

Article

# Smart Cities: The Main Drivers for Increasing the Intelligence of Cities

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**Abstract:** Since the concept of smart cities was introduced, there has been a growing number of surveys aiming to identify the dimensions that characterize them. However, there is still no consensus on the main factors that should be considered to make a city more intelligent and sustainable. This report contributes to the topic by identifying the most important smart city drivers from the perspective of professionals from four broad areas of expertise: applied social sciences, engineering, exact and Earth sciences, and human sciences, which provide important insights for the understanding of smart and sustainable cities. In this study, we conducted a wide and detailed literature review, in which 20 potential smart city drivers were identified. The drivers were prioritized from the results of a survey conducted with 807 professionals that work in the concerned field. The results showed that the seven drivers identified as the most important to increase the intelligence of cities are related to the governance of cities.

**Keywords:** smart city; sustainable city; smart governance; drivers

## 1. Introduction

In a context of the accelerated growth of cities and the increasing demand for solutions that enable more appropriate responses to sustainability challenges, researchers have become more interested in issues related to smart cities. Because of this, recent debates on sustainable urban development have been intrinsically related to smart cities [1–3]. In fact, it is currently difficult to think of a smart city without associating it with aspects of sustainability and vice versa.

The concept of a smart city is not new and has evolved in recent decades [4], mainly as an answer to the challenges imposed by growing urbanization, digital revolution, and the demands of society for more efficient and sustainable urban services and the improvement of quality of life.

As a matter of fact, the concept of smart cities has been expanded over time, incorporating variables that reflect ways of dealing with challenges imposed by the transformations resulting from the way cities are owned and perceived by society. Thus, these variables, which could signify possible solutions to the growing challenges, have been assuming a much more reactive character than a proactive and strategic way of thinking of cities.

Recently, several studies have been developed to better understand smart cities from the dimensions that characterize them [5–9]. These studies began to intensify the multidisciplinary character of a variety of domains and disciplines [10], which emphasizes different aspects of the phenomenon depending on the context [11,12]. Although a smart city is still a diffuse concept that can

have several interpretations, [13,14] it is possible to identify the convergence over time of the concepts of an intelligent city and a sustainable city [15]. The consensus is that it must be inclusive, secure, resilient, sustainable, and based on information technologies [12,16,17].

Other studies have also been developed focusing on the challenge of transforming today's cities into "smarter cities", searching for possible drivers that potentiate this transformation. The main research on this subject can be grouped in studies of technology and governance, with these two approaches being present in most articles consulted. Technology-related approaches, in short, aim to improve the efficiency of services and infrastructure (e.g., communication, transport, supply, etc.), mainly related to information and communication technologies (ICT). On the other hand, the approaches related to governance focus on management and the interactions between the various stakeholders in the city, connecting and developing socioeconomic and productive interactions among networks of urban actors.

Therefore, a more current and comprehensive way of understanding a smart city from the integration of existing knowledge and experiences is that of an innovative city, which combines aspects of intelligence and sustainability through a governance that integrates stakeholder interactions and that uses the technology to optimize services and infrastructure to improve quality of life. It is an orchestrated city in its actions and projects, interconnected and more intelligent, with the intensive use of technologies, such as the ones of sensing, information, and communication, in order to increase the efficiency of energy networks, transportation, and other logistical operations. The technology provides the means for the improvement and the connection of actors and services aiming to achieve a sustainable urban development, upgrading the socioeconomic, ecological, logistical, managerial, and competitive performance of the city and the quality of life of its population, thus ensuring that the needs of present and future generations are met [15,16,18–24].

Towards the aim of understanding the dimensions that characterize smart cities and the drivers that stimulate today's cities to become "smarter", studies have also been developed to classify how smart a city is. These studies focused mainly on the development of rankings from terms such as technology, economics, people, governance, mobility, health, environment, and quality of life, among others. However, the word smart was always attached to a set of indicators to explain the cities performance factors from certain contexts [25,26]. However, even today, there is no consensus on the main factors that should be considered to make cities smarter and sustainable. Studies on this topic are scarce.

This study addresses this gap and contributes to the literature regarding smart cities; in particular, it adds to the literature on what factors make cities smarter and sustainable. Therefore, the identification of the drivers was made more important by the researchers who published on the subject, from a broad and detailed bibliographic search.

Another contribution is the prioritization of these drivers based on the vision of 807 Brazilian experts, who have expertise in the priority areas pointed out by the literature on smart cities and work in four main areas of knowledge: applied social sciences, engineering, exact and Earth sciences, and human sciences.

The results showed that the twenty drivers identified as important in the literature were also considered important by experts, and from these, 15 drivers mainly focus on the governance of cities and the other five focus on technology. In addition, five drivers were rated as "extremely important" by all experts. The importance of identifying this smaller set of drivers considered as a priority is that leaders of these cities need to focus on those that are most important, considering the Brazilian scenario of scarcity of resources and that a great majority of Brazilian cities have the same main problems.

Consider that of the 20 drivers, 15 are mainly focused on the governance of cities. This, at first, suggests that governance is the main problem faced by cities. We also take this opportunity to reflect on possible solutions based on governance actions.

## 2. Materials and Methods

### 2.1. General Approach

The main research question of this study was “what are the main drivers for increasing the intelligence of cities?” To answer this question, we designed an approach in four steps: bibliographic research, identification of smart city drivers, survey with expert’s opinions, and data analysis.

### 2.2. Bibliographic Research

Due to the multidisciplinary nature of the studies on smart cities, a wide and detailed bibliographical search was carried out. Several search engines and databases were used, especially those available at the “Portal Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior” of the Coordination for the Improvement of Higher Education Personnel (CAPES), Brazil. This tool provides access to the full texts available in more than 38,000 international and national periodicals, as well as to several databases (Web of Science, Scopus, Scielo, etc.). The “Portal Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior” includes references and abstracts of academic and scientific studies to technical standards, theses, and dissertations, among other types of materials, covering all areas of knowledge. The search was also carried out on the website of the main scientific periodicals and Google Scholar.

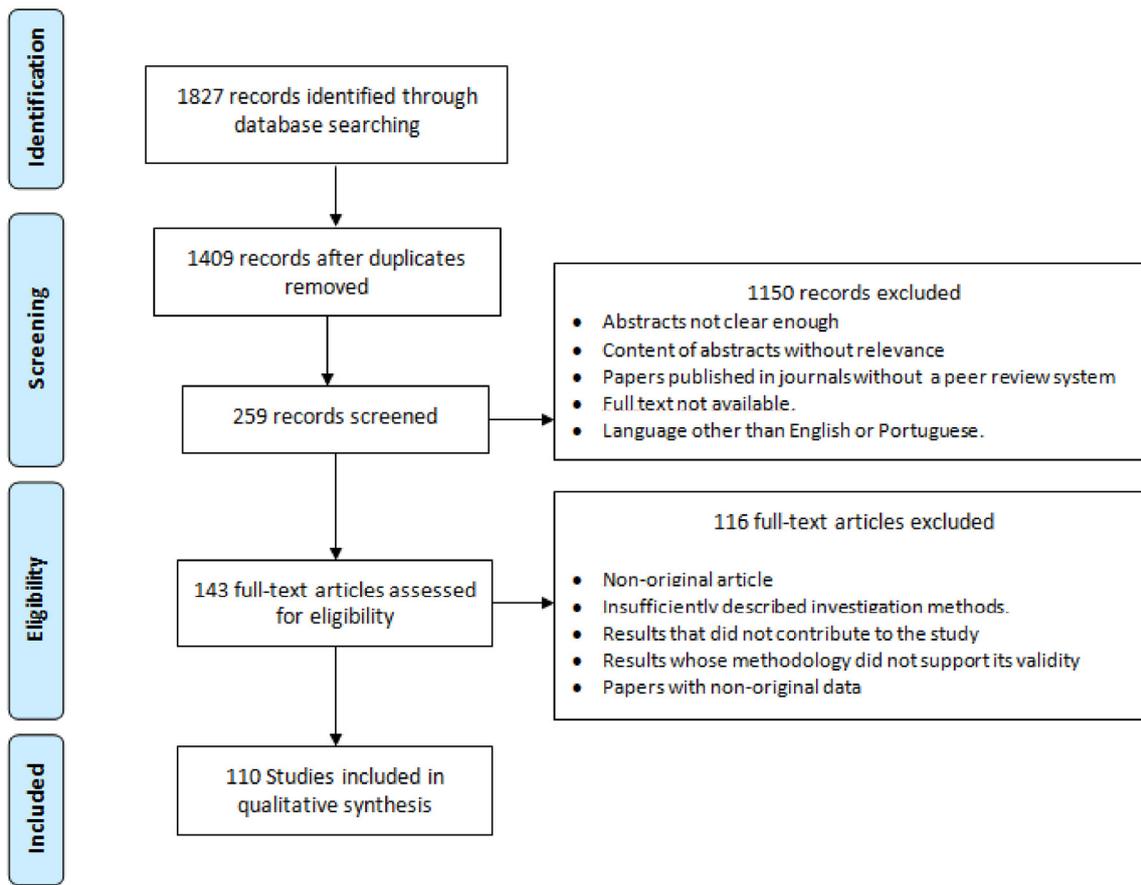
The literature search included papers published in the last 10 years, so that the drivers were more representative of current reality. The keywords searched were “smart cities”, “smart city”, “smarter cities”, “smarter planet”, “digital cities”, “sustainable cities”, and “ecological cities”, which were combined with the terms “drivers”, “dimensions”, “rankings”, and “components”.

To accomplish the bibliographical search, we adopted the recommendations of Webster and Watson (2002) [27] and of the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA). The main strategy was to initially conduct an exploratory reading based on a brief study of titles and abstracts in order to exclude all articles that did not have some evidence or information on the issues addressed. After that, a selective reading was carried out. The articles whose abstracts were selected went through a full reading, excluding those who did not have relevant primary information to the research questions. The bibliographic research was finished when we concluded that we were not finding new papers with relevant information.

Thus, from the keywords, we identified 1827 articles from the last 10 years. After excluding the 418 duplicates, the number of papers was reduced to 1409. From the exploratory reading of titles and abstracts, we discarded 1150 articles. The exclusion criteria were abstracts that were not clear enough to identify relevance to our study or whose content did not express this relevance. Papers published in journals without a peer review system or that did not provide full text were also excluded, as were articles whose language was not English or Portuguese.

For the remaining 259 articles, we performed a selective reading to verify if our perception of the contribution to the research from the abstracts was proven. This step resulted in the exclusion of 116 papers. The exclusion criteria were non-original articles, those which insufficiently described investigation methods, results that did not contribute to the study, and results whose methodology did not support their validity.

The remaining 143 articles were analyzed in detail. For the present study, 110 articles were effectively used, of which 61 were the basis for the choice of drivers. From these articles a spreadsheet was created containing the most relevant sections to support and answer the research problem. Figure 1 summarizes the literature search using the PRISMA flowchart.



**Figure 1.** Literature search from the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) flowchart.

### 2.3. Identification of Smart City Drivers

For the identification of the potential drivers for smart cities, a reflective and interpretive reading of the articles selected in the bibliographic search was carried out, and an examination of the perspectives, multiplicity, and plurality of approaches was performed. This aimed to understand what was already done concerning the proposed research and the latest developments in the field of smart cities. The strategy was to obtain a solid theoretical basis for our study, to order and summarize the information, to relate the main concepts and knowledge from already published papers to the scope of the research, and, finally, to identify a set of potential drivers.

In order for a potential driver to be considered of great relevance for increasing the intelligence of cities, its importance had to be portrayed in at least two works that did not refer to each other. As a result, we obtained a list containing twenty drivers.

The prioritization of the drivers based on their importance to the increase of the intelligence of the cities was carried out from the results of the survey of expert's opinions.

### 2.4. Survey of Expert Opinions

To carry out the survey, we used a questionnaire developed in an online platform (Google Forms), containing questions regarding demographic data and questions addressing the importance of the selected drivers in the bibliographic research. In the questionnaire, experts expressed their professional opinion about the importance of the contribution of each driver to make a city smarter, according to a five-point Likert scale, ranging from extremely important to minimally important. The drivers were randomly presented to avoid responses being influenced by the order in which they appeared.

We invited professionals that work in the main fields focused on in this report to answer the pre-test and the reviewed questionnaire. The inclusion criteria were to have expertise in the priority areas indicated in the literature for smart cities, to have training experience of more than five years, and to hold a degree in one of the following areas: applied social sciences, engineering, exact and Earth science, and human sciences.

These areas of knowledge are organized by Coordination for the CAPES from the clustering of several areas of formation, due to the affinity of their objects, cognitive methods, and instrumental resources reflecting specific sociopolitical contexts. The areas considered were Applied social sciences encompass the interdisciplinary areas of knowledge that deal with aspects related to public and private administration, accounting and tourism, architecture, urbanism and design, communication and information, law, economics, urban and regional planning/demography, and social services.

Human sciences have a human-centered approach and focus on the connections with history, beliefs, and the time/local space that can connect them. In this sense, human sciences involve themes related to anthropology, archeology, political science and international relations, religion and theology sciences, education, philosophy, geography, history, psychology, and sociology.

Engineering is characterized by the study and application of several branches of technology in order to materialize ideas in reality through techniques to solve problems and satisfy human needs—that is, applying methods and scientific vision for solving problems. It includes all engineering courses.

Exact and Earth sciences encompass disciplines based on physical-mathematical calculations, such as astronomy, physics, computer science, geosciences, mathematics, probability, statistics, and chemistry.

To get the experts opinions, we followed two strategies. The first was to use events in 2017 in which the authors participated in the organizing committee or as speakers in order to invite the speakers and participants with a potential to respond to the research. The events were “Corporate dilemmas—A critical view of the current scenario and practical solutions” held on 25 April 2017, “Corporate Dilemmas and Smart Cities” held on 25 May 2017, “Smart Cities Connecting with the Future” held on 24 October 2017, “Smart Cities and Creative Solutions” held on 6 November 2017, “Smart Cities and Creative Solutions—second meeting” on 16 November 2017, and “International Seminar on Policies, Incentives, Technology and Regulation of Smart Grids” held on 4 December 2017.

The second strategy was to request the coordinators of expert networks on issues related to smart cities working in Brazil to appoint specialists. Accordingly, several coordinators of various agencies cooperated with the questionnaire, such as the Innovation Agency of the Federal University of Fluminense (AGIR/UFF); the Laboratory of Innovation, Technology, and Sustainability of UFF (LITS/UFF); the Center for Smart Technologies (CTSMART); Rede Brasileira de Cidades Inteligentes e Humanas (RBCIH); the Smart City Business America (SCBA); and the Project Management Office (EGP/Niterói) of the Niterói City Hall.

The experts were invited in person, by e-mail, by Whatsapp, and by LinkedIn. Nine hundred and ninety experts from various regions of Brazil were invited, of which 895 agreed to participate.

To receive the answers of a minimum number of respondents per knowledge area that were interested in participating in the survey, we used all the sources described above, and the survey took 10 months to complete.

With regards to qualification and professional experience, we decided that participants had to have at least one of the specialties that make up the four areas of knowledge researched in this paper. Also, they had to work in fields related to smart cities and have five years of professional experience or more since, in Brazil, this is usually the minimum amount of professional experience required to carry out specific activities that require deep knowledge.

The pre-test was executed in person with 10 specialists, using printed questionnaires, to identify possible doubts and eliminate inconsistencies. Thus, the respondents expressed their opinion about the overall design of the questionnaire, the clarity and pertinence of the questions, the preferred layout, and the order of the questions. The questionnaire was reviewed based on the comments received.

All questions of the survey were completed by the 895 respondents in 16 weeks (from 19 August 2017 to 8 December 2017). The professionals who did not have a complete higher education level and a minimum of five years of experience were excluded from the sample, as well as professionals from other areas, which resulted in a sample containing 807 respondents.

### 2.5. Data Analysis

After completing the data collection, we used Cronbach’s alpha to evaluate the reliability of the data collection tool and the respondents. For that, the measurement of the variance of the responses of each item and the variance of the responses of each respondent were made [28]. Cronbach’s alpha is one of the most important and widespread statistical tools in research involving the construction of tests and their application, because it accounts for the variance attributed to the subjects and the variance attributed to the interaction between subjects and items, resulting in an index used to evaluate the magnitude to which the items of an instrument are correlated. Thus, this makes it possible to evaluate the average of the correlations between the items that are part of an instrument and the extent to which the factor measured is present in each item [29].

To prioritize the data, we created the concept of relative median, which is represented by an indicator that allows for the hierarchization of the drivers in each semantic classification of the Likert scale. Taking the two lines of Figure 2 as an example, which presents a median equal to four, we can see that the median in the first line is much closer to the frequency represented by the number three. In the second line, when you add more cells to the frequency represented by the number five, the median moves farther to the right. When comparing the first with the second line, although both have medians equal to four, the driver of the second line can be interpreted as more important, since it received more classifications as five and kept the other frequencies.

1	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5												
1	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Figure 2. Example of the median position.

The formula used to calculate the relative medians was

$$RM = \left\{ \begin{array}{l} 1 \quad x = 1 \\ m + \frac{P_{med} - \sum_{i=1}^{m-1} j_i}{j_m} \quad 2 \leq x \leq N \\ N \quad x = N \end{array} \right\}$$

where RM is the relative median, m is the median, P<sub>med</sub> is the position of the median, N is the number of respondents, and j<sub>i</sub> is the number of respondents who were assigned a semantic classification of “i”.

## 3. Results and Discussion

Through the methodology described above, we obtained two main results. The first is the set of drivers identified from the papers selected in the bibliographic search. The second is the summary of the information obtained from the survey.

### 3.1. Selected Drivers

Twenty drivers were selected according to the criteria described in the materials and methods, as shown in Table 1.

**Table 1.** Selected drivers.

Driver	Source
<b>Urban planning:</b> Territorial management through the use of tools and indexes, including urban environmental quality, air quality, and well-being	[12,15,30–44]
<b>City infrastructure:</b> Management of the basic networks of rainwater, sanitation and water, and sewage services	[30,33,42,45–49]
<b>Smart grids (energy):</b> Intelligent management of energy sources and energy networks	[33,47,49–51]
<b>Smart buildings:</b> Use of sensors to minimize energy consumption without compromising comfort and safety (e.g., temperature, lighting, air quality, and natural ventilation)	[32,33,42,49,51–55]
<b>Urban risks:</b> Vulnerabilities, monitoring, prevention, and response to disasters in cities	[32,47,48,56–58]
<b>Sustainability:</b> Efficient management of natural resources to increase the quality of life of citizens for present and future generations	[12,15,33,34,38,48,59,60]
<b>Mobility:</b> Multimodal transport (individual and collective), intelligent urban mobility	[15,32,33,47,49,54,55,60–62]
<b>Logistic solutions:</b> Stocking, storage, transport, and distribution of products with optimization of the logistics chain	[33,62–67]
<b>Logistic applications:</b> Radio-frequency identification (RFID), geographic information systems (GIS), electronic routing of goods, drones	[47,51–53,62,68–70]
<b>Public safety:</b> Prevention and control of crime and violence by public entities	[32,33,36,47,50,51,71–74]
<b>Health:</b> Quality of public health and care (elective and emergency)	[33,40,46,55,75–80]
<b>Innovation:</b> Development of culture, intelligence, and collective co-creation for new products, services, businesses, or processes	[15,30,33,35,48,81–84]
<b>Business networks management:</b> Network of strategic partnerships (stakeholders) to boost innovation	[12,47,48,55,61,81,85,86]
<b>Funding of new solutions:</b> Public or private financial support or through public-private partnerships (PPP)	[12,32,33,47,48,55,72,85,87–91]
<b>Relationship management:</b> Analysis of the influence of the actors that compose the city as a social group	[12,30,33,41,42,81,85,92]
<b>Technological applications for cities:</b> Use of information and communication technologies (ICT) for smarter solutions	[12,30,32,33,42,46,48,52,54,55,62,73,76,82,85,93–97]
<b>The sociotechnical impacts of digitization:</b> Impact of technology on productive and labor tasks	[12,32,35,36,54,85,96,98,99]
<b>Public policies:</b> Planning and development of public policies for an intelligent city	[4,12,32,33,35,41,46,48,55,60,62,85,97,100–103]
<b>Self-regulation:</b> Elaboration and establishment by the community itself of the rules that discipline the market with the adoption of ethical standards	[32,85,97,101,104–107]
<b>Regulation:</b> Set of rules developed by state agencies to guide the economy and mechanisms of social control	[30,32,55,72,96,97,101,108–110]

Of the 20 selected drivers, 15 focus mainly on city governance and 5 focus on technology (Table 2). The drivers were considered for table composition after an interpretive process. In the “Source” column of Table 1 we cite authors who helped in the construction of the thoughts about smarter cities.

Table 2. Drivers grouped from their approaches.

Governance	Technology
Urban planning	Smart grids energy
Cities infrastructure	Smart buildings
Urban risks	Logistics applications
Sustainability	Technological applications for cities
Mobility	The sociotechnical impacts of digitalization
Logistic solutions	
Public safety	
Health	
Innovation	
Business network management	
Funding of new solutions	
Relationship management	
Public policies	
Self-regulation	
Regulation	

### 3.2. Survey Results

Initially, we calculated the Cronbach’s Alpha, the value of which was 0.904 and confirmed the reliability of the questionnaire and the data. Next, we used the demographic data from the first section of the questionnaire to identify the profile of the respondents, considering their educational area and their professional experience (Figure 3). For all four areas, at least 70% of the respondents had more than 10 years’ experience.

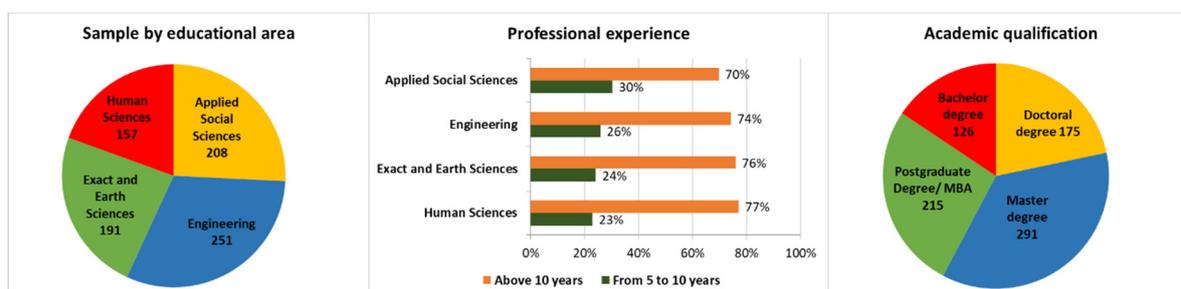


Figure 3. Demographic data.

Figure 4 shows the drivers ranked by the relative median. The drivers were classified from the judgment of the specialists of each training area. Figure 5 presents the same classification for all the respondents.

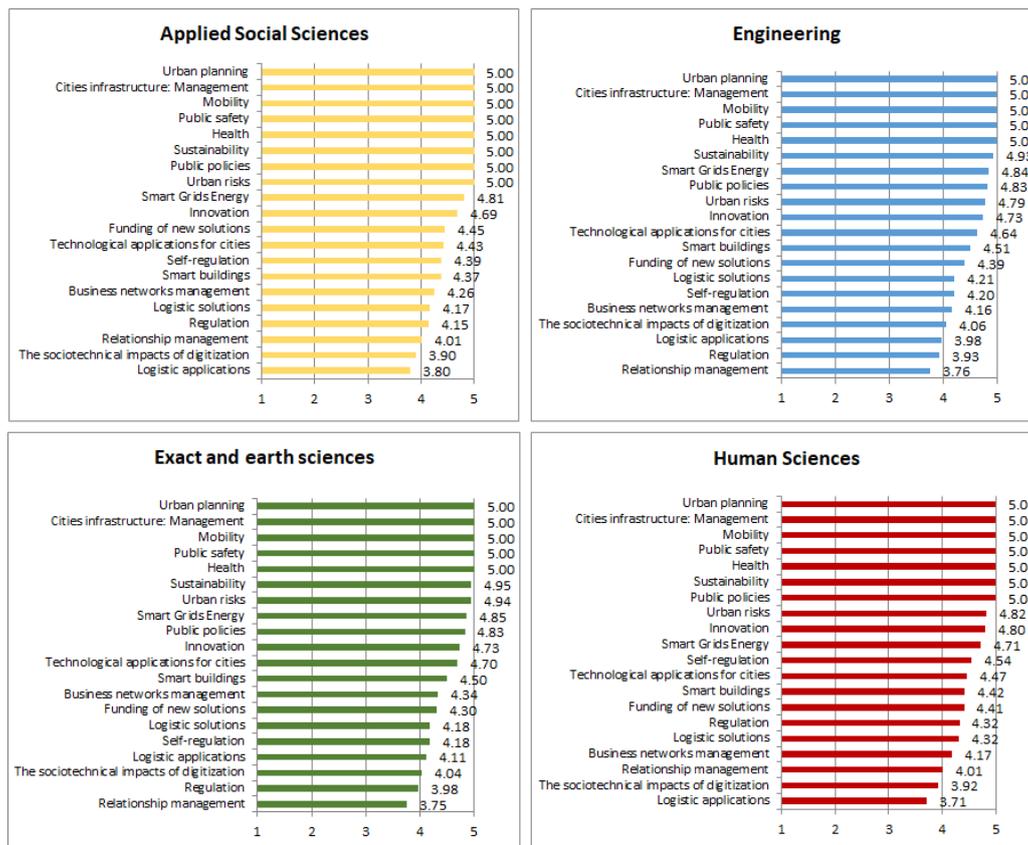


Figure 4. Drivers ranked by the relative median for the four areas of knowledge.

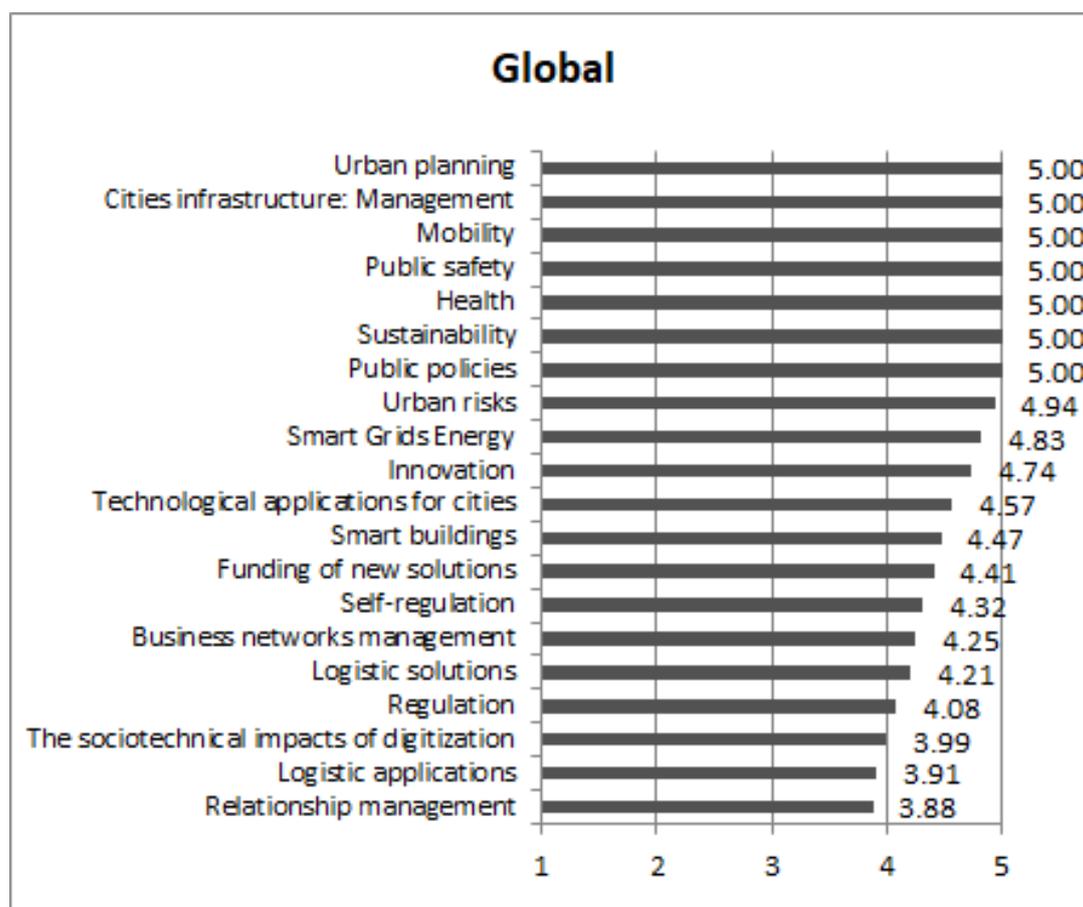


Figure 5. Drivers ranked by the relative median based on the total respondents.

Table 3 lists the drivers that were rated by experts as “extremely important” (equal to 5) from the relative median.

Table 3. Drivers ranked as “extremely important”.

Drivers	Applied Social Sciences	Engineering	Exact and Earth Sciences	Human Sciences	Entire Sample
Urban planning	5	5	5	5	5
Cities infrastructure	5	5	5	5	5
Mobility	5	5	5	5	5
Public safety	5	5	5	5	5
Health	5	5	5	5	5
Sustainability	5			5	5
Public policies	5			5	5
Urban risks	5				5

Figures 4 and 5 showed the drivers ranked from the relative median. It is possible to observe that all these drivers were considered important by the specialists (the relative medians were higher than 3.0), corroborating with the view of the researchers who published on the subject. From this result, the drivers considered as “extremely important” (equal to five) by training area were investigated (Table 3), and eight drivers met this requirement (urban planning, cities infrastructure, mobility, public safety and health, sustainability, public policies, and urban risks).

Taking into account this set of eight drivers, it was investigated which drivers were ranked as “extremely important” for the training areas, considering as the most relevant those that received the top rating evaluation for all the areas. Only five drivers met this requirement (urban planning, cities infrastructure, mobility, public safety, and health). From this evaluation, this set of five drivers was

considered as the most important for stakeholders to prioritize their decisions, being denominated as the top five group.

By continuing the analysis of Table 3, it was observed that two other drivers (i.e., sustainability and public policies) received the top rating in at least two of the four training areas (human sciences and applied social sciences). This finding corroborated with the analysis by the relative median based on the total respondents in the sample as a whole, also shown in Table 3. Thus, by adding these two drivers to the top 5, a top 7 were composed. The driver “urban risks” has only been rated as “extremely important” by applied social sciences experts.

Figures 6 and 7 present the behavior of the drivers when the evaluations by training areas are compared with the evaluations carried out by the whole sample.

At the bottom of the scale of importance in Figure 6, three drivers that were evaluated as “important” stand out as being important but not a priority for all respondents: the sociotechnical impacts of digitalization, logistic applications, and relationship management, whose relative medians are between 3 and 4.

Eight drivers showed variations between the relative medians 4.01 and 4.99. These drivers are considered important but secondary in priority: smart grid energy, innovation, technological applications for cities, smart buildings, funding of new solutions, self-regulation, business networks management, and logistics solutions.

Two drivers were presented as borderline. The “urban risks” driver stands out as an “extremely important” driver for the applied social sciences group, and the “regulation” driver tends to be considered as a low priority, being very close to the three least priority ones, for three of the four professional groups researched.

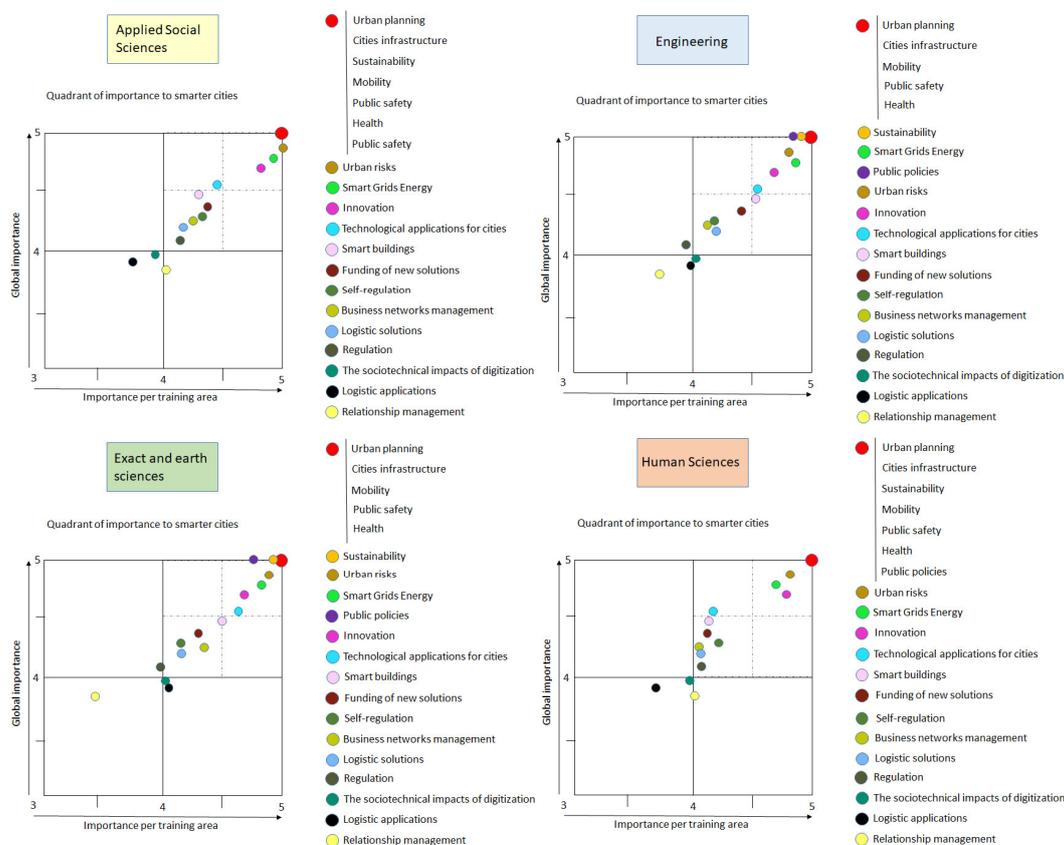


Figure 6. Drivers’ behavior by training areas, related to the whole sample.

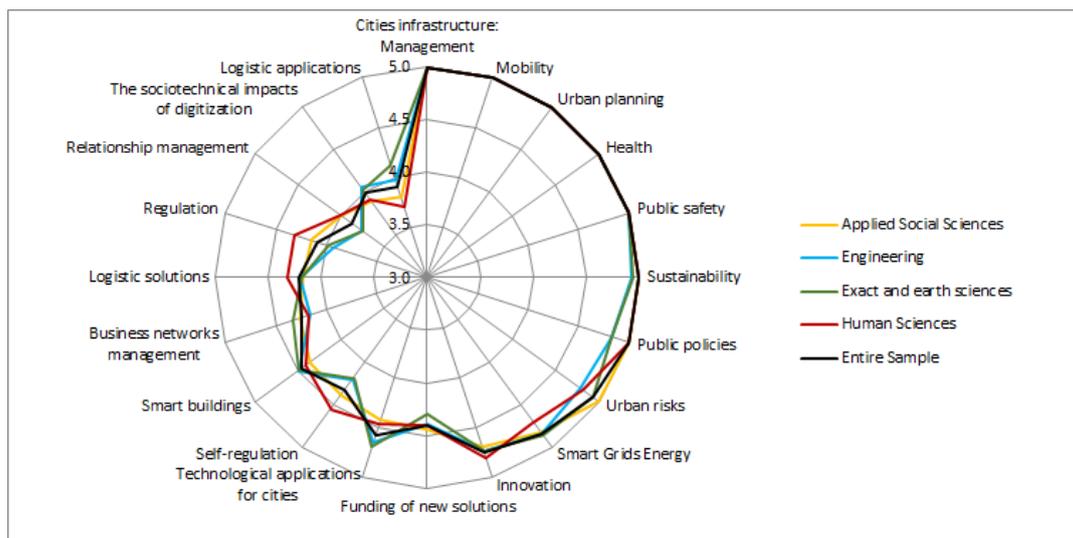


Figure 7. Drivers' behavior.

Considering the results obtained, and that all seven drivers are related to city governance, two fundamental questions arose. The first is, “why do drivers with a technological approach not appear among the top seven given that, in the existing literature, technology is widely addressed?” Using an analogy with the human body, we think of the heart and the brain as the most important for its functioning, and we hardly think of the circulatory system, although it is what maintains the life of these organs. We think of these organs as living parts and, consequently, imply the inclusion of what is necessary to keep them alive. We believe that something similar happened during the trial. The fact that, today, technological resources are massively present in our lives means that we do not think of most of the things we do with the technology being used. For example, when we use our smartphones, laptops, etc., we know that they are made possible by technological resources, but we do not think of these. This reasoning means that technological resources are not felt in isolation but are incorporated into something. Thereby, the technology layer appears in a transverse way, contributing to the improvement and efficiency of the services and infrastructure of the cities. The literature points to a strong correlation of these concepts with the governance [32,60,98,99,103] and orchestration of services [5,10,30,42,87] in cities.

The second question is, “can the top seven drivers be considered as the most important for cities of all countries?” We believe that they should be considered in relation to the reality of each country, because the way the city is perceived and owned by society is strongly influenced by the context in which the cities are inserted.

This understanding is because cities of each country have characteristics that differentiate them (e.g., government profile, socio-environmental culture, financing capacity, citizen participation, etc.). Thus, in several cities of other countries, the perception of the problems is different from those in Brazil, as Brazilian’s cities problems are lack of planning, lack of infrastructure, and lack of adequate basic services, such as health care.

In recent years, Brazilian society has experienced a serious political and financial crisis, which has intensified the deterioration of services and urban infrastructure without most management bodies being able to propose solutions. In this sense, there is a perception of lack of planning, lack of infrastructure, and lack of adequate basic services, such as those related to health. Thus, concerning Brazilian cities, the results are fully justifiable. On the other hand, if we consider the studies consulted during the bibliographic search (Table 1), the results found can also be easily understood from the following understanding:

**Urban planning:** the management of territories through tools and indexes, including urban environmental quality, air quality, and well-being. This connects with all areas of the city because, to develop cities, planning is a fundamental tool for defining the priorities that operationalize the public policies, enabling cities to become more intelligent and sustainable.

**City infrastructure:** this includes the management of basic rainwater networks, sanitation, and water and sewage services. These must be managed as living systems, with efficient operation and management. For this driver, it is reasonable to note the need for large-scale management to provide a reasonable minimum sustainability of finite resources to citizens.

**Mobility:** multimodal transport (individual and collective) and intelligent urban mobility are the key sectors of smart cities. In the future we will have autonomous and electric vehicles providing an immediate impact on the transport systems [49]. This driver corroborates with what some authors point out: that there are more favorable conditions for smart city initiatives with these configurations aimed at public transport [33].

**Public safety:** the prevention and the control of crime and violence by public entities can use the potential of an intelligent city, where camera systems, motion detectors, electronic surveillance by control and command centers, real-time monitoring of security teams (patrolling), and monitoring of incidents can enhance the safety of smart cities. One well-known success story is New York's 911 that associated technologies with a political response to security.

**Health:** the quality of public health and elective and emergency services are being transformed in smarter cities. Through the adoption of advanced tools and technologies, the deficiencies found in municipalities can be supplied with health services that use concepts disseminated in private health, such as m-health, e-health, telemedicine [77], or the concept of smart health (s-health) that uses information and communication technologies for the good of individuals and of life in society [46].

**Sustainability:** the efficient management of natural resources contributes to raising the quality of life of the citizens for present and future generations. Social, economic, and environmental sustainability are strategic vectors for smart cities.

**Public policies:** the planning and development of public policies in favor of an intelligent city appears crucial for all the groups surveyed, since the municipal administrations are the entities that depend heavily on local policies to manage the projects, actions, and services. As these management groups involve various actors, they sometimes may seem to disagree. This view approaches the theoretical context pointed out by some authors such as Melo, Macedo, and Baptista [62].

Of the twenty drivers identified in the literature review, fifteen have as their main focus the governance of cities. This, at first, suggests that this is the main problem faced by cities. In Brazil this is true, since the eight drivers that received a maximum rating are also related to governance. Thus, possible solutions go through governance actions.

Developing a smarter city cannot be a top-down process. Drivers such as urban planning, city infrastructure, mobility, public safety, health, sustainability, and public policies demand a holistic and integrated vision focused on the priorities of society. The participation of the citizens in the initiatives of smart cities is fundamental for Brazil to avoid a utopia or a biased tendency towards the solution of having cities with an exclusively business vision.

Governance challenges can build on the helix quadruple, uniting the forces and intelligences of universities, the market, society, and governments for an integrated and combined solution to local priorities. A new way of governance for Brazilian cities should be based on intelligent collaboration and the use of information and communication technologies as a transverse and integrating resource.

In addition, policies aimed at the transformation of cities must be more comprehensive, effective, and have the integrated participation of all levels of government. In this context, municipal managers play a fundamental role and should incorporate better efficiency and effectiveness in the intelligent application of resources into city planning and strategic project execution to improve management.

We must overcome challenges with more innovative solutions. The intensification of public awareness and engagement programs in the monitoring of the application of resources can also help

to avoid the deterioration of services and infrastructure in Brazilian cities, since few resources for new investments are available.

#### 4. Conclusions

The concept of a smart city has incorporated evolutions and expansions over time. This is mainly from the convergence of the concepts of smart city and sustainable city. It is also due to the incorporation of variables that reflect ways of dealing with challenges imposed by the transformations caused by how cities are owned and perceived by society. However, even today, there is no consensus on the main factors that should be considered to make a city smarter and sustainable.

This paper sought to contribute to the subject by proposing the main question of this research: “What are the main drivers for increasing the intelligence of cities?” In order to answer this question, we identified and prioritized potential smart city drivers from a broad review of the literature and a survey conducted with specialists in the concerned fields who had undergraduate degrees in one of the following areas of expertise: applied social sciences, engineering, exact and Earth sciences, and human sciences.

The results demonstrated that of the 20 drivers identified in the literature, seven (i.e., urban planning, cities infrastructure, sustainability, mobility, public safety, health, and public policies) were considered as the highest priority for the development of more intelligent and sustainable cities. An eighth driver (i.e., urban risks), did not integrate into this group because it was evaluated with priority by only one of the areas of knowledge. In addition, three drivers (i.e., the sociotechnical impacts of digitization, logistics applications, and relationship management) were evaluated as not being a priority. We also observed that all seven priority drivers are related to city governance.

It was questioned why the drivers with technological approaches do not appear among the top seven since in the existing literature, technology is widely addressed. It was also asked if the top seven drivers could be considered as the most important for cities of all countries. Our conclusion is that the technology layer appears in a transverse way, contributing to the improvement and efficiency of the services and infrastructure of the cities. The literature consulted points to a strong correlation of these concepts to the governance and orchestration of services in the cities. However, it is important that the results are considered in the light of the reality of each country, since the way a city is perceived and owned by society is strongly influenced by the context in which they are inserted.

The present study has some limitations. First, even though we have done extensive and detailed bibliographic research, there is always the risk that some important contribution may not have been addressed in our analysis. The second is that for the prioritization of drivers, we relied only on the evaluations of Brazilian experts, who have certainly been influenced by the reality of the Brazilian cities. Thus, local realities should be considered. However, it is important to note that the reality experienced in most underdeveloped and developing countries are like those experienced by Brazilian cities.

Considering that citizens perceive the cities from their characteristics, this paper did not aim to compare these perceptions (and consequently the most important drivers from these perceptions) to the different cities of the world, which would be an interesting development for a further study.

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