Decision-making based on citizens' standpoint: an importance-performance analysis of smart city indicators

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Abstract: The smart city perspective arose to guaranteeing the quality of life for its citizens. Thus, this research analysed the leading smart city characteristics based on the inhabitants' point of view. The data collection was through an online questionnaire applied in a sample of 395 Campina Grande City inhabitants. Data analysis was performed using the importance-performance analysis (IPA) matrix, to verify the municipality inhabitant's satisfaction related to 32 variables distributed in 12 dimensions of a smart city. The results indicated the inhabitant's satisfaction gaps regarding the items that classified the smart city, providing 16 key-factors for decision-making actors to prioritise actions. Also, we found eight factors of good performance, and eight factors of low priority. These results provide a managerial direction for the public sector to increase the ranking position and resident satisfaction. It still confirms the theoretical assumptions concerning the items' importance that evaluates the process of a city smartisation.

Keywords: smart city; importance-performance analysis; IPA; Brazil; citizen participation.

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1 Introduction

The United Nations expects population growth to increase around 2.5 billion by 2050 and estimates an increase of 61% of the 80-year-old population by 2030 (United Nations, 2015). Facing that, it is necessary to focus efforts on sustainable development. Thus, cities assume an essential role in human progress based on innovative investments to support life's fundamental areas.

The concept of smart city emerged during the 1990s inside the smart growth movement that proposed the modernisation of city infrastructures, mainly through information technology (Albino et al., 2015; Neirotti et al., 2014). The smart city term became popular, even though its inaccuracy due to the existence of various definitions and a lack of consensus among the authors about its scope or indicators (Albino et al., 2015; Angelidou, 2015; Dameri and Cocchia, 2013; Lee et al., 2014; Neirotti et al., 2014).

In general, a city is categorised as a smart city if the investments in human and social capital, as well as traditional and modern communications infrastructure drive sustainable economic growth and a high quality of life. At the same time, it should have intelligent management of natural resources through participatory governance (Caragliu et al., 2011). Also, it has a well-performing environment built on the smart combination of endowments and activities of self-decisive, independent, and aware citizens (Giffinger et al., 2007).

Every theoretical approach of smart cities connects the most intelligent behaviour through the improvements of the citizen's quality of life (Lee et al., 2014). Therefore, its concept is linked to technology and engagement of people and institutions, transforming city areas in smart ones, since basic units until community dimensions such as smart homes, systems, industries, education, infrastructure, and health (Albino et al., 2015; Romero et al., 2020), which raises improvements in various aspects such as economy, mobility, environment and social living.

The number of scientific studies shows the relevance of the smart city approach. Between 2010 and 2012 there was a 500% growth in publications compared with the period of 1992–2009 (Mora et al., 2017). In addition, several smart city monitors have been created by different institutions. For instance, the Easypark smart cities index ranks the smartest cities globally, assessing 500 cities from different countries. Another example is the connected smart cities ranking developed by Urban Systems to provide an assessment of Brazilian cities.

There is still a lack of customised schemes for smart city assessment in the Global South (Sharifi, 2020). In Brazil, the urban systems, together with Sator Institution created the connected smart cities ranking that points out the Top 100 cities in Brazil according to their performance related to intelligence, connection, and sustainability (Urban Systems, 2018). In this monitor, the smartisation level, i.e., the process to become a smart city, is based on a full connection of all city sectors and the understanding that economic sustainability should underpin social and environmental sustainability (Urban Systems, 2018). These institutions verify about 700 Brazilian cities every year to choose the Top-100 smart cities.

The connected smart cities ranking results of 2018 included Campina Grande city among the best smart cities of Brazil (Urban Systems, 2018). Campina Grande is the second largest city of Paraíba province, located in the northeast of Brazil. It has around 400,000 inhabitants, per capita Gross Domestic Product (GDP) of U$ 4,847. Also, it is one of the six pioneer cities to receive a smart city project in Brazil, according to the Instituto Brasileiro de Geografia e Estatística (IBGE) and Brazilian Micro and Small Business Support Service (SEBRAE). However, the inhabitants' satisfaction may differ towards the items used to characterise a smart city. Local inhabitants gather knowledge not only from the importance of the smart city indicators but also about its effective performance in the region.

A critical issue in smart cities is the exclusion of citizens from governance structures and strategic decision-making processes, as well as projects' creation, designs and implementation (Kumar et al., 2020; Lynch, 2020; Nesti, 2020). Then, the research aims to analyse the main characteristics of a smart city from citizens' standpoint to verify which indicators are more vital to them simultaneously with its satisfaction level. We chose Campina Grande City as the unity of analysis and the categories were based on Urban Systems (2018) ranking that has 11 dimensions and 70 indicators. The research was conducted through a quantitative methodology classified as an exploratory and descriptive study, using an importance-performance analysis (IPA).

2 Theoretical background

The urban population growth is motivated by rural exodus across the globe. In some regions, up to 80% of the population will be living in urban environments by 2050 (United Nations, 2015). This scenario alters people's needs and increases demographic, political, administrative and social problems (Daniel and Doran, 2013; Hara et al., 2016; Harrison and Donnelly, 2011; Lee et al., 2014). Which meets the objective of Smart cities: the need to create cities capable of supporting the increasing number of urban inhabitants, guaranteeing a satisfactory and sustainable quality of life, mostly through technology (Dameri and Cocchia, 2013; Glasmeier and Christopherson, 2015).

The smart city definition emerged in the 1990s from the smart growth movement (Harrison and Donnelly, 2011). Its first study was by David V. Gibson, George Kozmetsky and Raymond W. Smilor's book "The Technopolis Phenomenon: Smart Cities, Fast Systems and Global Networks" published in 1992 (Mora et al., 2017). The smart city became increasingly important for different stakeholder groups, attracting researchers, universities, governments, institutions and businesses, as an icon of innovation and development (de Wijs et al., 2017). However, in the first 10 years of its emergence, only 19 documentary sources were published. Across time occurred a growing scientific production, however, it was faster after 2009. In 2010–2012, more than 900 new papers were written, forming 86% of all publications on the subject in only three years (Mora et al., 2017).

The smart city concept, schemes, and indicators still have lack of consensus and may be used as synonymous of other terms (Angelidou, 2015; Dadkhah and Shahbazi, 2015; Dameri and Cocchia, 2013; Hollands, 2008; Lee et al., 2014; Neirotti et al., 2014; Sharifi, 2020). The term goes beyond innovation and technology applications, seeking to improve the citizen's quality of life in all its aspects (Fernandez-Anez et al., 2018; Garau and Pavan, 2018; Höjer and Wangel, 2014; Kobayashi et al., 2017; Walravens, 2015).

To provide an overview, Table 1 presents some smart city definitions and highlights its main elements.

Table 1 Definitions of smart city

Definition	*Author*	*Main elements*
It is a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens. Smart city generally refers to the search and identification of intelligent solutions which allow modern cities to enhance the quality of the services provided to citizens.	Giffinger et al. (2007)	Economic prospective Governance Mobility Environment Living Citizens activities Smart solutions
It is the use of Smart Computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient.	Washburn et al. (2010)	Technologies Infrastructure services City's management Smart services Interconnection Efficiency
A city is a smart city when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.	Caragliu et al. (2011)	Human and social capital Infrastructure ICT Sustainable economic growth Quality of life Governance
Smart city are territories with a high capacity for learning and innovation, which is built in the creativity of their population, their institutions of knowledge creation and their digital infrastructure for communication and knowledge management.	Komninos et al. (2013)	Learning Innovation Creativity Digital infrastructure Knowledge management

Source: Elaborated by the authors

Table 1 Definitions of smart city (continued)

Definition	*Author*	*Main elements*
A smart city is defined with the meaning of smartness penetrating the urban context, the role of technologies in making a city smarter, and focal domain (infrastructures and services) that need to be smarter	Nam and Pardo (2014)	Urban context Focal domains Service smartness
It is an integrated and multidimensional system that aims to address urban challenges based on a multi-stakeholder partnership.	Fernandez-Anez et al. (2018)	Multidimensional and integrated system Urban challenges Multi-stakeholders
Smart cities use an information system (IS) centric approach to the intelligent use of ICT within an interactive infrastructure to provide advanced and innovative services to its citizens, impacting quality of life and sustainable management of natural resources.	Ismagilova et al. (2019)	Information system ICT Interactive service Quality of life

Source: Elaborated by the authors

The vast theoretical approaches created a lack of cohesion among scholars and a divided intellectual structure of disconnected publications. Although, there is theoretical articulation thanks to the presence of co-citations, which indicates an active exchange of knowledge among its principal authors (Mora et al., 2017). Based in Table 1, the main objective of smart cities is to optimise and improve its citizens lives through the technological initiative to generate smart solutions that permeate participatory governance and integration of social, environmental, and economic spheres. Then, the rationale to become smart is the process of smartisation, and it is based on the implementation of better policies for environmental issues, economic purposes, and the improvement of the citizen quality of life (Nesti, 2020).

The smart city literature has two distinct conceptual lines. One is based on the Smart Growth Agenda approach, which comprehends the concept holistically, aiming to make cities smarter through its various components, such as governance, politics, society, culture, etc. Thus, it is a human-centred perspective. The second is a technology-centred perspective, based on a corporate vision, comprising information and communication technology (ICT) and the Internet of Things (IoT) as the backbone of all city's activities and tools (Angelidou, 2015; Fernandez-Anez et al., 2018; Glasmeier and Christopherson, 2015; Hollands, 2008; Mora et al., 2017; Romero et al., 2020; Walravens, 2015).

Although the smart city concept is enabled by ICT developments as a digital ecosystem, such as Industry 4.0, big data applications, and even games (Angelidou and Psaltoglou, 2019; Caputo et al., 2019; Clarizia et al., 2020; Oztemel and Gursev, 2020), it also needs the citizens to understand and enroll in planning, leading, and to participate in the implementation and decision-making process for the urban space future development, which is a significant contribution to enable social, environmental, economic and cultural progress (Angelidou and Psaltoglou, 2019; Caputo et al., 2019; Nam and Pardo, 2014). Then, the smart cities development and implementation depends upon integration due to its complex system made up of several intelligently interconnected components. (Angelidou, 2015; Dirks et al., 2010).

The evolution of smart city models reflects the adoption of a bottom-up citizen-centred approach, with a key role played by its stakeholders to achieve urban development, bringing better citizen participation, public and private partnerships (Caragliu and Del Bo, 2016; De Guimarães et al., 2020; Fernandez-Anez et al., 2018; Rondini et al., 2018). This citizen empowerment is also viewed in both most influential papers in the smart city research. Giffinger et al. (2007) offered a model that was a background to several authors, and it is considered as one of the most influential sources on the subject (Fernandez-Anez et al., 2018; Mora et al., 2017), as they presented six smart dimensions as components of a smart city: economy, living, mobility, governance, environment, and people. Their theoretical proposal uses a traditional and neoclassical perspective of growth and urban development theories and also includes a quality of life evaluation (Albino et al., 2015; Caragliu et al., 2011; Garau and Pavan, 2018). The model focused in the presence of governance and active participation of multi-stakeholders, mainly centred in population to achieve a satisfactory quality of life in the city.

Caragliu et al. (2011) presented six characteristics of the smart city:

1 the use of a network infrastructure for political-economic and socio-cultural improvements, in addition to urban development

2 emphasis on economic neoliberalism, observed by corporate-driven urban development

3 social inclusion

4 the crucial role of creative and high-tech companies

5 deep attention to social and relational capital

6 environmental and social sustainability.

From a policy and research perspective, Caragliu et al. (2011) stressed items 5 and 6 as the most interest and promising ones for the development of a smart city.

The smart city development is a win-win situation that brings several benefits for its stakeholders, such as improved quality of service for citizens and economic advantages to governments and businesses (Zanella et al., 2014). However, there are some criticisms on this approach. For instance, cities might label themselves as smart city only for marketing and political purposes, rather than the concept goal, turning political issues of urban governance into problems with 'technical' solutions (Hollands, 2008; Lynch, 2020). Other critiques include the technological societies as a cover up for a business-based informational city and its adverse effects, and a new form of securitisation, surveillance and control; economic and social fragmentation and polarisation; doubts about the smart city 'eco' friendship with economic growth; and concerns about data privacy, the lack of transparency, and the privatisation of public services (Hollands, 2008; Lynch, 2020).

There is a wide range of 'models, tools, frameworks, and indicators', also called schemes, to verify the results of a smart city implementation, that is, to assess the progress of the smartisation process of a city (Sharifi, 2020). For instance, Giffinger et al. (2007) and Caragliu et al. (2011) developed a set of variables to European cities; while Neirotti et al. (2014) offered indicators to other locations (de Wijs et al., 2017). Although, government planners still have difficulties in identifying the priorities to focus efforts and resources (Albino et al., 2015).

Some organisations performed a smart city ranking based on predefined variables and dimensions, such as the Japanese Institute for Urban Strategies, the University of Vienna, the Council for the Defense of Natural Resources, Forbes, and IBM (Albino et al., 2015). Nevertheless, the schemes are diverse, as they vary in geographic focus and target audience; aims, methods and approaches to scoring and assessment; format; data type and sources; weighting; and implementation (Sharifi, 2020). Technology-centred models are more used by commercial enterprises, while citizen-centred models are often used by scientific scholars or governmental institutions.

3 Methodology

We used a quantitative methodology for an exploratory-descriptive approach, through an IPA, in which we performed an analysis from the inhabitants' perception using a synthesis of the smart city indicators extracted by the fourth edition of connected smart cities ranking (Urban Systems, 2018). The IPA Matrix allowed this research to go beyond a simple smartness level verification in the city. This method provided a correlation between the residents' degree of satisfaction with the importance given to indicators. Therefore, it allows the public manager to identify the existence of non-important items in the smart city monitoring system according to the citizens viewpoint. The local people are a critical factor of success and crucial for technological infrastructure achieve its better results, thus their perceptions should be a guide to public administration (Caragliu and Del Bo, 2016).

Table 2 Connected smart cities ranking characteristics

Characteristics (Sharifi, 2020)	*Connected smart cities ranking (Urban Systems, 2019)*
Major focus	Be useful for decision-making actors and to optimise the citizen's quality of life, according to the connectivity concept of the triple bottom line, understanding the economic sustainability as a base for social and environmental sustainability
Themes and indicators	Two-tiered system composed by 11 dimensions and 70 indicators
Format	Index
Data type and sources	Secondary data in national and international publications
Weighting	Market quality index (own methodology, based on max and min values)
Methods and approaches to scoring and assessment	Market-oriented/benchmarking
Implementation	Brazil

Source: Elaborated by the authors

The connected smart cities ranking has five editions (2015–2019) and aims to map the Brazilian cities with the highest development potential, using secondary data by national and international publications, such as 'Brazil competitive profile', 'World council on city data', and in the last edition it also used ISO 37.120 and ISO 37.122, which provides indicators for smart cities and the sustainable development goals (Urban Systems, 2019).

It is produced by Urban Systems, a 20-year-old research firm that conducts over 900 projects in 700 Brazilian cities. They use 70 indicators distributed in 11 dimensions: mobility and accessibility, environment, urbanism, technology and innovation, health, security, education, entrepreneurship, energy, governance, and economy (Urban Systems, 2019). To better understand its characteristics, we used Sharifi (2020) classification, as shown in Table 2.

The empirical work was conducted in Campina Grande city in Brazil, which appeared in three editions and in 2018 was at 43rd general position in the Top-100 ranking. It was among the ten best cities in the environment (6th) and entrepreneurship (7th) dimensions, and it was among the 50 best in technology and innovation (17th) and education (21st) (Urban Systems, 2018). The smartisation process in Campina Grande was remarkable according to Urban Systems (2018), since in 2017 it was in the 97th general position among the 100 Brazilian smart cities (Urban Systems, 2017).

3.1 Data collection

Data collection was conducted in April and May of 2019 through online survey questionnaires hosted on Google forms. That procedure allowed easy and flexible access to respondents besides the absence of researcher's influence on responses. For the questionnaire to reach more inhabitants, it was available on social networks, such as Facebook, Instagram and Whatsapp groups of Campina Grande. We chose random groups of the city inhabitants, as well as students and neighbourhood associations, etc. According to the Brazilian Institute of Geography and Statistics (IBGE), in 2018 Campina Grande-PB has 400,000 inhabitants. Thus, a simple random sample with a confidence level and margin of error equivalent to 95% and 5%, respectively was adopted, corresponding to 384 respondents, all residents of the city.

A pre-test of the questionnaire was performed, and a filter question was included to ensure the sample adequacy, which inquired if the participant lived in Campina Grande city. If the answer was 'yes', the form opened the questionnaire. Otherwise, the screen showed a thanking message and closed. For those who continued, it was offered a definition of smart city based on Giffinger et al. (2007), as "a city with governance-based economic and socio-environmental development with mobility that combines the use of resources and activities, through intelligent solutions that improve the quality of services provided to citizens." With this concept in mind, the participant evaluated 32 items. They were organised in two grades, one to importance, and another to performance. The evaluation used a 5-points scale, in which the lowest importance and performance was indicated by the value 1, the median values measured between 2 and 3, and the best evaluations were quoted by values 4 and 5. At the end, the participant should inform some demographic data: gender, age group and education level.

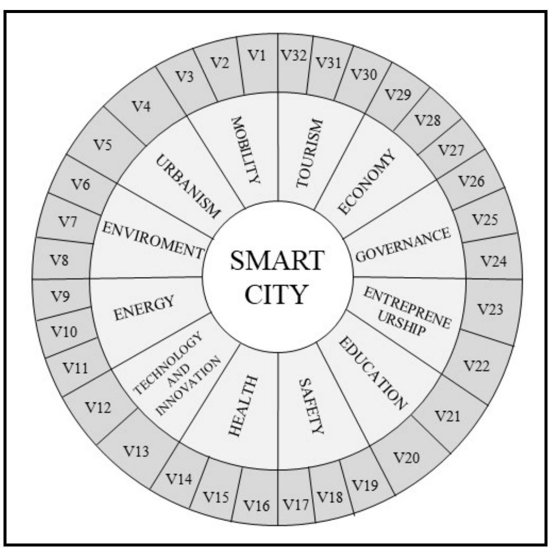
In this analysis, we adapted the variables of the connected smart cities ranking's fourth edition (Urban Systems, 2018). To shorten the questionnaire, we chose the leading indicators in each dimension (Table 3). We also added questions related to the tourism dimension based on the generation of opportunities for the local population as suggested by Del Chiappa and Baggio (2015). Thus, the final model has 32 indicators distributed in 12 dimensions (Figure 1).

Table 3 Smart city dimensions and its indicators

Mobility	*Safety*
V1 – Quantity of public transportation	V17 – Policing
V2 – Quality of public transportation	V18 – Accident control
V3 – Air transport to the city	V19 – Woman and child police station
Urbanism	*Education*
V4 – Quality paving	V20 – Vacancies in public universities
V5 – Soil zoning	V21 – Illiteracy reduction programs
Environment	*Entrepreneurship*
V6 – Sewage treatment	V22 – Technology companies
V7 – Recycling	V23 – Business incubators and technology hubs
V8 – Potable water	*Governance*
Energy	V24 – Municipal budget
V9 – Electricity	V25 – Municipal government transparency
V10 – Alternative means of energy	V26 – Administrative councils
V11 – Eco-modern street lighting	*Economy*
Technology and innovation	V27 – Jobs vacancies
V12 – Public internet access	V28 – Presence of companies in the city
V13 – Internet coverage in the city	V29 – Worker's average income
Health	*Tourism*
V14 – Health centre in neighbourhoods	V30 – Touristic offer
V15 – Diversity of medical specialties	V31 – Inclusive tourism routes
V16 – Number of hospital beds	V32 – Tourist assistance service

Source: Elaborated by the authors

Figure 1 Smart city dimensions and indicators

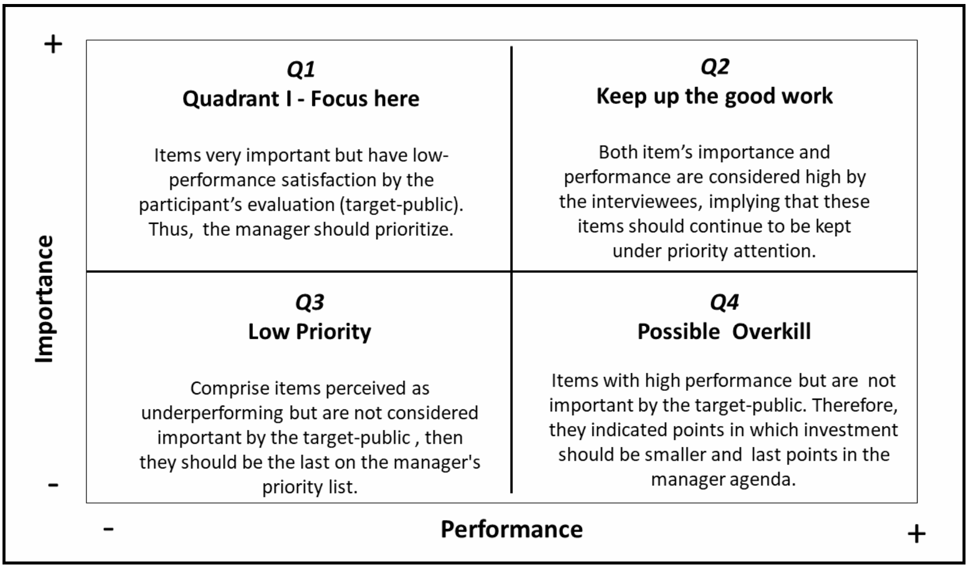


Source: Elaborated by the authors

3.2 IPA matrix

The IPA method was proposed by Martilla and James (1977) as a technique to evaluate the importance and performance of product attributes to develop more effective marketing actions. The matrix is divided into four quadrants (Figure 2) that assists the decision-maker toward strategy formulation.

Figure 2 IPA matrix



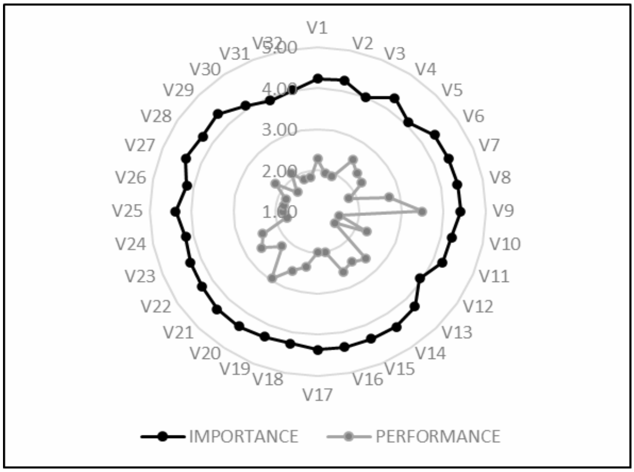
Source: Elaborated by the authors based on Martilla and James (1977).

Although the IPA method was designed for companies focusing on marketing and strategy, the technique acquired popularity in other areas, for instance, to analyse aspects of tourism (Boley et al., 2017; Chon et al., 1991; Deng, 2007), to measure service satisfaction (Chen et al., 2016; Ennew et al., 1993; Wong et al., 2011) to verify satisfaction in higher education (McLeay et al., 2017), and as part of a mixed method to evaluate the services of a smart city (Rondini et al., 2018). This research uses IPA in the smart city context, exploring the dimensions and indicators previously exposed. The results were analysed through SPSS software that plotted each indicator in the matrix according to its average score of importance and performance.

4 Discussion and results

We obtained 395 valid questionnaires answers. The main sample characteristics were female (56.5%) with age ranging between 19 and 30 years (62.3%), and incomplete higher education level (41.8%). Thus, it is characterised as a gender-balanced group, mostly young and highly educated, given the substantial margin between incomplete higher education and complete postgraduate education. Figure 3 shows the variables' difference between its Importance and Performance, i.e. the lack of satisfaction on the target public.

Figure 3 Difference between importance and performance



Source: Elaborated by the authors

Most variables are very important for a smart city statement, as the importance range was 3.92 to 4.41 and the overall average of the variables was 4.26. However, the public opinion about the performance of these items in Campina Grande was between bad and regular, since its overall average was 2.20, with range between 1.50 to 3.50 (Figure 3).

Regarding importance, the prominent dimensions in the city inhabitants' opinion were education (4.37), environment (4.37), and safety (4.36). On the other side, the lowest values were in tourism (4.01), technology and information (4.11), and mobility (4.16). However, it is necessary to underline that all dimensions were categorised as very important due to the average scores, which are above 4 points. Concerning performance, the best aspects according to the citizens perception were education (2.57), followed by entrepreneurship (2.50) and energy (2.44). At the other hand, the lowest values were governance (1.79), economy (1.89), and tourism (1.93).

Table 4 Average results of variables and I-P gap

Dimension	*Variable*	*Importance (I)*	*Performance (P)*	*Gap (I-P)*
Mobility	V1 – Number of buses running for public transportation	4.23	2.28	1.95
	V2– Quality of public transport buses	4.25	1.96	2.29
	V3 – Existence of flights to the city	4.01	1.92	2.09
Urbanism	V4 – Existence of quality paved streets	4.32	2.52	1.81
	V5 – Land zoning law	4.07	2.33	1.74
Environment	V6 – Presence of sewage treatment stations	4.35	2.27	2.08
	V7 – Existence of waste recycling sites	4.37	1.82	2.56
	V8 – Supply of drinking water to the population	4.39	2.75	1.64

Source: Elaborated by the authors

Table 4 Average results of variables and I-P gap (continued)

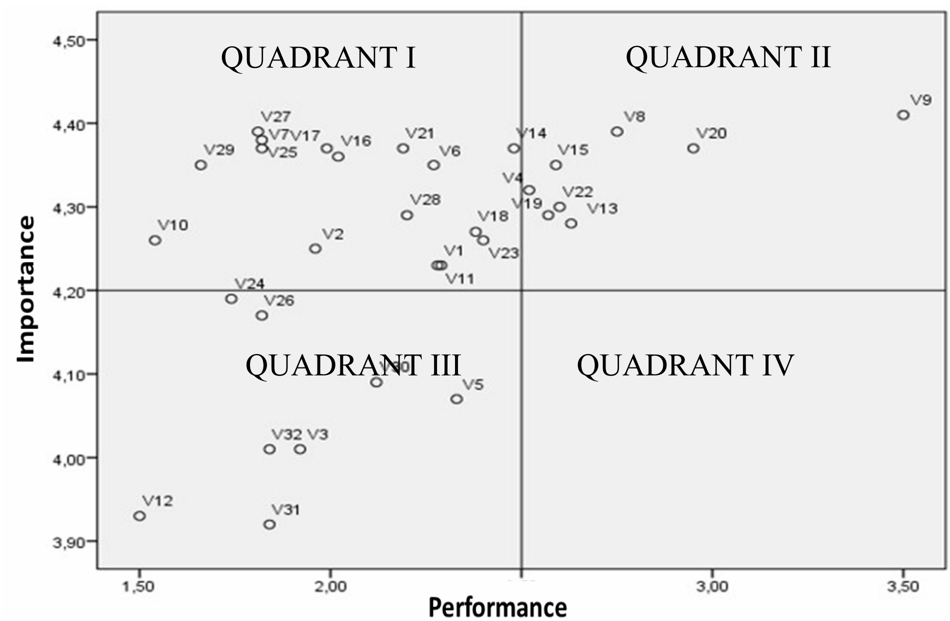
Dimension	*Variable*	*Importance (I)*	*Performance (P)*	*Gap (I-P)*
Energy	V9 – Supply of electricity to the population	4.41	3.50	0.90
	V10 –Existence of alternative energy sources	4.26	1.54	2.71
	V 11 – Eco-modern street lighting	4.23	2.29	1.95
Technology and information	V12 – Public internet access (Wi-fi)	3.93	1.50	2.43
	V13 – Internet coverage within the city	4.28	2.63	1.65
Health	V14 – Presence of health centres in neighbourhoods	4.37	2.48	1.90
	V15 – Number of doctors with varied specialties	4.35	2.59	1.76
	V16 – Number of beds in public hospitals	4.36	2.02	2.34
Safety	V17 – Policing to guarantee public safety	4.37	1.99	2.37
	V18 – Traffic accident control	4.27	2.38	1.89
	V19 – Police station for the protection of women and children	4.29	2.57	1.73
Education	V20 – Number of vacancies in public universities	4.37	2.95	1.41
	V21 Existence of programs to reduce illiteracy	4.37	2.19	2.18
Entrepreneurship	V22 – Presence of technology companies	4.30	2.60	1.70
	V23 – Existence of business incubators and technology hubs	4.26	2.40	1.86
Governance	V24 – Municipal budget defined by consultation with citizens	4.19	1.74	2.45
	V25 – Transparency of municipal public government	4.38	1.82	2.55
	V26 – Existence of municipal administrative councils formed of citizens	4.17	1.82	2.35
Economy	V27 – Job vacancies	4.39	1.81	2.58
	V28 – Growth of enterprises presence in the city	4.29	2.20	2.08
	V29 – Increased average worker income	4.35	1.66	2.68
Tourism	V30 – Inclusion of small business in the touristic offer	4.09	2.12	1.98
	V31 – Existence of tourism routes around small communities	3.92	1.84	2.08
	V32 – Existence of tourist assistance service	4.01	1.84	2.17
AVERAGE		4.26	2.20	2.06

Source: Elaborated by the authors

Table 4 shows the average value for importance (I), performance (P), and the difference between both (I-P), which shows the gap in the residents' satisfaction with the smart city; thus, it is a new assessment on the smart city label.

Table 4 shows that the worst levels of resident satisfaction are related to internet access in public areas, the existence of alternative sources of energy, the average worker income increase, government transparency, employment levels and adequate waste recycling facilities. Governance and Economy are the dimensions of which Campina Grande city gathers the highest levels of dissatisfaction in the residents' perception. Nevertheless, all items presented Importance versus Performance gaps. Thus, to identify the priority items for management action, the IPA matrix were applied (Figure 4).

Figure 4 IPA matrix



Source: Elaborated by the authors

The axes in the IPA matrix corresponds to the values median, thus it provided an analysis by the results trend and it allowed to verify the quadrant performance, as well as of each variable. The first quadrant concentrated most of the items (50%), so they should receive more considerable attention from municipal planners to implement actions to improve them, as they have high importance but low performance. Among these variables, we highlight the 'job vacancies (V27)', as the most important in the quadrant and second most relevant in the general framework. It is also worth noting V7 and V25, corresponding respectively to 'existence of waste recycling sites' and 'transparency of municipal public government', because they are close to V27 scores.

The Quadrant 1 presents a domain of variables related to health, security, mobility and urban services, for instance, the number and quality of public transport buses (V1 and V2), presence of sewage treatment stations (V6), existence of alternative energy sources (V10), eco-modern street lighting (V11), presence of health centres in neighbourhoods (V14), number of beds in public hospitals (V6), policing to guarantee public safety

(V17), accident control traffic (V18), and the existence of programs to reduce illiteracy (V21), which are under the responsibility of public administration. These are internal variables and represent primordial items to the city hall, since, despite its importance to both citizens and smart city label, the population is unsatisfied with the services.

Also, Quadrant 1 has variables related to economic issues, namely, the existence of business incubators and technology hubs (V23), growth of enterprise presence in the city (V28) and increased average worker income (V29). These variables are not internal issues since there is a dependence on the country's economy. However, a domestic endeavour can improve them through a joint effort among various organisations, such as the City Hall, universities, business associations, and so on.

The second quadrant represents 'keep up the good work'. The IPA results showed 08 variables (25%), of issues considered by the inhabitants as important and with good performance. Among these variables are 'supply of electricity service to the population (V9)', followed by V20 and V8, representing 'number of vacancies in public universities' and 'supply of drinking water to the population', respectively. Still in this quadrant are: existence of quality paved streets (V4), internet coverage within the city (V13), number of doctors with varied specialties (V15), existence of police station for protection of women and children (V19), and presence of technology companies (V22). They are a mix of federal and municipal services together with private providers on which the inhabitants are relatively satisfy.

The third quadrant presents the variables that should receive low government priority since they had both low performance and importance results. The IPA indicated that 25% of variables belong to this category, i.e. eight items, namely 'internet access – Wi-Fi (V12)', followed by V31 and V32, referring respectively to 'existence of tourism routes around small communities' and 'existence of tourist assistance service'. Also, the issues related to municipal budget defined by consultation with citizens (V24), existence of flights to the city (V3), land zoning law (V5), existence of municipal administrative councils formed by citizens (V26), inclusion of small businesses in the touristic offer (V30). Maybe, some of these questions were imputed as low importance due to citizens' unknowledge, for instance, land zoning law or items related to participation in the city governance. All issues related to tourism are in this quadrant. This result indicated that the citizens don't understand the tourism vocation of the city, neither the tourism sector as a driver to local development.

Quadrant 4 did not present any variable. This result indicates no deviation of attention in the city management according to the inhabitants' perception. However, it is probably due to non-existence of items evaluated with high satisfaction by the resident, but none with high performance (>4).

Overall, the most important variable for a smart city, according to Campina Grande's citizens was 'supply of electricity to the population (V9)', which was also the one that achieved the best performance in the city (I-4.41 and P-3.50). While, the least important was the 'existence of tourism routes around the small communities (V31)', which also had poor performance (I-3.92 and P-1.82). Regarding performance, the least developed variable, it was the 'public internet (Wi-fi) access (V12)' (1.50). However, this variable is not a priority according to the IPA results, observed in its low importance (3.93).

The I-P gaps varied between 2.7 to 0.9 with an average gap of 2.05, considering a 5-points-Likert scale. This result can be high to a smart city, because this indicated that its inhabitants are not satisfied with the city context, and after all, the main goal of a smart city is to provide a better quality of life to the local population.

5 Conclusions

This research aimed to analyse the main characteristics of a smart city from the inhabitants' viewpoint, comparing their level of satisfaction with the items used to include the city in the connected smart cities ranking. Campina Grande city, which is located in the northeast of Brazil, was selected as a unit of analysis, and an IPA matrix showed a dual result, related to the importance and performance of the issues used to classify a smart city. In this manner, our findings enabled three sets of conclusions.

The first set identified the existence of residents' satisfaction gaps regarding items that classify Campina Grande as a smart city. The score of variables whether indicates problems in data collection made by the institution that grants the label or a lack of knowledge by the inhabitants on the issues. The results may put into question the title of smart city given to the city, since it performed low or medium, differing from the Giffinger et al. (2007) concept.

The human, social and infrastructure investments that enable a better quality of life, as well as the smart management of natural resources and governance systems also show large deficits in the city, on the contrary of what is defended in the literature of smart city, for instance, in Caragliu et al. (2011). Thus, based on the findings, we concluded that the resident's view differs from the analysis performed by the research institution and scholars. Thereby, through the theoretical lens of Smartization, Campina Grande city would not be a smart city, since the emergence of this concept and perspective aims to meet the growing demands of urban inhabitants, making investments based on economic, environmental and social sustainability to ensure a satisfactory and sustainable quality of life (Glasmeier and Christopherson, 2015). As a confirmation, the latest edition of connected smart cities ranking (2019), showed that Campina Grande is no longer in the general listing of 100-Top Brazilian cities. However, it is still present in some best results rankings (Urban Systems, 2019).

The second set of results showed that the categories and indicators used by Urban Systems to evaluate a smart city are also considered as essential requirements by the inhabitants, since most items were evaluated above four points. This finding demonstrated a consensus between theory and practice regarding the model to evaluate a smartisation process in a city. Nonetheless, the city should seek to increase its score among the observed variables, improving its services to achieve a satisfactory smartness level and provide a better quality of life for its citizens. Also, the managerial team should seek to include more collaboration and citizen empowerment in planning and enrolment of smart city services and projects, since it is one of the most relevant relation over quality of life, because of the promotion of a better perception of the population needs (De Guimarães et al., 2020).

The third set of results generated through the IPA matrix defined the items that must be prioritised by the decision-making actors to maintain coherence between its title of smart city and the service offered to the local citizens. In this sense, this research finding produced practical managerial contributions indicating 16 key-factors as priorities for the decision-maker, highlighting: job vacancies (V27), existence of waste recycling sites (V7) and Transparency of the municipal public government (V25).

The reduction of items in each dimension to compose the questionnaire was the main limitation of this research. The Urban Systems instrument has 70 variables in 11 dimensions. However, our survey was destined to the general population, so the model was adapted to 32 variables arranged in 12 dimensions. Further research on the subject is recommended, expanding the sample, and implementing stratification-based sampling techniques to confirm the findings, mainly because of the research limitation, and that the results points to a contradictory analysis between the inhabitants' view that uses public services in the local context and the analysis performed by an external auditor company.

Thus, Campina Grande's inhabitants presented Urbanism, Entrepreneurship and Education as the best dimensions of the city, according to the smallest difference between importance and performance (I-P Gap). The Urban Systems report presented a similar score to Entrepreneurship, but according to that report, the city also achieved a good performance in Environment. The citizens disagree, though. Another difference between the Urban System evaluation and our findings is in Technology and Information. The inhabitants' assessment was the second-worst result; on the contrary, Tech and innovation were highlighted by the institution with high performance. In general, it is understood that the evolution of smart city models is citizen-centred and for this reason an institutional research should be complemented with the residents' view on the performance of attributes used to define the city smartisation process.

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