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Smart sustainable cities evaluation and sense of community

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ABSTRACT

This paper pursued to evaluate the residents' evaluation on the smart sustainable city and the sense of community. The study analyzed interviews with 392 citizens from five neighboring cities from a micro-region in southern Brazil. Factorial analysis and linear regression were applied. The investigation recognized three factors for smart sustainable cities evaluation: public services and facilities; material well-being, and environmental well-being. Linear regression reveals that residents' satisfaction with the city is predicated on the material well-being, public services and facilities, environmental well-being, and sense of community, which explain 40.2% of satisfaction with the city. Considering a smart sustainable city viewpoint, the study accomplishes that: (i) policies should be projected from the neighborhood standpoint, due to the facility of understanding shared values (ii) sense of community should be included in policies for smart sustainable city; (iii) the design of neighborhoods and cities should prioritize social interactions, with the view to build social capital and facilitate policies implementation. By integrating the smartness to sustainability approaches in the city context, this study intends to contribute to a major discussion on sustainable development, with special attention to residents' evaluation. Finally, the paper offers pertinent outcomes for urban planners and social researchers, by finding factors that influence the sense of community and residents' evaluation on their city and by offering elements for academic, political and debates.

1. Introduction

The current proportion of the global population in urban areas added to the increasing debate on sustainable development raised the attention – not only from academia but also from policymaking and planning – on the smart and sustainable cities development. Sustainable city concept typically focuses on technical results for a more effective urban transformation, based on sustainability impacts (Bulkeley and Betsill, 2005; Nevens et al., 2013; Höjer and Wangel, 2015; Chastenet et al., 2016), while smart city definition encompasses the social capital and human investments, combined with transport and telecommunication infrastructure for economic and sustainable and development (Nam and Pardo, 2011; Papa et al., 2015; Giffinger et al., 2007; Caragliu et al., 2011).

Cities can be sustainable without smartness, in the same way, that smart technologies can be used without considering sustainable development (Cohen, 2006; Höjer and Wangel, 2015; Rostami et al., 2015; Han et al., 2017; Blewitt, 2018). Only when smart Information and Communications Technology (ICT) is applied to sustainable purposes in the cities, that the smart sustainable city concept emerges (Yigitcanlar et al., 2019).

In line with Brundtland definition, the smart sustainable city is a city that: (1) converges the needs of its citizens; (2) without harming the capacity of other people or future generations to meet their needs, and (3) where it is supported by smart ICT (Höjer and Wangel, 2015; Caragliu et al., 2011). The smart-sustainable interface raises two different main approaches. The smart one is based on the bottom-up perspective, and the second, on the deductive (top-down) approach. In order to define the sustainable perspective, the deductive approach is used, since, sustainability is a normative and socially constructed concept (Cohen, 2006; Blewitt, 2018).

A new approach can be built by suggesting the reconciliation of both views and by considering that the challenge is to integrate bottom-up and top-down approaches and to go beyond the pre-established stakeholders' agendas and strategies (Kulkki, 2014; Monzon, 2015; Appels et al., 2017). In this way, by integrating and synchronizing formal leadership with endogenous democratic

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social involvement in an IT-based urban ecosystem, the smartness becomes something more than just a label and becomes translated into behaviors (Letaifa, 2015). The smart sustainable city is reached by integrating the crucial role that leader's performance in driving the city's smart programs with people and their community relations (Bennett et al., 2016; Yigitcanlar et al., 2019).

For both sustainable and smart point of views, the engagement with a better life in the cities has its origins in the sense of community perception (Rostami et al., 2015). The sense or the pride of belonging to a place is frequently defined as a 'sense of community' and is associated not only to other citizens but to the common shared norms, social order, and, to a slighter degree, civic ethos in a neighborhood (Dempsey et al., 2011; Kearns and Forrest, 2000).

Since Jane Jacob's (1961) seminal work, the sense of community has been related to strong common values, norms of reciprocity and codes of behavior (Fukuyama, 2000; Dempsey et al., 2011; Missimer et al., 2017). Such a sense of community might be revealed via the constructed environment and can be influenced by the perceived livability, in other words, by the perception of citizens' ties with the dwelling in which they live in (Talen, 1999; Rogers, 2010).

Despite this evidence, there are few studies relating to smart or sustainable cities and a sense of community. In effect, considering a search in the Web of Science™ database, with the keywords "sustainab* cit*" AND "sense of community", resulted in only 3 papers were found (Rogers, 2010; Rostami et al., 2015; Appels et al., 2017), while the search for the keywords "smart cit*" AND "sense of community" resulted in none result found. In this same line, by advocating that a city to be smart needs to be primarily sustainable, Yigitcanlar et al. (2019) conducted a systematic review in Scopus™, Web of Science™, Science Direct™, Directory of Open Access Journal™, and Wiley Online Library™ databases, that revealed research gaps to be explored. The keyword search (("smart" OR "smartness") AND ("sustainable" OR "sustainability" AND ("city" OR "cities" OR "urban")) was directed to title and abstracts and resulted in a base of 423 papers (Yigitcanlar et al., 2019). After refinement by relevance, 35 papers remained to analysis. Among them, there were only eight articles that related, in some way, citizens with their communities (such as quality of life, sustainable urban agendas, the built environment, and human interaction) and none of them studied the sense of community in a smart sustainable city context.

In order to highlight the relevance of addressing this gap, three main arguments can be raised to support the present study. Firstly, it is important to combine bottom-up and top-down perspectives, to allow a more comprehensive approach by considering social and environmental conditions beyond technological issues in the cities. (Höjer and Wangel, 2015; Giffinger, 2015). Secondly, citizens' participation, a pre-requisite for smart sustainable cities development (Gabrys, 2014), is closely related to the sense of community (Putnam, 1993; Kearns and Forrest, 2000). Finally, the simultaneous evaluation of smartness and sustainability evaluation in the cities and the sense of community allows the comparison of different cities, by considering their diverse social and cultural contexts (Gabrys, 2014; Fahey et al., 2003; Machado Junior et al., 2018).

After these considerations, this paper aims to fulfill the study gap about residents' evaluation of smart sustainable city and sense of community in a developing country context. In order to analyze these perceptions and to identify the main explained factors, a survey was done with citizens from the southern State in Brazil.

In the following section, the theoretical background about smart sustainable cities, and, specifically about social issues and sense of community. In section three, the methodological steps used in the survey are debated. In section four, the results are presented and discussed. Finally, the conclusions of the study are offered, highlighting the theoretical and applied contributions.

2. Smart sustainable cities: a social perspective

The debate on sustainable development concerning cities has gained growing recognition; despite this recognition, the sustainable city concept is ambiguous (Yigitcanlar et al., 2019). Sustainable cities have as their main task, the implementation of greener policies that mitigate negative impacts and can lead to strategies for environment regeneration (Cohen, 2006; Newman and Jennings, 2008). However, describing a sustainable city is not an easy job: the cities are different in regards to climate, geography, history, wealth, culture, and so many other factors which prevent us from any possibility of a unique approach for urban sustainability (Murphy, 2012; Gardner, 2016; Chastenet et al., 2016).

Even not being able to reach its absolute level, sustainability has an important main role to configure "smart cities" (Tregua et al., 2015; Bibri, 2018), by challenging the use of smart technologies in the mitigation of the negative environmental impacts (Haarstad, 2017) to render regeneration strategies, as well as if it happened in the natural ecosystems (Ahvenniemi et al., 2017).

Therefore, the city evolves to a space in which the concepts of smartness and sustainability may be synergistically connected (Höjer and Wangel, 2015). Moreover, the incorporation of sustainability in the very definition of smart activities reveals the acquired importance by the sustainability dimension and strengthens the process of "smartization" (Schaffers et al., 2011; Tregua et al., 2015). The solutions, besides smart, are projected for the sustainable development: rather than questioning if smart cities are beneficial or not for the sustainability (Yigitcanlar et al., 2019), the center of attention is how cities can become more sustainable and smarter (Höjer and Wangel, 2015; Blewitt, 2018).

Such smart and sustainable initiatives also need to be profitable, integrated and efficient in regard to resources and must create impacts, not only on the environmental sustainability targets (Haarstad, 2017), but also on the well-being of the citizens and the financial sustainability (Agudelo-Vera et al., 2011; Batagan, 2011; Schaffers et al., 2011; Kyriazopoulou, 2015; Machado Junior et al., 2018). As a further matter, more specific topics must be considered such as learning, governance, participation, and infrastructure which boost the innovation, services quality and well-being (Schaffers et al., 2011; Yigitcanlar et al., 2019). The smart city then becomes the result of a strategy that connects to feasible and unfeasible systems, in which the sustainability operates as a traverse principle (Giffinger et al., 2007; Harrison and Donnelly, 2011).

In the smart sustainable city approach is embedded the triple bottom line concept, conceived by Elkington in 1994, which articulates the interdependence of the economic, social and environmental dimensions, converted in the main tendency in research and politics (De Jong et al., 2015; Rogers, 2010). The smart sustainable city "focuses on a continuous transformative process, based on stakeholder engagement and collaboration, and building different types of human, institutional and technical capacities" (Estevez et al., 2017, p. 1). In this perspective, the city contributes to improving the quality of life of its citizens by seeking socio-economic development and preserving natural resources among other locally-defined priorities.

The incorporation of sustainability aspect in a smart city plan encompasses the implementation of smart technologies concerning alleviate environment effects and fulfill guidelines of natural ecosystem regeneration (Höjer and Wangel, 2015; Ahvenniemi et al., 2017). Besides that, the smart solutions will demand to be cost-effective and resource efficiently integrated and should have an influence not exclusively on conservational sustainability issues, but also on monetary matters and inhabitants' wellbeing (Colldahl et al., 2013; Schaffers et al., 2011).

Otherwise, the sustainability and intelligence of the Smart City

are attached concepts; however, with no needed interdependence between each other (Bibri, 2018). That sustainability may not be relevant to every stakeholder at the same level or to all the perspectives (Macke et al., 2018). On the other hand, the city only becomes intelligent and sustainable as long as the use of technology can improve its sustainability (Höjer and Wangel, 2015; Yigitcanlar et al., 2019).

Other researchers consider, however, that "sustainable" or "smart" cities are formed by a common and comprehensive understanding of urban development and regeneration that seeks to balance social, economic and environmental dimensions in a mutually beneficial (Caragliu et al., 2011; De Jong et al., 2015). In this perspective, cities' sustainability policies must overcome conflicts of interest and project themselves in a balanced way on the various objectives of the population (Cohen, 2006; Monfaredzadeh and Krueger, 2015).

As an aggregate evaluation and in response to the vagueness and lack of clarity in the general sustainability field, the present paper considers the smart sustainable city when investments in social/human capital and modern (ICT) communication infrastructure nourish a high quality of life and sustainable economic growth, with an intelligent natural resource management, athwart participatory governance (Schaffers et al., 2011).

2.1. Sustainability in smart cities: a social perspective

Historically, the smart cities have been conceived focused in the information technology, based on a new governance model "top-down" induced through government (Letaifa, 2015). Although this model considers the posture of citizens, it usually reflects them as mere users, testes, or consumer in place of producers and sources of creativity and innovation (Alverti et al., 2016).

Several authors emphasize the importance of approaching the social and community affairs as a piece of intelligent cities, often neglected using deepen more technological and governmental aspects (Hollands, 2008; Chourabi et al., 2012; Monfaredzadeh and Krueger, 2015). This technological protagonist is strengthened by the capacity of collecting and managing data in real time and fulfill the needs of citizens in a faster and more efficient way in continuous progress (Han et al., 2017). Such idea is taken to those utopian perspective that citizens have the technology of the future, which exist in every aspect of our daily basis that, despite all its relevance to facilitate people lives, disturb when it dismisses the political, social and shared governance (Kearns and Forrest, 2000; Schaffers et al., 2011). As Bibri and Krogstie (2017) suggested, smart sustainable cities are designed by, and contribute, to socio-cultural and politico-institutional structures formation.

The incorporation of the human factor in the technocentric model of smart cities avoids the mistaken point of view that technology can solve any problems itself (Giffinger, 2015; Breuer et al., 2014). Moreover, citizens' participation in the governance of smart cities not only elect them as active users of the innovations (Haarstad, 2017), as well as promote straightforward, educated and participative citizens, which bears upon the livability in the city in a positive way (Chourabi et al., 2012).

Such a bottom-up perspective holds a more experimental approach and allows the citizen to nurture innovation as a user of the city. The citizens then co-create with other stakeholders based on the demand in a process that must be stimulated by the government (Alverti et al., 2016). Strictly technocratic management generates resistance among citizens who fear the rigidity of technological bureaucracy, and among those who suspect that an invasion of their private data may affect their privacy (Romero and Lille, 2017).

Nevertheless, the smart city based on citizenship, gathered to its democratic virtue, has to consent to some way of chaos – which can case conflicts against the goals defined by decision makers, whereas the disordered bottom-up processes counterbalance the idea of an "ideal" plan (Walravens, 2016). This is often the case both by the multiple views of citizens and by highly complex technology initiatives where citizens do not have sufficient resources to position themselves without the government's prominent intervention, such as in the case of disruptive technologies (Capdevila and Zarlenga, 2015).

Consequently, the smart city needs to be developed in a fertile environment that includes the citizens and other relevant actors, which are oriented by a clear point of view and efficient actions (Alverti et al., 2016). The implementation a smart city model should be guided by an incremental, longstanding, planned process that aggregates educational, and community organization, conceiving public guidelines in a common and clear view (Giffinger, 2015; Appels et al., 2017).

Another approach suggests a reconciliation of both views and considers that the challenge is to integrate the bottom-up and top-down proposals and go beyond the agendas and strategies pre-established by stakeholders (Kulkki, 2014; Monzon, 2015). In this way, by integrating and synchronizing endogenous democratic participation with formal leadership in an IT-based urban ecosystem, intelligence becomes something more than a label and becomes translated into behaviors (Letaifa, 2015). The idea is, on the one hand, to integrate the crucial role that leaders' performance in driving the city's smart programs with people at the local level whose proactivity and creativity are key for creating a better life for their communities (Bennett et al., 2016). As Bibri and Krogstie (2017, p. 193) postulated the term smart sustainable city "is used to denote a city that is supported by a pervasive presence and massive use of advanced ICT, which, in connection with various urban domains and how these intricately interrelate and inform one another, enables cities to become more sustainable and to provide citizens with a better quality of life".

This interpretation drives to the definition of the smart city as a cultural shift that creates more civic (citizen-centered), attractive, prosperous and sustainable cities, characterized by using technology that puts people at the heart of the city. (Alverti et al., 2016). However, several studies acknowledge that one of the most important success factors in building smart cities is to enable leaders and citizens to work together (sense of community) to create and maintain a new collaborative community-based model (Monfaredzadeh and Krueger, 2015; Bennett et al., 2016).

2.2. The sense of community

The sense of community increases the efficiency of the public policies of smart sustainable cities, as it provides levels of social capital to sustain citizen participation (Missimer et al., 2017; Bibri and Krogstie, 2017). The exercise of this citizenship increases trust levels while reducing opportunism and the need for monitoring costs throughout the process (Macke et al., 2018). Another consequence is related to the encouragement of cooperative behavior by encouraging the development of new forms of organization (Putnam, 1993; Gabrys, 2014). In this perspective, the sense of community is fundamental for understanding innovation, institutional dynamics, and value creation (Nahapiet and Ghoshal, 1998; Wood et al., 2010) – essential elements for smart sustainable city projects.

The sense of community is a feeling that citizens have of belonging and being important to each other and a shared trust that citizens' needs will be met by the engagement to be together' (McMillan and Chavis, 1986; Dempsey et al., 2011; Wood et al., 2010).

The literature points out a close correlation between the performance of a regional government and the degree of participation in the political and social life of the region, even the most economically developed regions have more efficient regional governments because there is more civic participation in them (Putnam, 1993). Such participation is closely related to the sense of community; thenceforth it adopts into the aggregated civic society concept: participation and civic sociability in organized activities (Putnam, 1993; Dempsey et al., 2011).

In a civic community, citizens do not do what they want, because they know that their freedom is a consequence of their willingness to deliberate and act by agreement. In a less civic community, there is greater insecurity, citizens are more suspicious, and laws and public politics are "made to be defied" (Putnam, 1993; Rostami et al., 2015).

In civic areas, collective life is facilitated by the belief that others will follow the rules. Assuming that others will do so, it is most likely that one citizen will do the same, thus satisfying collective expectancy. In less civic regions, almost everyone supposes others to break the rules. It seems silly to obey traffic rules, tax laws, or social security rules when others are expected to disobey them. So many people disobey, and so the cynical and dreadful expectations of all end up being confirmed – the self-fulfilling prophecy (Putnam, 2000; Dempsey et al., 2011).

There is a positive and direct relation between norms of reciprocity and sense of community and shared values: "the deeper and more strongly held these common values are, the stronger the sense of community is" (Fukuyama, 2000, p.15). These norms and values are part of the existing social capital stock in a community, and the development of a democratic spirit in a smart sustainable city can be achieved by strengthening civic participation through social interaction (social capital) and sense of community (Rostami et al., 2015; Appels et al., 2017; Macke et al., 2018).

That sense of community can reveal itself through the constructed environment, i.e., employing rules of reciprocity and conduct, such as informal rules about how to be a good neighbor. Pride and sense of belonging to a place are strictly connected to the built environment since these emotional states can be influenced by the perceived livability (Talen, 1999; Kearns and Forrest, 2000; Dempsey et al., 2011).

3. Method

3.1. Questionnaire design

With the purpose of evaluating the evaluation of citizens regarding to its sense of community and the degree of smart sustainability in their cities, the researchers adopted the instruments used by Wood et al. (2010) and Macke et al. (2018), which was, in turn, based on the Eurobarometer survey (European Union, 2016). The Eurobarometer is a reference for analysis of social issues like social capital, behaviors, participation, and quality of life (Fahey et al., 2003).

Reverse translation (from English to Portuguese and vice versa) was used to assurance the variables comprehension. A pilot test was done with 20 interviewees, and the questionnaire was fully understood. The final version comprised 25 variables separated into three blocks: i) smart sustainable city; ii) sense of community, and iii) socio-demographic variables: family income, age, educational background, gender, and paid work. During face-to-face meetings, the researches decided about the final layout of the questionnaire. Variables were measured through a Likert seven-point scale (1 = strongly disagree; 7 = strongly agree).

3.2. Survey procedures and data analysis

Data collection occurred through an on-site survey, managed in October 2017 in five neighboring cities in South Brazil: Caràzinho, Ibirubá, Não-Me-Toque, Passo Fundo, and Tapera. Citizens were sampled on weekends and working days between 9 a.m. and 6 p.m. On each place, people were interviewed randomly.

The total of 392 respondents was approached for voluntary participation; each interviewer informed that there was no correct answer and that they should answer individually, being ensured the anonymity of answers. Average time of 10 min was enough to conclude the answers.

Descriptive statistics were done for socio-demographic variables. For smart sustainable variables, the factorial analysis was applied to identifying the factors. For the sense of community concept, the Cronbach's alpha was calculated for factor reliability (Hair et al., 2003). The identification of the degree of influence of each factor in the general evaluation of smart sustainability in the city was calculated through linear regression. The study proceeds with the software SPSS (Statistical Package for the Social Sciences, version 20) for Windows®.

4. Smart sustainable cities and sense of community evaluations: results and discussion

4.1. The Passo Fundo region in southern Brazil: examining a countryside region in a developing country

The micro-region of Passo Fundo is considered a major center of social and economic development, having a privileged location within the MERCOSUR, being in the center of the economic hubs of São Paulo, Rio de Janeiro, Montevideo, and Buenos Aires, which allows accessing the capitals of southern Brazil and neighboring countries. Its land structure, historically characterized by small and medium-sized farms, has transformed, from a strictly agrarian economy to a broad urban development based on industry, commerce, and services. Micro-region of Passo Fundo (Northwest Mesoregion of the State of Rio Grande do Sul) includes 26 municipalities, of which 5 were the target of this study (Passo Fundo City Hall, 2018).

The Human Development Index (HDI) of Passo Fundo is 0.776, in 2010, which places this municipality in the High Human Development range (IDHM between 0.700 and 0.799). The dimension that contributes most to the HDI of the municipality is Longevity, with an index of 0.849, followed by Income, with an index of 0.787, and Education, with an index of 0.699. Passo Fundo is ranked 168th among the 5,565 Brazilian municipalities according to the HDI (Atlas of Human Development in Brazil, 2018).

In 2016, Passo Fundo started a smart-sustainable mobility program, aiming to promote active mobility, health, and sustainability. The population estimated of the city is 198.799 inhabitants, with a territorial area of 783,421 km^2 and population density of 235,92 hab/km^2. The bike-sharing system distributed by the bikes lanes, based on sharing experiences, which goal is incentivizing the use of ecologic transport non-motorized, easy, clean, silent, healthy and without emission of harmful gases to atmosphere (Passo Fundo City Hall, 2018).

Sustainability is also present in green areas and public spaces, such as, Parque da Gare (Fig. 1), Parque Linear do Sétimo Céu, Parque Ambiental Banhado da Vergueiro, and Praça Tochetto, which are being revitalized (Passo Fundo City Hall, 2018). The rehabilitation of living spaces, rest and recreation are examples of the transformations that Passo Fundo has been experiencing in the sense of urban sustainability, preservation of historical patrimony and appropriation of space by the population, to build a sense of community.

Fig. 1. Main Green Park in the region – Parque da Gare (Brazil). Source: PMPF.

4.2. Outcomes

The most relevant characteristics of the sample were revealed by descriptive analysis: 48.6% were aged 30 years or less; 50.0% of the interviewees were female; 91.8% of the interviewed were employed; family income of 75.6% was up to 5 basic salaries; 56.7% had secondary education, and 86.0% intend to continue living in the city in the next 5 years.

The adequacy of the sample measured by the Kaiser-Meyer-Olkin (KMO) index was 0.827, and Bartlett's Test of Sphericity (significant to 0.000). The factorial analysis used PCA (Principal Component Analysis), with listwise treatment for the missing data and varimax rotation. The factorial analysis comprised 13 variables in the final model. Communality analysis and loadings inferior to 0.4 were the two criteria to removed variables (three in total).

Factor analysis outcomes met in four iterations and showed that residents' evaluation of smart sustainable city is explicated by the three factors, which together explain 52.05% of the total variance. The Cronbach's Alpha for this construct was 0.842, which denotes a very satisfactory range for an exploratory study (Hair et al., 2003). These results indicate that the items in each construct are suitable for smart sustainable city evaluation (Table 1).

Considering the explained variance, there is a stable partition between the three factors. “Public services and facilities” factor explains 20.84% of the total variance, followed by the “Material well-being”, with 15.84% and finally “Environmental well-being”, with 15.37% of the variance explained.

The sense of community was evaluated according to Wood et al. (2010). The consistency level for this construct measured through Cronbach's alpha was 0.902, indicating an excellent level of consistency, and the mean was 3.69, indicating a medium degree of general agreement about this topic. The variables: “Living in my neighborhood gives me a sense of community” and “It is easy to make friends in my neighborhood” were the highest performing variables for the sense of community in this study.

Linear regression was applied to investigate the effect of each factor on a general evaluation of the city by using the variable: “I am satisfied to live in my city”, as dependent variable (Table 2). The general satisfaction with the city is explained by the factors: “Material well-being”, “Public services and facilities”, “Environmental well-being”, “Sense of community”. These factors explained 40.2% of the general evaluation of the citizen's satisfaction with the city they live (Table 3). These factors were discussed in the next section.

4.3. Identification and analysis of factors for smart sustainable cities in developing countries

The study revealed three main factors that represent residents' evaluation of smart sustainable cities. The first factor, with the highest level of significance, was “Public services and facilities”, which refers to the tangible structures to promote good life, livability, and social inclusion. The variables are related to cultural and sports facilities, green and public spaces, public transport, and the conditions of the buildings and the streets – all elements supported by the government.

The fact that the most representative factor for a smart sustainable city is related to government support has its roots on the actual level of cities growth in developing countries. In this context, cities in developing countries have public services and facilities as one of the most challenging issues. A common situation in developing countries is a lacking of institutional capacity for the cities – especially small ones – to be capable of managing their quickly increasing populations. This fact leads to a more complex and challenging task of managing cities (Cohen, 2006; Estevez et al., 2017; Blewitt, 2018).

Large investments in public transportation systems have been applied as a response to urban transportation problems. Less consideration has been dedicated to increasing and upgrading public bus networks, which tend to be overloaded and insufficiently preserved (Cohen, 2006; Han et al., 2017). This situation leads to an increasing of private transportation – cars and motorcycles – instead of collective (buses and metros) and active modes (bicycles)

Table 1
Factorial results for Citizen's perception on smart sustainable cities.

Factor	Items	Loading	Mean	Standard deviation
Public services and facilities (0.794)[a]	04 - I am satisfied with cultural facilities in my city	0.774	3.66	1.402
	03 - I am satisfied with sports facilities in my city	0.745	4.27	1.375
	07 - I am satisfied with green spaces	0.728	4.42	1.305
	01 - I am satisfied with public transport in my city	0.614	3.65	1.387
	06 - I am satisfied with public spaces	0.580	4.53	1.195
	05 – I am satisfied with the state of the streets and buildings	0.535	4.08	1.321
Material well-being (0.778)[a]	16 – I am satisfied with the place where I live	0.796	5.57	1.181
	15 – I am satisfied with the life I lead	0.767	5.40	1.093
	14 – I am satisfied with the financial situation of your household	0.713	4.88	1.126
	13 – I am satisfied with my personal job situation	0.690	5.24	1.363
Environmental well-being (0.785)[a]	12 - I am satisfied with cleanliness	0.829	4.27	1.332
	10 - I am satisfied with the quality of the air	0.791	4.98	1.387
	11 - I am satisfied with noise level	0.763	4.29	1.444

[a] Cronbach's Alpha.

Table 2
Linear regression model.

Model	R	R Square	Adjusted R Square	St. Error of the Estimate	Durbin-Watson
1	0.532[a]	0.283	0.281	1.152	
2	0.600[b]	0.360	0.356	1.090	
3	0.630[c]	0.397	0.391	1.060	
4	0.639[d]	0.409	0.402	1.051	1.645

[e]. Dependent Variable: I am satisfied to live in my city.
[a] Predictors: (Constant), Material well-being.
[b] Predictors: (Constant), Material well-being, Public services and facilities.
[c] Predictors: (Constant), Material well-being, Public services and facilities, Environmental well-being.
[d] Predictors: (Constant), Material well-being, Public services and facilities, Environmental well-being, Sense of community.

Table 3
Linear regression coefficients.

Final Model	Unstandardized		Standardized	t	Sig.
	B	Std. Error	Beta		
(Constant)	−0.400	0.382		−1.047	0.296
Material well-being	0.534	0.070	0.360	7.609	0.000
Public services and facilities	0.302	0.070	0.209	4.289	0.000
Environmental well-being	0.230	0.054	0.196	4.287	0.000
Sense of community	0.133	0.052	0.126	2.587	0.010

a. Dependent Variable: I am satisfied to live in my city.

As the classical definition of sustainable development states (UNEP, 2016), the concept of needs, especially the essentials need for the poor, should be prioritized. The task of appointing priorities should be driven by a participatory budget (Schaffers et al., 2011; Blewitt, 2018), such as it occurs in Curitiba (Macke et al., 2018). Besides that, the nature and the responsibilities of city governance are also experiencing important transformation, which requires technical and managerial expertise in local governments.

The second factor emerged was “Material well-being”, which refers to personal job situation and the essence of a citizen's connection with others in their home, and their community. This factor reveals significant elements for sustainable societies, among which “employment” has a key role.

In Brazil, unemployment rates have increased in recent years, reaching 12.2% in the first quarter of 2018 (IBGE, 2018). Unemployment leads to extremely precarious housing conditions: people's housing reflects the financial situation, neighborhoods in the periphery are deprived of basic public services (treated water, sewage, lighting, among others). From the second half of the twentieth century, urban centers had great growth. However, the increase was not accompanied by the infrastructure, forming marginalized districts (Cohen, 2006; Chourabi et al., 2012; Monfaredzadeh and Krueger, 2015).

The problems with social sustainability are in the root of cities development. In the case of unemployment, policy development should focus more on forms of income redistribution and social empowerment as drivers for social sustainability (Blewitt, 2018). A smart sustainable city project only will be viable when the eradication of poverty and social exclusion were real (Rostami et al., 2015; Appels et al., 2017; Blewitt, 2018).

Finally, the study reveals the “Environmental well-being” factor, in which citizens consider their evaluation of cleanliness, quality of the air, and noise level in their neighborhood. These elements raise the debate about the interrelations of eco-scarcity, natural limits, and overpopulation (Talen, 1999; Rogers, 2010).

Air pollution is a major environmental risk to health. Concentrations of carbon monoxide, lead and suspended particulate matter in many cities greatly exceed the World Health Organization (WHO) guidelines. In 2016, 91% of the world population was living in places where the air quality guidelines levels were not reached; this was estimated to cause 4.2 million premature deaths worldwide in that year. By minimizing air pollution levels, nations can diminish the weight of disease from heart disease, stroke, chronic respiratory diseases, and lung cancer (WHO, 2018).

As the revitalization of green areas and the bike-sharing systems in Passo Fundo, the smart sustainable project can provide strategies for the benefits of cities with green spaces where ecosystems are present, maintaining biodiversity and regulating the urban climate - since vegetation and planting trees near houses and apartments cool the weather. Besides, the project delivers resources to deal with pollution control related to atmospheric and noise pollution.

Analyzing the three factors found, it is possible to identify that the factor with the most fragile performance (lower means) was the environmental well-being. This aspect is relevant because it shows how difficult it is to combine the concept of smartness with that of sustainable. To a city become smart and sustainable, it is necessary that besides the technology-based innovation in the stages of planning, design, operation, and management of a city, the city be constituted in a sustainable system with focus in the long term. This long-term focus should include renewable energy production and consumption, efficient and sustainable transport, livability, and sustainable community (Bibri, 2018; Yigitcanlar et al., 2019).

In the case of Brazilian cities, the union between smartness and sustainable becomes even more necessary (Machado Junior et al., 2018). Brazil is a country abundant in natural resources, which makes the discussion of sustainability deferred to the detriment of the need to expand the supply of technological products and services. In this line, the country has challenges in the management of megacities (over 10 million inhabitants), as is the case of São Paulo and Rio de Janeiro.

In the case of medium-sized cities, as in the case of Passo Fundo, the problems of urban management are not, of course, so serious. Even so, there are many issues to be resolved, especially in the context of urban violence, which undermines urban planning and public policy initiatives. In Passo Fundo, the homicide rate is 30.8 cases per 100,000 inhabitants (IPEA, 2019), which is considered endemic by UN standards (up to 10 murders per 100,000 inhabitants). This is a national problem since the country's average is 30.3 cases per 100,000 inhabitants (IPEA, 2019).

Violence seems to be at the root of the problems of sustainable

development in developing countries since it undermines confidence in society and governments. Without trust, it is not possible to build a participatory, livable, and sustainable society. In the case of Passo Fundo, a square in the central area (Praça da Gare), which was, in the past, degraded and marked by violence, was completely revitalized, transforming itself into an area of conviviality, culture, and leisure. This project, in line with the city's sustainability-focused development plan, has transformed the city towards smartness and sustainability.

In order to develop smart sustainable cities, we need a paradigm change in sustainable education and political action, particularly in developing countries. For reducing the main sources of pollution, investments in municipal waste management, energy-efficient homes, cleaner means of transportation, power generation, and even, citizen's participation and trust are needed.

Linear regression allows the identification of the comparative weight of the factors in defining the overall evaluation of citizens (significance when $p < 0.010$). The relative weight of each factor is demonstrated by Beta index. The degree of explanation of the group of variables, regarding the dependent variable is given by R square value (R^2). Stepwise model (Hair et al., 2003) was used as input criteria (Table 2).

The four domains identified (material well-being, public services and facilities, environmental well-being, and sense of community) were used as independent factors (variables) while the dependent variable was: "I am satisfied to live in my city". This variable covered the overall evaluation of citizens about the city, and through it, residents' overall evaluation on the smart sustainable city could be estimated.

The analysis shows that the model is statistically significant at $p < 0.010$; R^2 adjusted $= 0.402$). The model foresees that residents' satisfaction with the city is predicated on the material well-being, public services and facilities, environmental well-being, and sense of community, which explain 40.2% of satisfaction with the city. The model can be summarized according to the following equation (Table 3):

Residents' satisfaction = 0.360 *Material well-being + 0.209 * Public services and facilities + 0.196* Environmental well-being + 0.126 * Sense of community.

The regression model has good explanatory power for studies that infer about perceptions. The final model demonstrates that the independent variable with the higher power of explanation is Material well-being com $\beta = 0.360$; followed by Public services and facilities with $\beta = 0.209$; by Environmental well-being with $\beta = 0.196$ and by Sense of community with $\beta = 0.126$. When using partial coefficients beta, the constant is always zero; then it can be omitted (Hair et al., 2003).

Smart sustainable cities schemes comprise the formation of materials flow and recycling programs, green spaces, sustainable agriculture, land use planning, waste management, and natural resources conservation. These results indicate the most important variables to be considered in smart sustainable city projects in developing countries.

5. Final remarks

Increasing urbanization and climate change and are some components that have induced governments to adopt progressively complex strategies to deliver their citizens a liveability, wealth, and environmental well-being. These strategies include enhancements in urban services, infrastructure, and environmental issues as some observable cases. In this viewpoint, the discussion of smart sustainable development regarding cities has increased.

Despite this recognition, the sustainable city concept is ambiguous. Sustainable cities have as their main task, the implementation of greener policies that mitigate negative impacts and can lead to strategies for environment regeneration (Cohen, 2006; Newman and Jennings, 2008). However, unfolding a sustainable city is not a simple work. The cities are different regarding culture, history, climate, wealth, geography, and so many other factors which prevent us from any chance of a unique approach for urban sustainability.

Despite this recognition, both sustainable and smart city concepts are ambiguous. Sustainable cities have as their main job the implementation of greener policies that mitigate negative impacts and can lead to strategies for environment regeneration By integrating the smartness to sustainability approaches in the city context; this study intends to contribute to a major discussion on sustainable development, with special attention to residents' evaluation. In this line, the assessment of residents' evaluation on smart sustainable city reveals four main factors: material well-being, public services and facilities, environmental well-being, and sense of community. In a developing country context, material well-being (e.g., satisfaction with the economic condition of home) is still the most desirable factor for liveability satisfaction in the city.

Considering a smart sustainable city viewpoint, the study accomplishes that: (i) policies should be projected from the neighborhood standpoint, due to the facility of understanding shared values (ii) sense of community should be included in policies for smart sustainable city; (ii) policies should be proposed from the neighborhood perspective, due to the facility of understanding shared values; (iii) the design of neighborhoods and cities should prioritize social interactions, with the view to build social capital and facilitate policies implementation.

Considering these results, reaching these targets via public policies would improve citizens' wellbeing, by producing fertile ground for city development. The pledge to ideas such as social justice, efficient resources management, transparency, accessibility, and poverty reduction, supports the city to attain outstanding outcomes in smart sustainable projects.

Practical recommendations for public policies are the articulation of a strong set of shared values, as well as an independent local planning authority and the integration of planning processes. One key condition for developing these elements is the combination of social learning and democracy, which allows the creation of a collective urban imaginary of sense of community.

The present study contributes, firstly, for the integrative perspective on the smart sustainable city. Secondly, by including the subjective evaluation of citizens in their cities. Thirdly, the opportunity of replicating the method procedure in different Brazilian cities to examine and compare its performance of variables in different contexts. Fourthly, the paper provides understandings for urban planners and social researchers, by categorizing smart sustainable factors and providing foundations for academic and political debates. Lastly, the research subsidies to the academic dialogue about the sense of community in smart sustainable cities.

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