 9 shows how many indicators of each thematic axis influence others. The greater the external influence, the greater the size. Mobility, for example, has eleven indicators: it is influenced by a safety indicator, and it has seven of its own that exert external influence. Among the safety indicators, three are specific and influence other topics, and one is the result of the influence of the environment theme. Governance, in turn, appears as a theme resulting from other indicators since 60% of its indicators are originally from other areas. It has twelve

indicators in total; it is influenced by seven indicators from other themes and influences only the technology and innovation themes. This possibility of reading, considering the influences, facilitates the identification of driving themes and prioritizing actions. However, it does not provide guidelines for action.

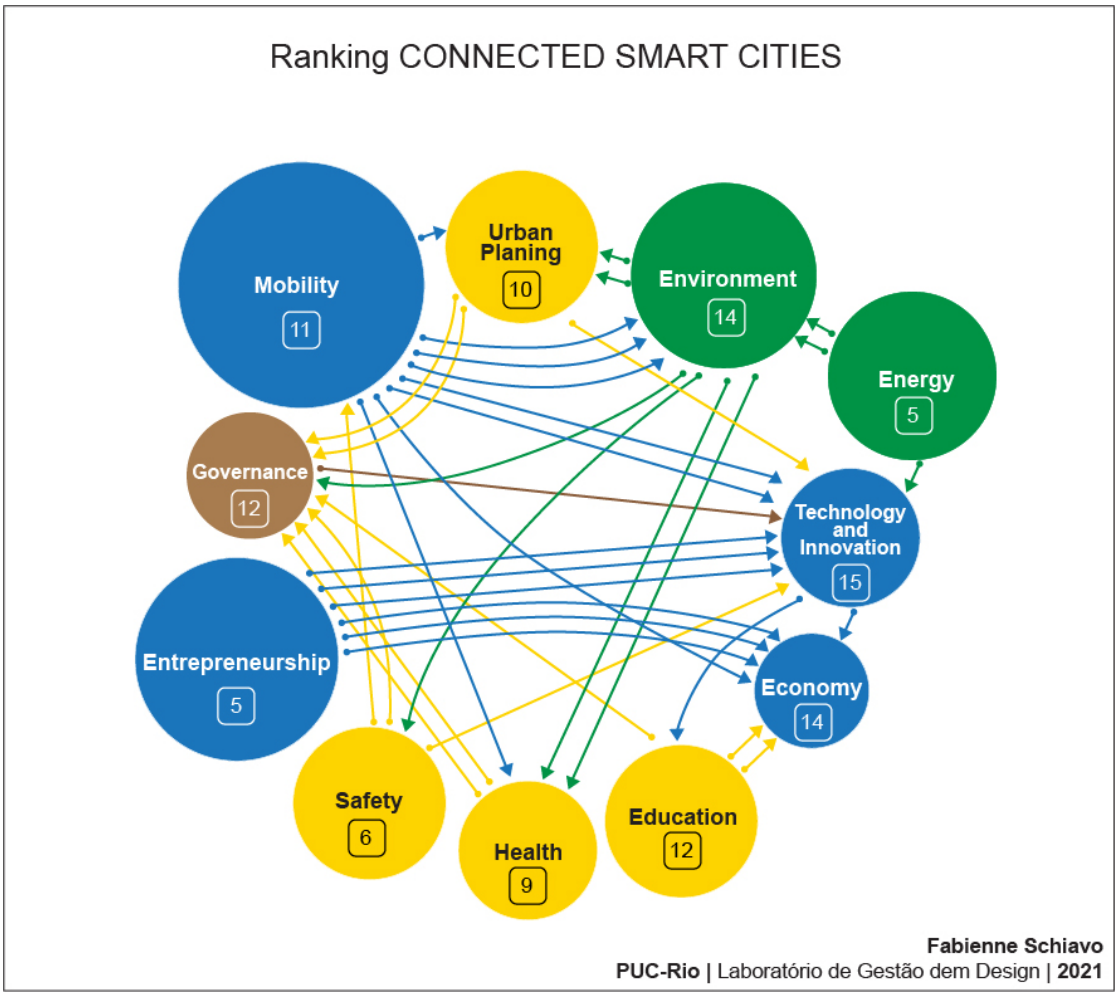

Figure 9. Themes and influences within the Connected Smart Cities ranking. Source: Connected Smart Cities Report [117]. Influence chart created by the author.

The ISO 37122 (Indicators for Smart Cities) is an international standard that considers sustainability as a general principle and the "smart city" as a guiding concept in the development of cities. When used with ISO 37120 (Indicators for Urban Services and Quality of Life), this standard helps cities identify indicators for the application of management systems and for the implementation of smart city policies, programs, and projects. Allowing an integrated vision with the issues that the indicators reflect, the sustainability purposes that they contribute enable and facilitate the planning of initiatives aligned with the city's strategic goals (Figure 10).

The smart sustainable cities maturity model created by the International Telecommunications Union (ITU) organizes the indicators according to the following dimensions of sustainability: economic, social, and environmental (Figure 11). However, it does not allow the reading of inter-relationships.

In addition to these, there is also the "Bright Cities" set of indicators. However, only the themes were considered in the analysis as the indicators' data are not available for consultation.

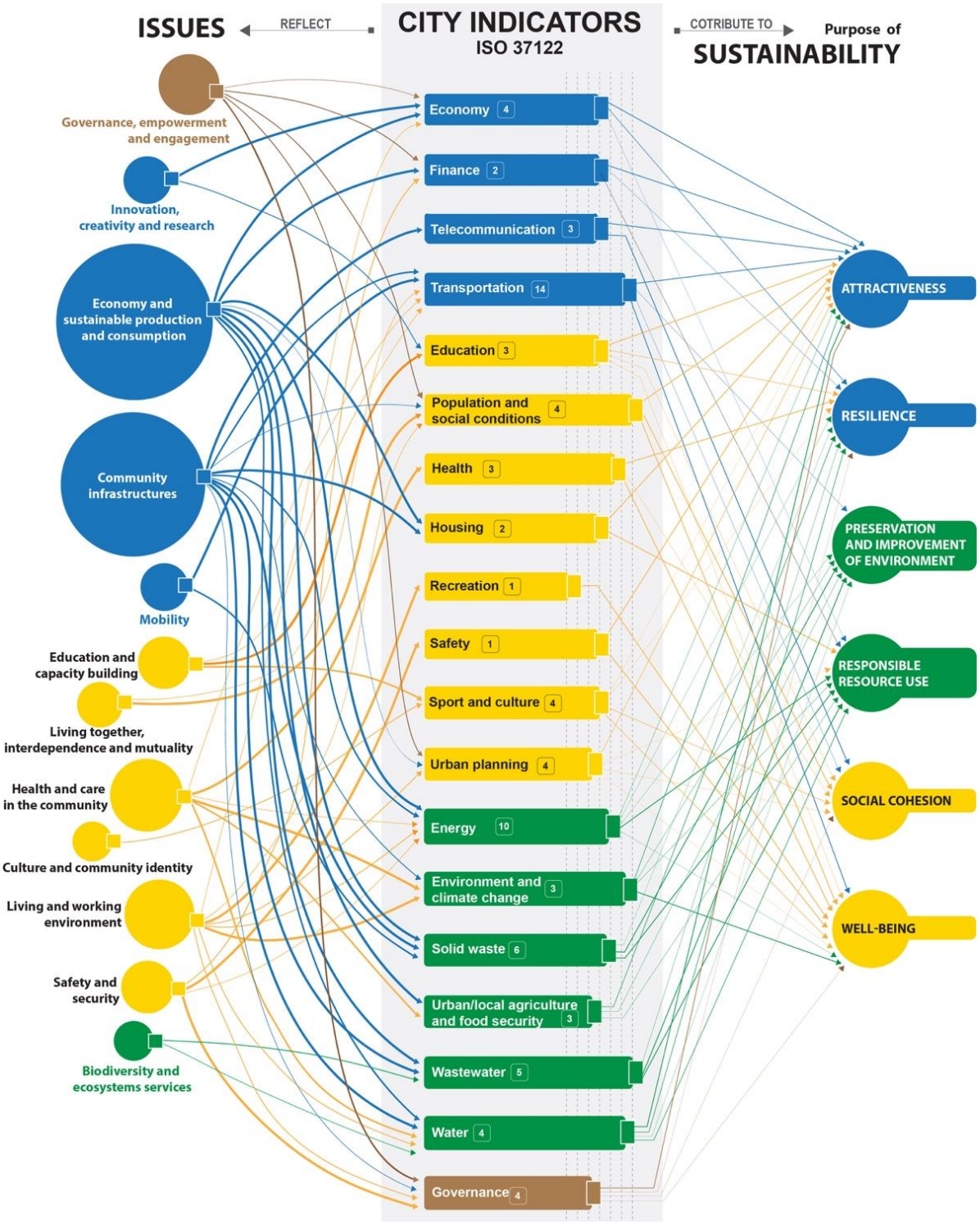

Figure 10. Themes, influences, and contribution to sustainability within ISO 37122. Source: [118]. Influence chart created by the author.

It could be clearly perceived that, from the perspective of reading and analysis, there are three types of sets of indicators: those that are simply presented without correlations or categorization; those that classify the indicators in macro dimensions (ITU); and those that indicate inter-relationships (Connected Smart Cities and ISO 37122).

Table 2 resumes the individual analyses presented in this article.

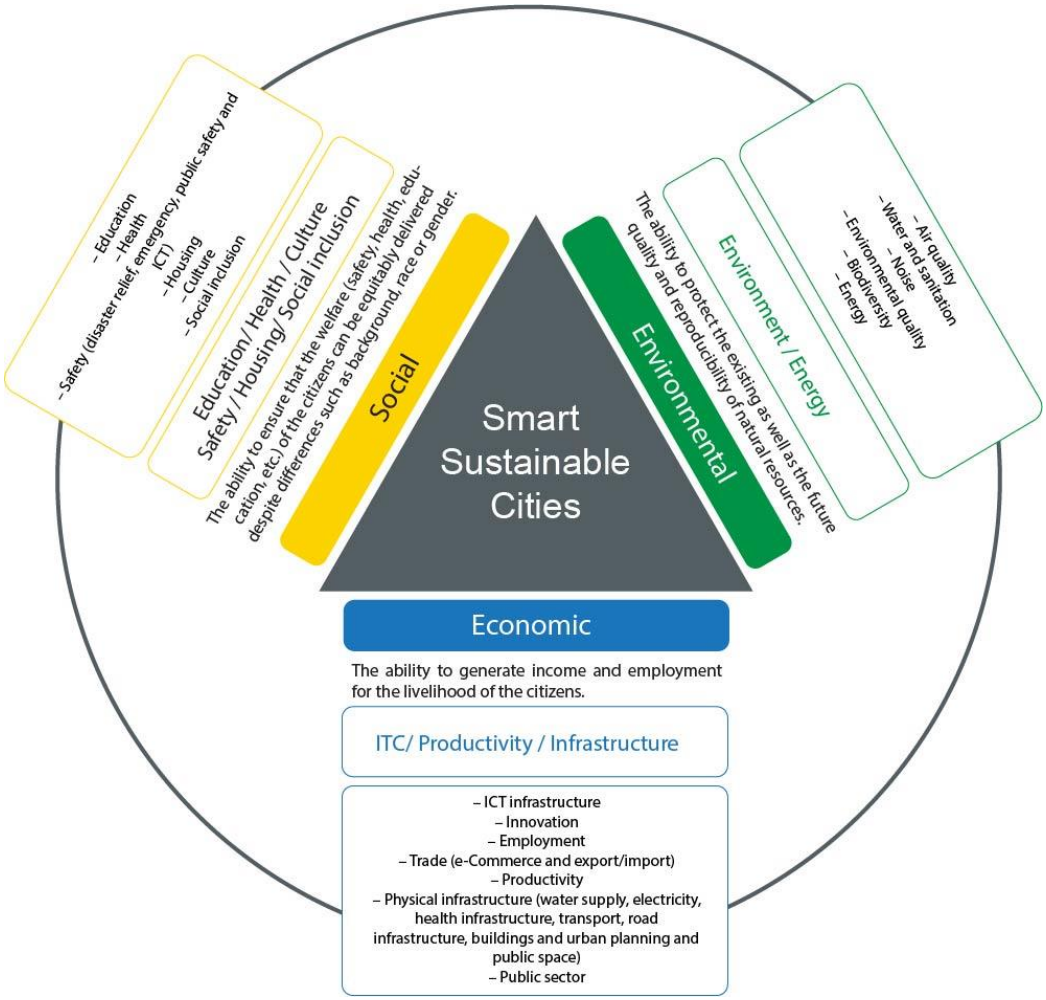

Figure 11. The tree dimensions of the smart sustainable cities maturity model and its categories. Source: [119,124]. Adapted by the author.

Table 2. Groups of indicators analyzed.

Groups of Indicators	Themes/Indicators	Analysis (Pros and Cons)	Types of Groups of Indicators (from the Perspective of Reading and Analysis)
The six dimensions of smart cities (Giffinger)	6/34	• The six dimensions proposed by Giffinger are most frequent in academic studies. • This model was designed with medium and large European cities as parameters. Thus, indicators may not be entirely adequate for cities from the global south. • There is no connection among themes.	Indicators without correlations or categorization
The Cities in Motion Index (IESE)	9/101	• This ranking is recurrent in academic articles and compares cities of different origins. In addition, it has been published since 2014, enabling historical analysis. • There is no connection among themes.	Indicators without correlations or categorization

Table 2. *Cont.*

Groups of Indicators	Themes/Indicators	Analysis (Pros and Cons)	Types of Groups of Indicators (from the Perspective of Reading and Analysis)
The Connected Smart Cities ranking (Urban Systems)	11/75	• This ranking has already analyzed more than 800 cities with more than 50,000 inhabitants in Latin America (LA). Nonetheless, indicators may not be entirely suitable for cities outside LA. • It has been published since 2015, enabling historical analysis. • It has used relevant studies in its composition. • It allocates variables in more than one theme, indicating their connections and allowing an integrated reading.	Present indicators and indicate inter-relationships
ISO 37122 (International Organization for Standardization—ISO)	19/80	• It is an international standard from a well-established organization. • It allows an integrated vision with sustainability purposes. • It is complex, and its adoption may require specialists.	Present indicators and indicate inter-relationships
The Smart and Sustainable Cities Maturity Model (ITU)	19/103	• It is an international model from a well-established organization. • The model organizes the indicators according to the sustainability dimensions. • It does not allow the reading of inter-relationships.	Classify the indicators into the sustainability dimensions

4.2. Comparative Analyses

The first comparative analysis was based on the themes addressed. The results indicate that there is no unity among the different groups, corroborating the findings of A. Huovila [115] and C. Patrao [2].

The consolidation of the themes (Table 3) indicates that, generally, the recurring themes within the scope of smart cities are education, health, safety, environment, economy, governance, mobility, and technology and innovation.

Education, health, safety, and the environment are topics considered by all. Governance, mobility, economy, and technology and innovation are also recurring themes and are considered in five of the six analyzed references.

In another group, there were themes considered in four of the six references: urban planning, entrepreneurship, energy, solid waste, housing, and culture. Here, it is essential to emphasize that entrepreneurship is considered a theme by some, while by others it is incorporated into economy. The same happens with solid waste, which can be found within the theme of the environment and also within the theme of culture, sometimes inserted into education.

Subsequently, there are the following themes present in two of the six references that are considered to be of low relevance: water, sewage, and population. Although not frequent as a thematic axis of their own, water and sewage are indicators commonly included in the evaluation and can be found within the environment axis.

Finally, the following topics occasionally appear: international projection, finance, telecommunications, infrastructure, and recreation. The latter, however, also appears as an indicator of the economy theme.

Table 3. Comparison of themes within the six groups of indicators analyzed.

	Connected Smart Cities	IESE	Bright Cities	ISO 37122	Maturity Model (ITU)	Giffinger	Frequency %
Education	X	X (human capital)	X	X	X	X (life)	**100%**
Health	X	X (social cohesion)	X	X	X	X (life)	**100%**
Infrastructure					X		**17%**
Mobility urban/transport	X	X	X	X		X	**83%**
Environment	X	X	X	X	X	X	**100%**
Urbanism/urban planning	X	X	X	X			**67%**
Safety	X	X (social cohesion)	X	X	X	X (life)	**100%**
Technology and innovation/ICT	X	X	X		X	x (econ.)	**83%**
Economy	X	X		X	X (dim.)	X	**83%**
Entrepreneurship	X		X			x (econ.)	**50%**
Governance	X	X	X	X		X	**83%**
Energy	X		X	X	X		**67%**
International projection		X					**17%**
Finance				X			**17%**
Telecommunication				X			**17%**
Waste solids	X (env.)	X (env.)		X			**50%**
Water	X (env.)			X			**33%**
Sewage	X (env.)			X			**33%**
Housing				X	X	X (life)	**50%**
Population/social conditions				X		X	**33%**
Recreation				X			**17%**
Culture/sport				X	X	X (life)	**50%**
Productivity					X		**17%**
Social inclusion					X	X (pop.)	**33%**
Life						X	**17%**

Table 4 consolidates the frequent themes, organizing them according to the dimensions of sustainability. In this case, the governance theme becomes transversal to the three dimensions.

Table 4. Most frequent themes within the six groups, organized by sustainability dimensions.

	Sociocultural Dimension	**Environmental Dimension**	**Economic Dimension**
More recurrent themes	Education Health Safety	Environment	Economy Mobility Technology and innovation
	Governance (Transverse Dimension)		

From the eight most recurrent themes, the indicators related to each were gathered to identify the common parameters. The research considered five groups of indicators—two rankings with a history of five years or more—and open data from the following: Connected Smart Cities and Cities in Motion, the smart sustainable cities maturity model (ITU), the six dimensions of Giffinger, and ISO 37122.

Within the education theme, the most frequent indicators were public, school, education, and culture.

The recurrent indicators for education, that is, those that appeared in at least 30% of the citations, were the following: public, school, education, culture, student, online, and management (Figure 12).

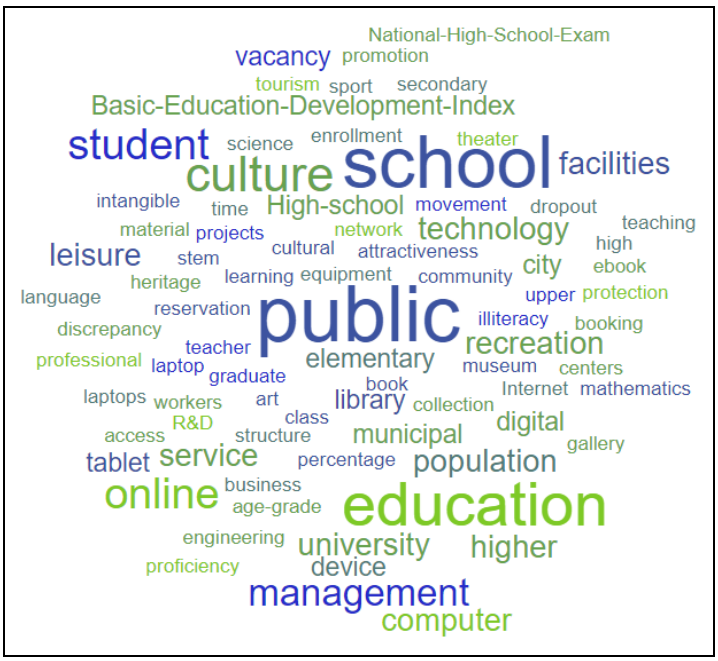

Figure 12. Most frequent indicators within the theme of "education".

Recreation and culture are considered by some as part of the "education" theme and by others as a separate theme. In this research, they were considered part of education.

Within the health theme, the most frequent indicators were the following: online, health, public (management/network), and doctor.

The recurrent health indicators, that is, those that appeared in at least 30% of the citations, were the following: online, health, public, doctor, network, job, record, female, bed, municipal, and management (Figure 13).

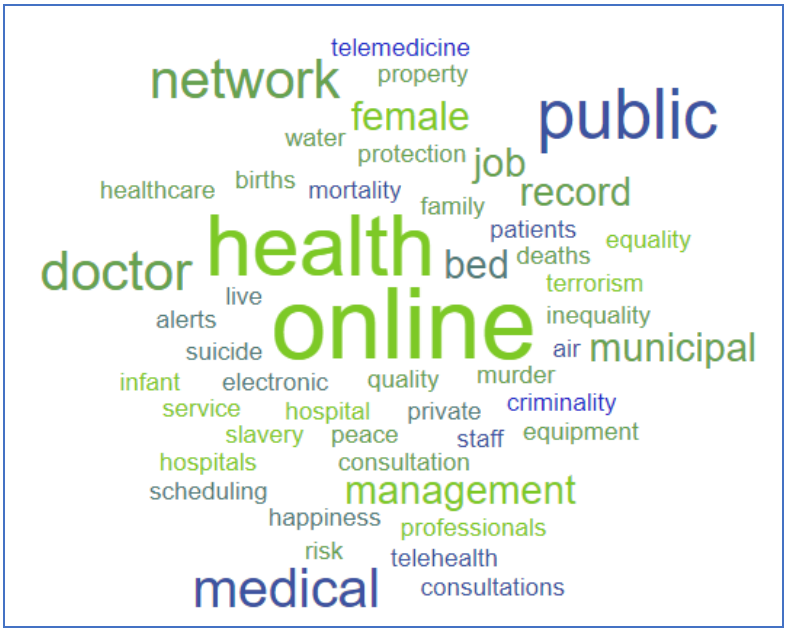

Figure 13. Most frequent indicators within the theme of "health".

Within the safety theme, the indicators referring to murder and safety were the most frequent.

The recurring safety indicators, that is, those that appeared in at least 50% of the citations, were the following: murder, safety, solution, management, traffic, monitoring, and public and natural disasters (Figure 14).

Figure 14. Most frequent indicators within the theme of "safety".

Within the environment theme, indicators referring to water and waste were the most frequent.

The recurring environmental indicators, that is, those that appeared in at least 30% of the citations, were the following: water, waste, monitoring, city, quality, smart, air, collection, solution, and sewage (Figure 15).

Figure 15. Most frequent indicators within the theme of "environment".

The "environment" theme in particular contained more indicators than other themes. Extending the frequency analysis to terms that appeared in at least 20% of the citations, the

following were added: distribution, amount, on-time, management, energy, consumption, service, station, plastic, environmental, and emissions (CO_2 or methane).

Within the economy theme, the most frequent indicators were the following: business, quantity, and growth.

The recurring economic indicators were the following: business, quantity, growth, GDP, workers, income, infrastructure, technology, productivity, and entrepreneurship (Figure 16).

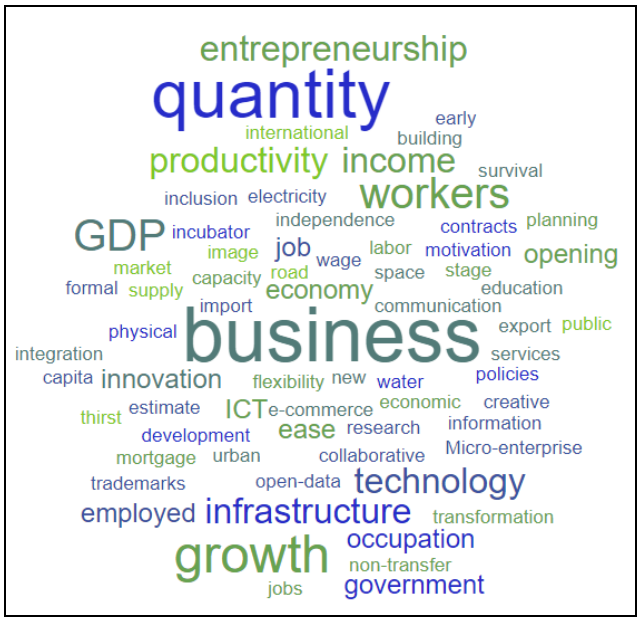

Figure 16. Most frequent indicators within the theme of "economy".

Entrepreneurship is considered by some as part of the economy and by others as a separate theme. This research incorporated it into the economy theme.

Within the mobility theme, the most frequent indicators were the following: system, public transport, and city.

The recurring indicators of mobility, that is, those that appeared in at least 30% of the citations, were the following: system, public transport, city, vehicle, traffic, bike, on-time, and population (Figure 17).

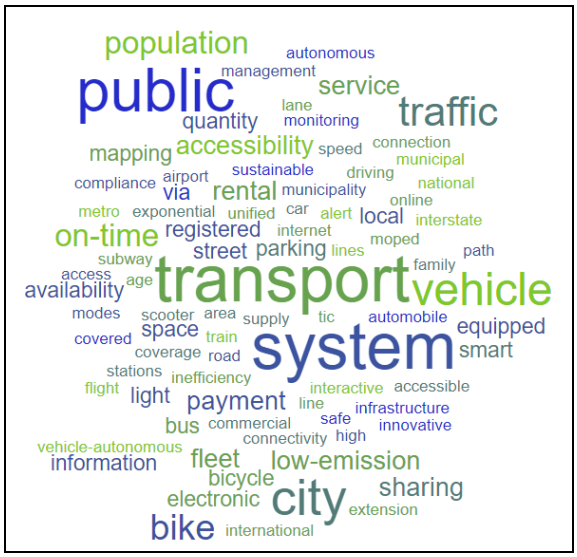

Figure 17. Most frequent indicators within the theme of "mobility".

The following terms were also relevant, appearing in at least 25% of the citations: accessibility, rental, fleet, service, payment, sharing, and low-emission.

Within the technology and innovation theme, the most frequent indicators were the following: internet, coverage, worker, and broadband.

The recurring indicators of technology and innovation, that is, those that appeared in at least 50% of the citations, were the following: internet, coverage, worker, broadband, municipality, speed, cell phone (mobile), online, and subscription (Figure 18).

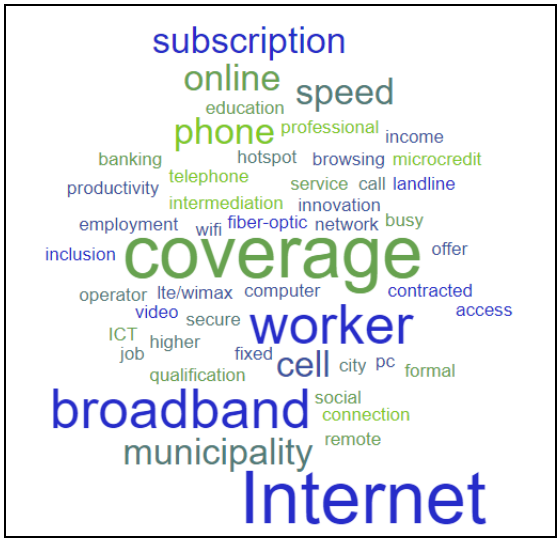

Figure 18. Most frequent indicators within the theme of "technology and innovation".

Within the governance theme, the most frequent indicators were the following: city, service, population, open data, participation, and online.

The recurring governance indicators, that is, those that appeared in at least 50% of the citations, were the following: city, service, population, open data, participation, online, economy, transparency, website, agility, services, public, platform, city hall, and management (Figure 19).

Figure 19. Most frequent indicators within the theme of "governance".

4.3. The Synthesis

Below are the analyses of the indicators present in each theme. To compare the indicators and find the similarities, the keywords of the indicators were used. Table 5 synthesizes the information analyzed.

Table 5. Consolidation of the most frequent indicators within all eight themes.

Sociocultural Dimension		**Environmental Dimension**		**Economic Dimension**	
Theme	**Indicators**	**Theme**	**Indicators**	**Theme**	**Indicators**
EDUCATION	**Public** **School** **Education** **Culture** *Student* *Online* *Management*			**ECONOMY**	**Business** **Quantity** **Growth** *GDP* *Workers* *Income* *Infrastructure* *Technology* *Productivity* *Entrepreneurship*
HEALTH	**Online** **Health** **Public** **Doctor** *(Public) Network* *Job* *Female* *Record (electronic medical record)* *Bed* *Municipal* *(Public)* *Management*	**ENVIRONMENT**	**Water** **Waste** *Monitoring* *City* *Quality* *Smart* *Air* *Collection (waste collection)* *Solution* *Sewage*	**MOBILITY**	**System** **Public transport** **City** *Vehicle* *Traffic* *Bike* *On-time* *Population*
SAFETY	***Murder*** ***Safety*** *Solution* *Management* *Traffic* *Natural disaster* *Monitoring* *Public*			**TECHNOLOGY AND INOVATION**	**Internet** **Coverage** **Worker** **Broadband** *Municipality* *Speed* *Cell phone* *Online* *Subscription*
Transverse Dimension					
Theme				**Indicators**	
GOVERNANCE				**City** **Service** **Population** **Open data** **Participation** **Online** *Economy* *Transparency* *Web site* *Agility* *Services* *Public* *Platform* *City hall* *Management*	

Among the most frequent, the most recurrent terms were the following: public, online, management, and city.

Given the diversity of information available, it is understood that the following are standard guidelines for smart cities: maintaining a public-centric approach; prioritizing online tools; prioritizing innovative ways of management; and focusing on cities' issues ("think globally, act locally").

5. Discussion

According to this research, it has become clear that the smart city is not defined by any single rigid concept. Instead, it makes more sense to associate a smart city with a mindset. In other words, a smart city indicates a direction combined with a management culture. Technology, in turn, is a tool, and people's well-being is the goal.

This research has focused on clarifying, for the benefit of managers and entrepreneurs, what should be considered and prioritized to structure a smart-city project.

The city was one of the terms most present in the indicators analyzed, reinforcing the importance of defining the territories in which one is acting. This result is in line with the findings of [23,41]. Therefore, this indicates that an initial stage of understanding regarding the city—its inhabitants and frequent visitors, needs, political structures, history, socioeconomic profile, habits, and culture—is fundamental for the planning of any initiative because, according to the review, it is precisely due to each location having its own characteristics that prevents a single definition of a smart city and the development of a model to be copied.

Along with the "city", "public", "management", and "online" constitute a group of the most recurrent terms within the sets of the indicators analyzed. This result is in line with the most frequent words in the different definitions of smart cities [18,21,23,39]—quality of life, services, citizens, ICT, and the fact that there is even a common objective among the lack of consensus on a definition—for the improvement of the quality of urban life [2,42]. Therefore, it makes sense to think of cities as spaces for citizens to inhabit with a good quality of life and to be able to exercise their duties and enjoy their rights with dignity. New technologies, in turn, can contribute to possible solutions that were previously unimaginable, such as the use of drones for monitoring or the use of artificial intelligence in management, effectively accelerating the achievement of the goals of smart cities. In smart cities, technologies are, therefore, tools to achieve something. Their usage, however, is not enough to classify a city as smart.

If the goal is to improve the quality of life through sustainably adopting technologies, then it is necessary to understand what this means before planning any initiatives. The World Health Organization [125] defines quality of life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. It involves well-being, social relationships, health, education, housing, sanitation, and other life circumstances. On the other hand, health is understood as a state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity. According to the results of this research, the goal of smart cities is, hence, the state of complete well-being. According to Martin Seligman's theory, this condition is supported by five pillars (Figure 20): positive emotions, engagement, relationships, meaning/purpose, and achievements [126], and it is related to the concept of flourishing.

Positive emotions refer to feeling good. They are a kind of common thread for well-being and satisfaction. They broaden the consciousness of individuals and stimulate new avenues through which one can explore thoughts and actions. They are responsible for feelings of joy and pleasure.

Engagement has to do with the state of being fully involved in the activities one performs. It concerns the conscious involvement of an individual with some occupation or work in which he/she uses his/her senses. It is usually associated with a challenge and is that moment when the individual does not feel time passing (having entered a flow

state). It occurs when there is a positive match between the person and the activity he/she is performing, and that activity should challenge the person's abilities.

Figure 20. PERMA model for Seligman's well-being theory. Source: [126]. Adapted by the author.

Relationships are associated with genuine connections between people. Positive relationships with family members, partners, friends, co-workers, and other people give a sense of support and connection. It is common for happy people to be sociable. Moments of intense emotion often occur when people join together. Positive relationships are the foundation of positive institutions (family, business, and community).

Meaning concerns one's meaning or purpose in life. It is the individual's connection to something greater than ones' self. According to [126], people linked to some kind of spirituality always appear happier and with greater well-being. Another way to connect with "something bigger" is through volunteer work.

Achievements are related to the feeling of conquest. They refer to achieving established objectives. They can be momentary (unrelated to a greater purpose) or a life milestone (imbued with meaning). Achieving life goals contributes to increased well-being.

Figure 21 compiles the most relevant information gathered in the research that should be considered when thinking about initiatives for smart cities:

- The central objective, which is well-being, and towards which all initiatives must be directed (a human well-being-centered approach);
- The economic, environmental and sociocultural dimensions of sustainability that must be managed and kept in balance, allowing the territory to sustain itself over time;
- The eight themes that must be worked on in a dynamic and integrated manner, considering the influences they exert on each other;
- Keywords to facilitate outlining specific objectives for each theme;
- The indicators that support the management of each theme and city, allowing continuous monitoring, situational diagnosis, iterative action, impact assessment, and corrective actions.

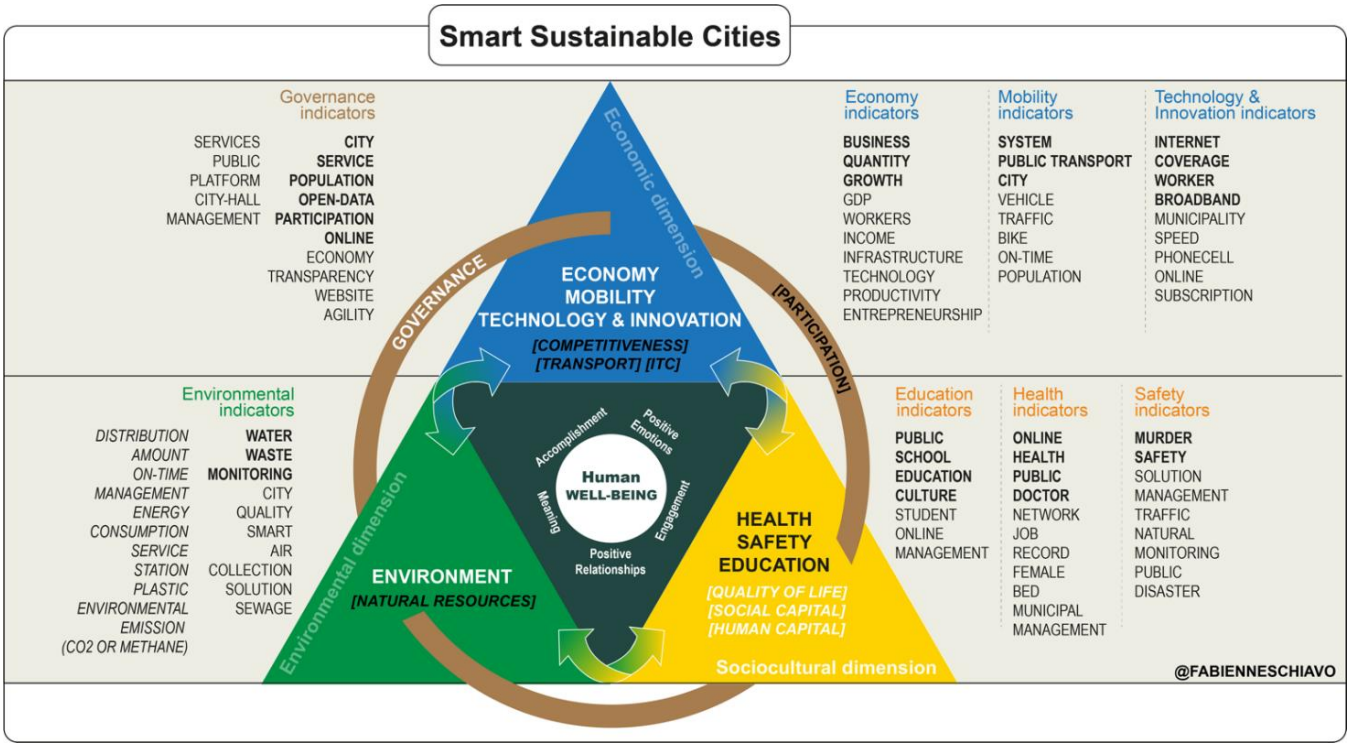

Figure 21. Synthetic scheme to plan initiatives for smart sustainable cities—a new proposal.

The proposed compilation of information differs from the study by Angelakoglou et al. [102], with the energy transition as a core focus. In the new one, "energy" was considered part of "environment," and "propagation" was not relevant among the set of indicators studied. ICT appears as a transversal to "economy", "mobility", "technology", and "innovation" and not as a single theme. Governance appears transversal to all. Finally, "social" is a dimension that includes health, safety, and education.

Compared to the model proposed by Attaran [29], the new one organizes information within the sustainable logic and indicates inter-relations among themes. The existent model may be combined with the suggested one in the later stages of the project.

This new scheme synthesizes the essential attributes that must be included in the projects and initiatives of smart cities and aim to facilitate the action of entrepreneurs and government officials.

The information is described and organized as follows:

- In the middle is the central objective, to which every initiative must be directed. For this reason, the model is labeled a human-well-being-centered approach.
- The social, environmental, and sociocultural dimensions of sustainability act as a cluster to all other information. The form of a triangle is associated with the triple bottom line approach to sustainability [127]. It is always necessary to keep a balance among all of them, enabling the sustainability of the territory. The scheme also points out their inter-relations, indicating that an integrated view is essential as they influence each other.
- It contains the eight recurrent themes: environment, education, health, safety, economy, mobility, technology, and governance. Seven are organized according to the dimensions of sustainability, and governance is transversal to all others.
- It brings the key terms for each dimension and the transversal theme: natural resources; competitiveness; transport; ICT; human capital; social capital; quality of life; participation. These terms help to formulate questions for the diagnosis and orient objectives.

- The indicators for each theme are described in order of frequency, close to the main structure. They may guide the project's planning and monitoring tools according to the diagnosis of the city.

In order to maintain a human-well-being-centered approach, the initiatives must include the following: causes relevant to the population of the territory; the development of networks that allow the relationship and promote the participation and engagement of the population; and decentralization so that there is a more significant number of small projects achievable, as opposed to a large and complex project, thereby enabling small achievements. In addition, a sense of belonging, accomplishments, and action concerning the causes of cities will trigger positive emotions.

In short, a smart city is a culture and indicates a direction; technology is a tool; and well-being is an objective.

To move in this direction, the following is necessary:

- Knowing the particularities of the city: its needs, strengths, vocation, and identity.
- Creating with and for the people who live in the city.
- Having purposes that positively impact people's lives.
- Using technologies to accelerate achievements and enable sustainable development.
- Developing innovative projects: small achievable initiatives, anchored in causes, capable of creating a network of people who are involved and have roles, thus promoting positive emotions both throughout the process and in the achievements, generating well-being.

Finally, after consolidating the attributes that must be contemplated in projects and initiatives for smart cities within a single guideline, a new question emerges: how should one think about the use of technology with the purpose of citizens' well-being, which is the ultimate objective of sustainable smart cities? It is not enough to simply "fit" technologies into old solutions without the participation of citizens. The connection between new technologies and well-being requires innovative approaches, including taking local culture and people's participation into account. The hypothesis is intrinsically characterized by creativity and encourages a holistic view and systemic approach with a focus on the human being, participatory and collaborative methods, and iteration, thus contributing to the ways in which global challenges are faced and to making cities smarter and more sustainable. This should thus be a new research scope.

6. Conclusions

This study has achieved the objective of identifying the essential elements that must be considered in the projects and initiatives of a city that seeks to be ranked as smart, and these elements have been synthetically structured to facilitate the action of entrepreneurs and governments.

The work here not only qualitatively reports a mismatch of the attributes of smart cities but also provides a comparative analysis that supports practical applications of smart city projects.

Within the main results and findings, the following are highlighted:

- There is no official definition of a smart city, but there are recurrent terms covering different concepts: quality of life, services, citizens, and ICT.
- In smart cities, only those technologies that improve human well-being are considered relevant.
- In smart cities, investing in technology makes sense if the citizens are able to use it or perceive its applicability.
- In smart cities, decentralized, anthropocentric, and collaborative approaches that facilitate the engagement of their communities are prevalent.
- Global smart city indicator sets need to be used and interpreted in conjunction with local realities. In other words, the themes and indicators must be prioritized consider-

ing the needs and strategies of the cities. They cannot be used in the same manner for every city.
- A holistic and systemic view is needed for the variables that qualify smart cities and related solutions: connection and integration are needed.
- The groups of indicators are based on official data, which often no longer represent the reality of each city and may result in an inappropriate diagnosis for the planning of local strategies.
- There is a lack of a project vision when considering new approaches to old problems, creatively adopting technology, and seeking well-being in the city.
- For smart cities, it makes more sense to develop projects within achievable dimensions, executed by an engaged community and anchored in a known cause or purpose.

Given that the current view of smart cities is no longer driven by a largely techno-economic approach but has shifted towards a decentralized, anthropocentric approach, new policies focused on incentives for local initiatives must be promoted. The public sector must incentive decentralization and, thus, decrease the dependence on the government and increase local solutions that fit real-world challenges. Moreover, adopting a holistic and systemic view of the territory will facilitate integrating the efforts of the public and private sectors, social organizations, and the academy. The public sector of each city must lead the adoption of a global vision of the territory to facilitate the practical adoption of "think globally and act locally."

From a practical perspective, this study provides project managers with the essentials that must be considered, analyzed, and combined when planning initiatives toward a smart, sustainable city. These elements are essential, especially at the start point. However, according to the findings, they should not be used in the same way for every city, only official data are not sufficient to define a frame of the city, and citizen engagement is relevant. Thus, we recommend further study on methods to frame local diagnostic, where the elements identified in this study help structure the city framing.

Although the attributes of smart cities are relevant, the design dimension should be given greater consideration in future studies, as it is transversal to the essential themes. These projects, aimed at improving people's well-being in cities, must foresee small, achievable initiatives involving partnerships between people, companies, governments, and causes. These projects should be designed for communities or neighborhoods with cultural or socioeconomic similarities, composing a network and making it possible to obtain real and current data and promote the engagement of local people during the process. As a proposal for future work, we suggest developing methods for planning projects and initiatives that not only use past data, but also include real-time data, as well as the participation of citizens and the main stakeholders involved in each theme, prioritizing the relevant available technologies.

Author Contributions: Conceptualization F.T.S. and C.F.d.M.; methodology, F.T.S.; software, F.T.S.; validation, F.T.S. and C.F.d.M.; formal analysis, F.T.S.; investigation, F.T.S.; resources, F.T.S.; data curation, F.T.S.; writing—original draft preparation, F.T.S.; writing—review and editing, F.T.S.; visualization, F.T.S.; supervision, C.F.d.M.; project administration, F.T.S.; funding acquisition, F.T.S. All authors have read and agreed to the published version of the manuscript.

Funding: The authors thank for the financial support provided by the Brazilian funding agencies CNPq, CAPES, FINEP and FAPERJ. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—Brasil (CAPES).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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