


Smart cities: Citizens perception of Southeast of Pará

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ABSTRACT

The present study analyzes the main components related to the paradigm of intelligent cities under the perception of the inhabitants of the municipality of Paragominas in the State of Pará. It is an exploratory study that considers the incipient relationship established between the concept of intelligent city and the reality of

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the northern region of Brazil. Data were collected through questionnaires applied to a non-probabilistic sample and selected for convenience. Labor Market, Participative Municipal Management and Participatory Environmental Management factors were identified. Thus, the adaptation of a theoretical framework of intelligent cities, specific for the analysis of the perception of the local inhabitants, was partially achieved, giving rise to more detailed studies with an expansion of the universe in the region surveyed.

Keywords: Perception, Environmental management, Population.



INTRODUCTION

The transformations that occur in a marked way in the space of cities cause substantial changes in their configuration, which promotes ruptures not only in the consolidated urban fabric, but also in the practices of appropriation and use of these spaces, compromising their sustainability (SCUSSEL; SATTTLER, 2010).

The development of Brazil's municipalities, especially its large metropolitan regions, as a rule, shows signs of disorderly urbanization, such as the irregularity of circulation routes and the size and shape of housing lots. It is also common for such disorder to be accompanied by a lack of essential public services (such as garbage collection, water supply, sewage, electricity and public lighting networks), which characterize the formation of subnormal agglomerations (IBGE, 2017), failing to consider on a large scale the social and economic aspects that guarantee the well-being of the population. Parallel to this reality, there is a global growth in the discussion around the planning and implementation of smart city projects, pointed out by Câmara et al. (2016) as a type of city that is intended for people, with the main objective of population well-being.

In addition, the "smart city" is based on the principle of combining experiences and proportion of public access to the internet. It should promote ease of communication, resolution of bureaucracies and adopt sustainability practices focused on the conservation of natural resources (HARRISON; DONNELLY, 2011).

Although there is an increase in the frequency of use of the phrase "smart city", there is still not a clear and complete consistent understanding of the concept among gym practitioners. There are only a limited number of studies that have begun to systematically consider issues related to this new phenomenon (CHOURABI et al., 2012).

Discussions about smart cities are not part of the reality of many Brazilian municipalities, especially in regions where the degree of integration with new technologies used in urban infrastructure is still low. However, in addition to technology, in order for a balance between economic growth and sustainability to occur at the municipal level, it is necessary that all populations of developed or developing cities have incorporated the main strategies and practices that can lead a city to the characterization of intelligent (MOUTINHO, 2011).

The population's knowledge of the main social and economic complexities is an important key to the elevation of a city to the condition of "smart". In addition, consideration of population information can serve as a basis for improving the main conceptualizations of the term "smart cities", given that the main objective of a *smart city* is to ensure population well-being (SILVA et al., 2017).

At this juncture, the purpose of this research is to analyze the Municipality of Paragominas and the perception of the population regarding the possibility of fostering a smarter city through its development process, taking into account the knowledge of the population and its willingness to



cooperate with the improvements of the city. In this sense, this article proposes to answer the following question: How do the inhabitants of the Municipality of Paragominas perceive the aspects of the development of their municipality in order to make it a more adequate city to the paradigm of *smart cities*?

Thus, this work aimed to carry out an exploratory research using the qualitative method of component analysis in order to reduce the existing space in the literature on smart cities considering the various regions of Brazil, electing, for this purpose, the municipality of Paragominas, -PA, because it presents a peculiarly paradoxical situation of projected urban space in a region marked by the strong disordered process of formation of urban spaces. taking into account the knowledge of the population and their willingness to cooperate with the improvements of the city. To this end, the dimensions of development of *smart cities* were adopted as a theoretical conceptual model, based on public policies that prioritize innovative management, through actions to improve economic competitiveness, human capital, governance, urban mobility, the environment and quality of life.

THEORETICAL FRAMEWORK

The phenomenon of urbanization has a complex and multidimensional character, and can be observed from historical, demographic, economic, sociological, psychological, among other perspectives. The urbanization process is commonly associated with interconnected changes in economy, technology, culture, and society, as well as a shift from low to high population density (BERTUCCI et al., 2016).

The process of urbanization of cities in Brazilian regions has not been dissociated from other problems, such as poor income distribution, slums and increased crime, just to name a few. Faced with these and other problems of an urban nature, some theorists and researchers have started to think of new ways to solve or minimize these obstacles. Recently, from the literature related to cities and their evolution towards urban environments that serve and promote the quality of life of their citizens, the concept of smart cities or *smart cities has emerged* (CÂMARA et al., 2016).

The term smart city characterizes a model where connectivity is the basis of development through the use of network infrastructure, in order to favor economic and political efficiency, in addition to allowing social, cultural and urban development. The term *smart city* emerged in the late 1990s through a movement that sought to advocate for new urban planning policies. In the 21st century, the expression began to be used by technology companies to define the application of information systems to the integration of urban infrastructure and services (DEPINÉ, 2016).

Smart cities are those that make use of *smart computing* technologies so that critical infrastructure and service components, such as city administration, education, health care, public safety, buildings, and transportation, become smarter (WASHBURN; SINDHU, 2010).



The main *focus of "smart cities"* is a model with a particular characteristic, presenting a modern vision of the urban development process. These also take into account the significant importance of information and communication technologies to drive competitiveness in the economy, environmental sustainability and quality of life. The concept goes far beyond the technical aspects that characterize a city as digital (DUTTA et al. 2011).

According to the emerging smart city model, significant investments should be made in technology and interactive platforms to obtain data related to sanitation, parking lots, security cameras, traffic lights, electricity, hospital beds, air and water quality, temperature, and many other indicators (WEISS; BERNARDES; CONSONI, 2013). The authors also point out that the tools mentioned above make it easier to control, act on demands, and improve people's quality of life.

According to Hamza (2015), for the implementation of smart cities to occur, it is necessary to follow three steps: develop an existing city; develop new smart cities; integrate smart cities. The author points out that the main objectives of countries dealing with high poverty is to focus on *smart people*. For this to happen, it is necessary that basic items such as infrastructure, health and education are accessible to all residents.

In this context, popular participation becomes essential, which expands the intervention of citizens in the innovation process, in a logic of co-creation and innovation. The population needs to be involved in the development of tests of innovative urban solutions, with the city appearing as a living laboratory, where the positive experience can be replicated with adaptations in other territories, and the projects are developed by governments, academics and the population itself (MOUTINHO, 2011).

For Câmara et al., (2016, p.5),

The concept of intelligent refers to the condition of an active population, committed to the collective interest, motivated to participate, identifying problems and feeling capable of contributing to solutions. Thus, studies on smart cities need to consider the characteristics of cities and the likelihood of change that they will face in the future, given that the population is the center of discussions and proposals.

Innovation and information and communication technology are the points of great significance in the process of elevating a city to the condition of being intelligent, or even in the process of building a *smart city*. The innovation of technology provides the basis for social, economic and environmental paradigms to be increasingly interconnected, and in a firmer way.

For Weiss, Bernardes and Consoni (2013), technological innovation has an extremely important role to be developed in the context of the future of cities, essentially because it demands and involves different skills and specializations, such as engineers, architects, academics, specialists in information and communication technologies, technicians in general. These professionals are



located in the cities and are prepared to carry out an assessment and understand in a more particular way the characteristics and needs of the cities.

For a city to prosper, Hollands (2008) proposes four factors that have dominated the different conceptions and projects of the city: focus on information and communication technologies and networked infrastructures; market-induced urban development; emphasis on technology-intensive industries; concern for environmental sustainability. The author shows that future cities with smart characteristics will start from the people and communities where they live and work. The smart city needs to create a real shift in the balance of power between the use of Information Technology (IT) by businesses, government, communities and ordinary people, as well as find the balance between economic growth and sustainability.

By studying the different approaches of the various *national and international rankings* developed for the concept of smart cities in Europe, Giffeng *et.al.* (2010) developed the framework (Chart 1) containing the main factors that allow the assessment of the degree of intelligence of cities.

Table 1 – Determinants of the development of *Smart Cities*

Economic competitiveness	Human Capital
<ul style="list-style-type: none"> • Spirit of innovation • Entrepreneurship • Productivity • Transformation Ability 	<ul style="list-style-type: none"> • Level of qualification • Continuous learning • Social plurality • Flexibility • Creativity • Cosmopolitanism • Participation in public life
Governance	Urban mobility
<ul style="list-style-type: none"> • Participation in decision-making • Participation in the management of public services. • Transparency • Participation in strategic policies 	<ul style="list-style-type: none"> • Local accessibility • Infrastructure • Sustainable transport system
Environment	Quality of life
<ul style="list-style-type: none"> • Pollution • Environmental preservation • Sustainable management of natural resources 	<ul style="list-style-type: none"> • Access to culture • Health • Safety • Housing • Education

Fonte: Adaptado de Giffeng *et.al.* (2010).

Brazil is a country that has a significant amount of its own characteristics, with a large territorial area. However, it presents a social, economic and political inequality that has lasted for a long time in a resistant way between its regions and states (CÂMARA *et al.*, 2016).



In this context, the municipality of Paragominas is no exception to the rule, even though it has shown improvements in its economic performance according to the national trend of the last two decades, maintaining a significant economic growth and capable of reflecting in an improvement in its social indicators (PINTO, et al., 2009): the human development index (HDI) of the municipality jumped from 0.471 in 2000 to 0.645 in 2010 and the gross domestic product (GDP) went from R\$ 277,276,000 in 2000 to R\$ 1,237,012,000 in 2010 (IBGE, 2012).

The municipality of Paragominas, founded in 1965, has a territorial extension of 19,330 square kilometers and concentrates most of the economic activities developed in the Amazon region, such as: cattle raising, logging, forest management, reforestation, soybean (and other grains) cultivation and bauxite mining (PINTO, et al., 2009). Its population in 2010 was 107,010 inhabitants, being the third largest in population in the State of Pará (IBGE, 2010).

According to studies carried out by Oliveira (2012), the urbanization indicator in the municipality of Paragominas presents an acceptable index of 0.7455 in 2000 and 0.7548 in 2010, showing that the municipality has gone from an acceptable performance to ideal. The densification of the urban area of the city has occurred acutely in the last two decades (76% in 2000 and 78% in 2010), following the national trend of urbanization.

MATERIALS AND METHOD

The work methodology consisted of a quantitative study carried out through an exploratory survey in the municipality of Paragominas, located in the northeast of Pará. A total of 90 questionnaires were applied to 90 residents of the municipality. Of these, only 85 were used. They were applied in May 2017, mainly in the city center, on busy days, in order to obtain data from citizens from different neighborhoods, socioeconomic classes and different age groups.

The research instrument used for the interview was the questionnaire format with the use of the Likert scale adapted to 5 points with the following meanings: 1 (Strongly disagree), 2 (Partially disagree), 3 (No Opinion), 4 (Partially Agree) and 5 (Strongly Agree). The questions in the questionnaire were elaborated based on the dimensions listed by Giffinger, Haindlmaier and Kramar (2010) as necessary for a city to be considered intelligent, namely: governance, economy, environment, quality of life, human resources, mobility and Information and Communication Technologies (ICT).

The data were analyzed through an exploratory component analysis, in such a way, it was possible to identify the main constructs formed to present the vision and capacity of the population to find solutions to the evolutionary dimensions associated with the concept of smart city.

Component Analysis is the most appropriate technique for data processing, in view of the characteristics of innovativeness and the exploratory nature of the theoretical model adopted. The



Statistical Package for the Social Sciences (SPSS) software was used, with the following criteria of adequacy proposed by Hair et al. (2009): KMO > 0.6; Bartlett's sphericity test < 0.05; commonalities > 0.5 and Cronbach's alpha > 0.6.

VARIABLES USED

In addition to the sociodemographic data of gender, age group, schooling and neighborhood where they live, a total of twenty-one variables were added to the questionnaire (Chart 2) in order to characterize the main components identified.

Chart 2 – Variables to identify the main influences exerted on the attributes associated with the development of a smart city from the point of view of the residents of the municipality of Paragominas.

	VARIABLE	DESCRIPTION
Economy	IMpin	Importance of technological innovation for the improvement of productivity and income in the municipality
	CIpem	Individual capacity for entrepreneurship to improve the productivity and income of the municipality.
	ADemp	Adequacy of the offer of jobs by specialty and diversity of functions in the municipality.
	ADjot	Adequacy of working hours for the jobs offered in the municipality.
	Adrem	Compatibility of remuneration of the jobs offered in the municipality.
Human resources	CIIdhu	Individual ability to contribute to the educational, professional and cultural improvement of the municipality's human resources.
	CIsea	Individual capacity to contribute to sustainable development (social, economic and environmental spheres)
	OPedu	Opportunities in education to contribute to the improvement of the municipality in general.
	RESoc	Social recognition of individual knowledge and qualification in the municipality.
Governance	DPdgm	Availability to participate in deliberative events promoted by government agencies or associations.
	TRmun	Transparency about municipal management.
	ESspb	Space for participation in the management of public services (supply of electricity, water, transport, etc.).
Environment	CIcpa	Individual ability to contribute to the preservation of the environment.
	GMamb	Actions and movements for the conservation of the environment in municipal management.
	OPgsm	Opportunity (or space) to participate in the sustainable environmental management of the municipality.
Urban Mobility	CTmub	Individual contribution to the urban mobility of the municipality.
	INtrp	Infrastructure and resources available for sustainability in public transport.
	ESmub	Space for participation in the management and contribution of urban mobility in the municipality.
Quality of Life	CIssc	Individual capacity to contribute to the health, safety and citizenship of the municipality.
	AMssc	Actions to improve health, safety and citizenship promoted by the municipal administration.
	ESmqv	Public participation space available for the presentation of actions or proposals to improve the quality of life in the municipality.

Source: Authors 2024



For the discussion of the results presented below, only 8 of the 21 variables of the questionnaire were used, because these were the ones that revealed a degree of correlation above 0.5 with other variables, allowing the component analysis to be adequate to the criteria and statistical tests for its acceptance.

RESULTS AND DISCUSSIONS

The use of component analysis for the listed variables identifies the formation of three main components, responsible for approximately 64% of the explanation of the total insignificant variances, as demonstrated by the observation of the percentages of variation of the eigenvalues of each component (Table 1), which show the abrupt reduction in the weight of the eigenvalues found for the components number 4 onwards. It is also possible to assume that the sample is valid, since it expresses a reasonable degree of correlation between the variables according to the result above 0.5 obtained for the *Kaiser-Meyer-Olkin test* (0.663). refuted the hypothesis that their data constitute an identity matrix by the sphericity test.

By means of the *Varimax* rotation algorithm, the three main components, in order from the one with the highest factor load to the lowest, are endowed with the respective approximate variances of 33, 24 and 13 percent, under which all eight variables listed for the identification of the constructs were accumulated.

Table 1 - Total variation explained rlett.

Component	Rotating sums of loads squared				
	Total	% change	Total	% change	Cumulative %
1	2,640	32,996	2,060	25,746	25,746
2	1,937	24,211	1,993	24,908	50,654
3	1,063	13,292	1,588	19,845	70,499
4	0,637	7,959			
5	0,551	6,886			
6	0,440	5,498			
7	0,430	5,377			
8	0,302	3,780			

Authors: 2024

It is also worth noting that the variables analyzed presented a degree of commonality above 0.6 (Table 2), and were therefore maintained for the formation of the constructs, taking into account their behavior that contributed to the discussion about the components found, which will be presented later.

Table 2 - Commonalities

Variable	Initial	Extraction
ADemp	1,000	0,679
ADjot	1,000	0,695
ADrem	1,000	0,703
GMamb	1,000	0,768
OPgsm	1,000	0,802
ESmub	1,000	0,745
AMssc	1,000	0,619
ESmqv	1,000	0,630

Source: Authors (2024).

Thus, taking into account their influence variables arranged according to the Matrix of Rotated Components (Table 3), we entered into the analysis of each of the three components in order to assign them the most appropriate definitions.

Table 3 - Matrix of Rotated Components

Variable	1	2	3
ADemp	0,814	,074	-,100
ADjot	0,829	,012	,083
ADrem	0,832	,058	,084
GMamb	0,008	,211	,851
OPgsm	0,046	,180	,876
ESmub	-0,19	,854	,120
AMssc	0,91	,769	,137
ESmqv	0,73	,765	,200

Source: Authors (2024).

The first component with higher factor loadings is formed by four variables: Ademp, ADjot and ADrem, both associated with the conditions of the stock of job offers and their effect on local income. The combination of these variables denotes the great relevance, attributed by the residents, to the conditions of job offer with a slight emphasis on the aspects of remuneration and adequacy of working hours to the detriment of others such as the issue of the diversity of functions and specialties offered.

It is possible to affirm, in view of the significance presented for this component, that the resident, in general, agrees with the belief that not only the offer of jobs, but also their attractive conditions constitute a preponderant factor for the achievement of improvements in life in the municipality through the flow of income that the offer of employment provides. This is a vision in line with the populist discourse employed by politicians who defend employment as the best existing social program.



The emphasis given to the issue of job supply as a way to improve municipal income goes so far as to acquire a relative *status* of exclusivity by the respondents, since other variables that express ideas considered alternative in the strategy and development literature, such as entrepreneurship (CIpem) and innovation (IMpin), did not present sufficient correlation significance to enrich this construct.

Therefore, this first component, formed by the four variables (Sustainable Procurement, Sustainable Criteria, Organizational Benefits, and Supplier Readiness) is the Labor Market.

The submission of the four staggered variables of this component to the *Cronbach reliability test* presented an alpha value of 0.770, demonstrating the aptitude of the variables used for the delimitation of the construct and its consequent analysis.

Entering the analysis of the second component, which can be called Participatory Municipal Management, there is a picture of greater complexity in its core due to the range of variables that present different themes such as: urban mobility (ESmub), safety, health, citizenship (AMssc) and quality of life; but complementary, as the results presented here ratify (under reliability demonstrated by Cronbach's *alpha* of 0.743).

According to these variables, it is possible to glimpse the residents' concern with the issues more directed to urban problems and their support structure. At this point, the aspect of the distribution of competences also acquires importance in the discussion, which was intentionally permeated among the variables used. When it comes to the issue of promoting safety, health and citizenship actions, its variable is linked to the responsibility of providing these actions to third-party agents (represented by the metonymic expression "my city"), which can be represented by the municipal administration or other entities that carry out actions of benefit to the population.

On the other hand, when it comes to more specific actions such as improving urban mobility, or contributing to the promotion of quality of life in general, the demand for space for popular participation in management or decision-making processes gains prominence.

The reference of popular participation present here, in view of the clear division of responsibilities and competences defined between the actions pertinent to municipal management, is, therefore, devoid of the transversality essential in the institution of a co-management scenario, as advocated by Cunha & Campos (2010), referring more approximately to the need for a space for deliberation of rational decisions or collective reflections in accordance with Scarabello Filho and Santos (2011), also in view of the demand for these spaces on specific topics that allow for prior understanding and less specialized consensus.

The third and last component, called Participatory Environmental Management, is delimited by the GMamb and OPgsm variables (whose reliability is attested by *Cronbach's Alpha* of 0.734), revealing the weight of the environmental dimension in terms of sustainability incorporated into local



values. This situation is reinforced by the development history of the municipality, whose beginning is marked by its association with deforestation due to the predatory exploitation of timber resources, which was gradually replaced by cattle ranching after its decline.

After being reputed as the largest municipality responsible for deforestation in the State of Pará, there was a counterflow of actions and measures reinforcing the need for local environmental preservation and sustainability, such as the restriction of credit for producers and ranchers in the municipality, the increase of reforestation areas and projects and the intensification of the inspection of deforested areas. culminating in the implementation of Operation Arc of Fire (jointly promoted by the Federal Police and IBAMA) in 2008.

In recent years, Paragominas has become an example of success in environmental sustainability by presenting a drastic reduction in its deforestation rate, becoming the first city in the state to participate in the "Green Municipality" project instituted by the state government. Both the turnaround in the performance of its environmental management and the importance of the environmental dimension for the sustainable development of Paragominas are recognized in the results presented by Oliveira et al. (2012).

In addition to the common environmental aspect among the variables, it is also observed, as in the second component, the difference in their attributes regarding the issue of the involvement of the agents responsible for environmental management in the municipality, being, according to the results obtained, the importance of the agents responsible for municipal management (public power) as well as the participation and involvement of civil society (non-governmental agents and citizens) in the search for solutions and actions related to this theme.

Once the three components of greatest relevance to the residents of the city of Paragominas have been identified under a scope of discussion outlined for the concept of smart cities, their values observed as a whole reveal the need for strategies and public policies focused on income generation, good governance for the solution of common problems and environmental preservation.

CONCLUSIONS

In this work, the perception of the population of the Municipality of Paragominas was analyzed in order to identify the main components of its development process for the promotion of a smarter city.

The identification of the three main components of Labor Market, Participatory Municipal Management and Participatory Environmental Management demonstrate the replication of the dimensions of Economy, Environment, Urban Mobility and Quality of Life, listed by Giffeng *et al.* (2010); while the dimensions of Governance and Human Resources were not relevant in the variables used to translate their perceptions among the inhabitants of the municipality.



This arrangement of components obtained and their partial representation in relation to the dimensions of the theoretical reference model, give rise to two possible readings based, respectively, on the presence and absence of these dimensions: a) that the inhabitants of the municipality of Paragominas recognize the importance of actions to promote economic development and socio-environmental improvements, through the creation of jobs, development of solutions to urban problems (mobility, health, quality of life, etc.) and attitudes towards environmental preservation; b) that there is no relevant perception among the inhabitants of the municipality of Paragominas regarding their individual competence and participatory power in the sense of contributing to improvement actions related to the urban economic and social problems of their daily lives.

It is worth emphasizing that the panorama defined here for the perception of the citizens of Paragominas does not establish a socio-demographic distinction such as income and age group, since these data were statistically insignificant.

In view of the above, it is possible to verify that the citizens of the place of study sustain a view that the opportunities for improvement of their place are of an exogenous nature to the individual capacity and to the movements given in the sense of popular participation in the search for solutions and decision-making for the development of the municipality. In spite of the citizen's ability to identify the main factors to be considered so that their municipality can evolve to the point of adapting to the smart *city paradigm*.

Thus, this work contributes to the subsidy for the promotion of public policies and reinforcing actions, whether for the development of the economic, social and environmental tripod, well defined within the perception of the citizens of Paragominas, or for the provision of greater spaces for participation and popular contribution with a view to good governance of the municipality. In addition, it provides the opportunity to open discussions about the *smart city paradigm* in the northern region of Brazil, taking into account its particularities visibly permeated in the results obtained, launching the proposal so that this type of research can be better supported by its extension to other municipalities in the region.



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