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► **To cite this version:**

Flavia Michelotto, Luiz Antonio Joia. The Social Representation of Smart Cities: A View from Brazil. 20th International Conference on Electronic Government (EGOV), Sep 2021, Granada, Spain. pp.217-228, 10.1007/978-3-030-84789-0\_16 . hal-04175093

**HAL Id: hal-04175093**

**<https://inria.hal.science/hal-04175093>**

Submitted on 1 Aug 2023

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# The Social Representation of Smart Cities: A View from Brazil

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**Abstract.** About 6,000 years after the emergence of the first cities, humanity faces the challenges and consequences of the development of cities, which threaten the quality of life of people and the world environment. To date, more than half of world's population live in urban areas and, by 2050, one estimates that almost 70% of them will live in cities. Thus, in order to avoid a total collapse, cities' urban planning must be rethought urgently by means of new planning and management models largely supported by robust digital technologies, innovations and a sustainable agenda. In this scenario, the concept of smart city emerges yet without a formal consensus. Smart city definitions have been derived from interdisciplinary concepts applied to cities most of them based on the management and heavy use of information and communication technology in cities. Thus, to allow a better comprehension of what is understood by smart city mainly under the perspective of emerging markets, this work seeks to identify what is the social representation of smart city amongst Brazilian citizens, comparing same to the extant literature on smart city definition.

**Keywords:** Smart City; Mobility; Sustainability; ICT; Social Representation Theory

## 1 Introduction

After many centuries of development and as the urban population have grown at an increasing rate, cities have become increasingly complex and important [1,2]. This high-speed population growth tends to worsen more and more the urbanization process [3]. One estimates that, by 2050, almost 70% of the world's population will live in cities [4]. This growth has made the management of cities increasingly complex, creating great challenges for their sustainable development, such as respect for the environment, provision of adequate transport, energy, and health for the community, in addition to attention to citizens, among others. Thus, there is an urgent need to find smarter ways to overcome these new challenges faced by cities worldwide [5,6].

In this context of concern with the risks arising from the accelerated growth of the urban population, associated with an urgency for the search for sustainability, the concept of smart city emerges associated with several definitions and encompassing, among others, the domains of technology, public policies, society, and politics [7]. Thus, as there is still

no single definition for the concept of smart city [1], a research gap opens up to refine its conceptualization.

Amid a scenario of challenges and possibilities, in addition to the lack of a consensual and comprehensive definition for the smart city construct, it is common to have questions about what leads a city to be considered smart or what are the main characteristics of a smart city.

As such, to improve the understanding of that social phenomenon and thus contribute to local development, this study aims to identify how Brazilian citizens perceive smart cities by using the Social Representation Theory [8].

The Social Representation Theory (SRT) is an efficient approach to better understand constructs in the Information Systems area [9], complying with the requirements to make clear the definition of a construct [10]. Thus, this paper aims to answer the following research question: what is the social representation of smart city for people in Brazil?

The focus in Brazil is supported by the very fact that the Brazilian context can be considered a proxy for other emerging economies in which concerns to smart cities. This statement can be backed by a double evidence. First, Brazil, like other emerging economies, has few smart city initiatives. Second, Brazil presents significant challenges for implementing smart cities, being the main one an inefficient connectivity infrastructure, besides a still large digital divide, which has limited the design and implementation of smart cities in the country, as well as in other emerging economies.

This article is divided into four sections after this introduction. The next section presents the theoretical background used in this work. Then, the methodological procedures adopted are described so that, in the next section, the results are presented. In the last section, the results are discussed, and the conclusions of the study are unveiled, including its implications for academia and public policy, as well as its limitations.

## **2 Theoretical Background**

### **2.1 Smart City**

The rapid growth of urban populations has led to several problems for the basic operation of a city, such as: poor waste management, scarcity of resources, pollution, deterioration of public health, traffic congestion, etc. [11]. To overcome these challenges, many cities in the world have sought to be better managed through the intensive use of new technologies, in order to guarantee adequate living conditions for their citizens in a context of rapid growth. In this context, the concept of smart city emerges [5].

However, there is so far no consensus on the definition of the “smart city” construct. In fact, the term smart city has been used around the world under different names and circumstances, which has generated several conceptual variants for same [1,7].

In fact, smart city is an interdisciplinary concept, whose sub-construct "smart" is not easy to define since it can be associated with different areas and connotations [12]. The first attempts to define this concept focused on the intelligence provided by information and communication technology (ICT) to manage various operations in a city, revitalize its economic opportunities, and strengthen its global competitiveness. Subsequently, the studies expanded their scope to include other issues, such as sustainability, quality of life, and services for citizens [3,7].

The concept was used, for the first time, to highlight the importance of ICT to overcome the challenges faced by modern cities [13,14]. Thus, the use of ICT has been considered a key factor to provide intelligence to a city, as it allows to detect, monitor, and control most services in same [7].

Academics point out problems associated with the concept of smart city, such as the dissonance between the construct and its reality and the difference between a true smart city and one that simply has a marketing label [15]. However, although there are different definitions for a smart city, some points in common appear in most of them: (1) the use of ICT in the city; (2) the presence of physical and network infrastructure; (3) better provision of services to the population; (4) the integration of systems and infrastructures that allow social, cultural, economic, and environmental development; and (5) the vision of a better future [11]. Despite this, the lack of consensus on a single definition for smart city has led to the formulation of different concepts on the topic.

In this research, 21 articles were obtained from a literature review on the concept of smart city. Analyzing these articles, 16 categories were found with significant association with the subject, as shown below in decreasing order of the number of related articles, namely: Technology (21), Sustainability (21), Innovation (20), Services (20), Economy/Business (20), Infrastructure (20), Quality of Life (20), People (20), Mobility/Transport (19), Planning (19), Society (19), Integration (19), Efficiency (18), Culture (18), Connectivity (16), and Security (16).

To consolidate and summarize the theoretical framework on smart city, Table 1 was organized, showing the 16 categories that present a significant association with the subject. The table identifies, for each publication, whether the category in question was cited by it. In addition, Table 1 is ranked according to the categories most frequently present in the publications, whose count appears in the final line.

## 2.2 Social Representation Theory

Conceived in the 1960s by Serge Moscovici, the Social Representation Theory (SRT) has become one of the predominant approaches to understand the development of common sense in different human groups [8,16,17].

The emergence of any social representation always coincides with the emergence of an unprecedented situation, an unknown phenomenon, or an unusual event [8]. Actually, social representations are not the product of society, but of the social groups that comprise it [18].

Academics conceptualize social representations as images that bring together multiple meanings, so that people can interpret what is happening [19]. Thus, social representations consist of a set of information, beliefs, opinions, and attitudes obtained to conceptualize a specific object through the organization and structuring of this set of elements [19].

**Central Nucleus Theory.** A social representation comprises two subsystems: the central nucleus and the peripheral system [20]. All representations are organized around a central nucleus, being this a fundamental element as it determines the meaning and organization of the representation [21]. The central nucleus is, therefore, strongly linked to the collective memory and history of the social group considered [21]. The central nucleus comprises, therefore, the fundamental meanings of the representation, namely those that give it identity [20] - in this case, the smart city.

Theoretical References	MAIN CATEGORIES - SMART CITIES															
	Technology	Sustainability	Innovation	Services	Economy/ Business	Infrastructure	Quality of Life	People	Mobility/ Transport	Planning	Society	Integration	Efficiency	Culture	Connectivity	Safety
[1]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[3]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[5]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[11]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[13]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[15]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[36]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[37]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[39]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[41]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[31]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[34]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[30]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[38]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[35]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[7]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[29]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[40]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[33]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[14]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
[32]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	21	21	20	20	20	20	20	20	19	19	19	19	18	18	16	16

**Table 1** – Smart Cities Main Categories from the Literature Review

On the other hand, the peripheral system addresses the differences in perception of the subjects involved in the research, thereby supporting the group’s heterogeneity, and accommodating the contradictions brought by the immediate context [9,22,23]. It is composed of elements around the central nucleus that the individual may revise and negotiate. It constitutes a protection shield for the central nucleus, allowing exchanges with other groups. It therefore enables the evolution of the social representation without modifying same [9,23].

### 3 Methodological Procedures

This study uses a quali-quantitative methodological approach, the data being collected via the words evocation technique and analyzed by means of the four-quadrant technique, namely Vergès’ quadrants. Data collection took place between April and June 2020. Questionnaires were sent by email, in addition to direct messages via social networks.

The questionnaire had two parts, totaling 25 questions, namely: part 1 with 12 questions, including the word evocation test and other information about smart city; part

2 with 13 questions related to the sample profile. The questionnaire was validated by two specialists in SRT and word evocation technique.

### **3.1 Sample**

The sample included participants with the following profile: over 18 years old, with higher education and who were not completely unaware of the term smart city. To compose the sample, 1,100 people were contacted, of which 348 accepted the invitation. Of this total, 284 fully answered the questionnaire and the remaining 64 left the questionnaire incomplete, being therefore eliminated. In addition, of the 284 respondents considered, 205 said they have heard about smart city (72%), against 79 respondents who said they did not know the term (28%). These latter were also discarded. Thus, the final sample comprised 205 respondents.

### **3.2 Word Evocation Technique**

There are distinct techniques to identify social representations, such as the words evocation technique [24]. The words evocation technique herein adopted is based on collecting words expressed by the respondents when a specific suggestive word or expression is presented to them orally or in writing [25]. Thus, in this work, the participants were asked to list the five words or expressions that immediately came to their minds [9] when they were faced with the expression smart city. The words evoked were then analyzed using the four-quadrant technique developed by Pierre Vergès, by means of which the words evoked were divided up and grouped into categories or clusters associated with the social representation under study [22,26]. The software EVOC was used to perform this operation. The four-quadrant technique cross-checks evocation frequency of the categories – of a quantitative nature – with the order of evocation of same – of a qualitative nature, as seen in Figure 1 [27,28].

<b>CENTRAL NUCLEUS</b>	<b>FIRST PERIPHERY</b>
Categories with evocation frequency higher than or equal to the Average Frequency of Evocation (AFE) and evocation order lower than the mean figure for the Average Order of Evocation (AOE).	Categories with evocation frequency higher than or equal to the Average Frequency of Evocation (AFE) and evocation order higher than or equal to the mean figure for the Average Order of Evocation (AOE).  Close link with the Central Nucleus.
<b>CONTRAST ZONE</b>	<b>PERIPHERAL SYSTEM</b>
Categories with evocation frequency lower than the Average Frequency of Evocation (AFE) and evocation order lower than the mean figure for the Average Order of Evocation (AOE).  Close link with the Central Nucleus.	Categories with evocation frequency lower than the Average Frequency of Evocation (AFE) and evocation order higher than or equal to the mean figure for the Average Order of Evocation (AOE).  Remote link with the Central Nucleus.

**Figure 1 - Vergès' Four-Quadrants Technique**

The average frequency of evocation (AFE) is calculated by the total number of evocations over the total number of distinct evoked words [9]. Furthermore, the average order of evocation (AOE) of a category is obtained by considering the average order in which the words pertaining to this category were evoked by the respondents, namely first, second, third, fourth or fifth place. The average of the AOE is then obtained by dividing the sum of all AOE's calculated by the number of distinct categories.

### **3.3 Vergès' Four-quadrant Technique**

The following steps constitute the Vergès' four-quadrant technique: i) organization of the words evoked into categories; ii) calculation of the frequency of evocation of the words via EVOC; iii) calculation of the average order of evocation of the categories via EVOC; iv) deployment of the reference points (averages) such that the categories are placed correctly within Vergès' four-quadrant technique, i.e., calculation of the AFE and mean figure for the AOE via EVOC; and v) individual comparison of the values referring to the categories with the AFE value and the mean figure for the AOE, whereby the Vergès' framework of smart city is obtained [20,24].

In this work, categories were sought to fulfil Vergès' quadrants, with special emphasis on some located in the upper left quadrant, referred to as the central nucleus, and in the lower right quadrant, referred to as the peripheral system [24,27]. The lower left quadrant (contrast zone) and upper right quadrant (first periphery) merely permits an indirect interpretation of the social representation, as they represent cognitions that are not as close to the central nucleus [27].



## 4. Results

### 4.1 Central Nucleus and Peripheral System

To define the central nucleus and the peripheral system, the participants had to answer the following question: "When you think of smart city, what are the first five expressions that come to your mind?" From the 205 questionnaires considered, 1,025 evoked terms were obtained (five per questionnaire), being used the Excel and EVOC software to generate the results. Once the tabulation of the results was performed, 88 different terms were obtained, which were grouped into 12 categories or clusters.

Then, it was verified which categories would be placed in the four quadrants of Vergès, with emphasis on the central nucleus and the peripheral system. For this, the minimum value of the evocation frequency was calculated. Academics [45] point out that the frequency that represents the average of evocations is academically accepted as the minimum frequency for studies on social representation - in this research, this figure was 22.

Of the 162 different categories surveyed, 12 were evoked 22 or more times (7.4% of the total). Technology was the most cited category (8.6%), followed by Mobility (8.2%) and Sustainability (6.7%).

A final step for assembling the quadrants is the calculation of the AOE (Average Order of Evocation), which represents the weighted average of the average order of evocation of each category *i* evoked (AOE<sub>i</sub>). Thus, of the 1,025 words evoked, 162 distinct categories were created, of which 12 (74% of 162) reached an AFE (average frequency of evocation) of at least 22. That way, it was possible to build the Vergès' quadrant generated by EVOC, composing the social representation of smart city, as shown in Figure 2.

<b>CENTRAL NUCLEUS</b>  Technology Mobility Sustainability Connectivity Quality of Life	<b>FIRST PERIPHERY</b>  Safety Ease of Use Integration
<b>CONTRAST ZONE</b>  Innovation Planning	<b>PERIPHERAL SYSTEM</b>  Efficiency Agility

**Figure 2** - Smart City Social Representation

## 5 Discussion and Conclusions

By means of the social representation of smart city, it is possible to identify the categories that are most strongly associated with this concept - that is, the categories that represent the collective thinking of the research sample carried out in Brazil. Academics then suggest a comparison between the social representation found and the theoretical references on the concept under analysis [20] – in this case, smart city.

As one can see in Figure 3, all categories of the central nucleus of the social representation - technology, mobility, sustainability, connectivity, quality of life - are among the most cited by the theoretical references.

Smart City Categories	Category Status	Theoretical References	Quantity
Technology	Central Nucleus	[1,3,5,7,11,13-15,29-41]	21
Sustainability	Central Nucleus		21
Innovation	Contrast Zone	[1,3,5,7,11,13-15,29-31,33-41]	20
Services	Cited but not located in the Vergès' Quadrant		20
Economy/Business	Cited but not located in the Vergès' Quadrant	[1,3,5,7,11,13,15,29-41]	20
Infrastructure	Cited but not located in the Vergès' Quadrant		20
Quality of Life	Peripheral System	[1,3,5,7,11,13-15,29-32,34-41]	20
People	Cited but not located in the Vergès' Quadrant	[1,3,5,7,11,13,15,29-41]	20
Mobility/Transport	Central Nucleus	[1,3,5,7,11,13-15,29-32,34-39,41]	19
Planning	Contrast Zone	[1,3,5,7,11,13-15,29,31-39,41]	19
Society (Citizen Participation)	Very little cited but not located in the Vergès	[1,3,5,7,11,13,15,30-41]	19
Integration	First Periphery	[1,3,5,11,13-15,30-41]	19
Efficiency	Peripheral System	[1,3,5,7,11,13-15,30-32,35-41]	18
Culture	Not cited at all	[1,3,5,7,11,13,15,29-32,34,36-41]	18
Connectivity	Central Nucleus	[1,3,5,11,13,15,29-34,36,37,39,41]	16
Safety	Peripheral System	[1,3,5,7,11,13,15,29,30,33-37,39,41]	16

**Figure 3** – Smart City Social Representation vs. Theoretical References

Innovation, Services, Economy, and Infrastructure are very common themes in the theoretical references, but they are not part of the central nucleus according to the words' evocation technique, although innovation is part of the contrast zone of the social representation. Besides, People, Society (also called Citizen Participation) and Culture do

not appear in the social representation but are among the most cited subjects in the theoretical references. Security appears less prominently in the theoretical context, also remaining absent in the central nucleus.

However, a fact that draws attention in this study is the strong presence of the categories Culture and Citizen Participation in the theoretical framework on smart city and conversely their almost total absence in the respondents' evocations. The Culture category appears related to smart city in 18 of the 21 articles in the theoretical framework. For example, in the ontological framework proposed by Ruhlandt [44], Culture appears as one of the enablers of intelligence of a city. Although it does not reach the same weight as other categories such as Technology, Environment, and Infrastructure, it still has prominence. Culture also figures as an important component in the rankings of smart cities [45], which consider the number of museums, art galleries and theaters, as well as the spending on leisure and recreation, as a reflection of the city's commitment to the theme [45].

The importance given to cultural aspects by developed countries, therefore, is quite different from that of Brazil. Culture does not appear in any of the 1,025 words evoked. One explanation may be the low importance of this category in the lives of Brazilians when compared to the diverse and enormous basic difficulties faced locally. Therefore, amid so many categories related to smart city, the Culture dimension is still not seen by Brazilians as a priority need.

Citizen Participation is another category that presented very low representativeness among the citations. However, the participation of citizens in the management of cities appears as an essential issue when talking about smart cities in developed countries [46]. Academics point to an evolution from the concept of smart city to “smart human city”, focusing on the human aspect of cities, where a new type of governance is needed to plan and develop cities that take care of their citizens' interests [47]. However, for this to happen, citizens must be involved in the planning and execution of smart city projects, assuming that cities are willing to open their databases. In Brazil, there is still a huge gap to be covered in terms of transparency and social participation. However, in recent years, with the advent of ICT, which allows greater access for citizens to public actions through websites and applications, it is already possible to see the emergence of citizens showing greater interest in government initiatives and seeking a more active participation in issues related to their cities [43].

## **5.1 Research Implications**

In discussions and planning about smart cities, it is important to have prior knowledge of the common sense about this subject. While there are excellent foreign examples of successful smart city initiatives, their mere replications in the context of emerging economies can be a resounding failure. Thus, the use of social representation is quite relevant for a deeper understanding of the perceptions of society or groups of local decision makers on the concept of the smart city. That way, this research can be a catalyst for raising local issues that can be solved through smart city initiatives.

This study, therefore, aims to help academics and public policy makers alike to understand how smart city initiatives can be successful in cities located in emerging markets.

## 5.2 Research Limitations

This research has limitations as detailed below.

Initially, the sample of respondents was very concentrated (over 90%) in the wealthiest states of Brazil - Rio de Janeiro and São Paulo. These two states account for about 30% of the Brazilian population. Thus, this research is not fully representative of the Brazilian population, although these states have as their capitals the two largest Brazilian cities - São Paulo and Rio de Janeiro.

In addition, the identification of the categories of the central nucleus of social representation was carried out through the interpretation of the evoked expressions and their consequent consolidation into categories. Therefore, this process may have given rise to bias in the interpretation, although two invited scholars have helped in the quality control of this categorization.

Finally, as detailed in the introduction of this research, Brazil was considered a proxy for other emerging economies, regarding the implementation of smart city initiatives. However, although there are huge similarities of contexts in these countries, it cannot be guaranteed that the social representation of smart city in Brazil corresponds exactly to the same to be found in other emerging economies.

## 5.3 Final Remarks

As demonstrated in the scientific literature, smart city is a polysemic construct, encompassing and linking a wide range of concepts and areas. Therefore, to make sense of the potential of smart cities, it is necessary to understand the demographic, environmental, economic, and institutional context in which they are implemented [48].

There is no doubt that smart cities have brought many opportunities to everyday life through ICT - the main factor for the advent of this new paradigm. However, smart city is not just about ICT, since some other critical categories, such as Quality of Life and Sustainability, to name just a few, are becoming increasingly associated with smart cities.

In sum, it is imperative to have defined, in a univocal way, what is a smart city. It is hoped that this work has helped clarifying this important issue.

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