Smart cities and the perspective of urban planning, as a sustainable vision to minimize vulnerability processes and avoid future problems

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ABSTRACT
With the constant need to preserve the environment and its natural resources and prioritize means and actions to enhance the improvement of the population's quality of life, it was necessary to develop studies to minimize vulnerability processes in order to avoid urban problems in the future.

Keywords: IBGE, Urban environment, Quality of life.

1 INTRODUCTION

With the constant need to preserve the environment and its natural resources and prioritize means and actions to enhance the improvement of the population's quality of life, it was necessary to develop studies to minimize vulnerability processes in order to avoid urban problems in the future.

Recent studies on a global scale have pointed out that smart cities, from the perspective of a sustainable vision, can contribute to the urban planning and development of cities. Smart cities, also known as "Smart City", are those that make strategic use of technology to improve infrastructure, optimize urban mobility, create sustainable solutions and other improvements necessary for the quality of life of the population.

According to IBGE data, 2018, the Brazilian urban population corresponds to 85% of the total population, evidencing an essentially urban country. With most of the population living in cities, problems related to the urban environment gain special relevance because they directly affect the vast majority of the country, the urban issue is therefore fundamental for the quality of life and sustainable development in the country.

Azeredo, 2018, defined urban development as "The act of planning the growth of cities in such a way as to ensure the safe, fair and dignified access of the population to urban services, such as mobility, infrastructure, health, education, environmental quality, among others".

> With the growth of cities, making them smart is essential, but for the transformation to happen it is necessary to implement cities in three major planning phases: [1]Connectivity is the first step that a city needs to take to become smart, that is, to transform itself into a digital city, making use of cutting-edge technology, with the implementation of digital infrastructure. [2]The development of vertical services incorporated into the digital infrastructure, for the strategic organization of education, health, tourism, etc. services depending on the needs of each city. [3]Finally, the interaction of citizens living in the city with the digital platform.

The main objective of this research project is the development of a field research, of a qualitative and exploratory nature, in which the studies will deal with urban and sustainable development, in municipalities

that are in the phase of structural transformations of cities to make them smart and thus investigate the potential of improving the quality of life of the population.

2 SPECIFIC OBJECTIVES

I. Explore academic and scientific content on the proposed topic for the development and strategic planning of field research.

II. Develop specific questionnaires to interview city residents, private companies, public offices and local authorities, in order to collect data related to the main urban problems and the factors that directly influence the quality of life of the population.

III. Diagnose the main problems in the urban environment and propose intelligent solutions in order to minimize the process of vulnerability to avoid future problems.

IV. Investigate the implementation of public policies of the municipality to make the city smart and accessible to the population.

V. Evaluate the implementation of digital infrastructure to establish connectivity and subsequently the collection of massive data in a digital way, in order to organize the urban space and propose strategic solutions for the urban and sustainable development of the city.

VI. Verify the city's need for the development of vertical services incorporated into digital infrastructure, for the strategic organization of education, health, leisure, tourism services, etc.

VII. Observe and evaluate the interaction of the population with the digital platform.

VIII. Analyze and discuss the data collected through the questionnaire mentioned in item II, to produce the results and later the conclusive arguments of the research.

3 THEORETICAL FRAMEWORK

3.1 SMART CITIES

In the context of the emergence of problems arising from population increase and high population density in large cities, the practical application of the principles of a smart city proved to be efficient in circumventing such obstacles and allowed for greater effectiveness and optimization in the provision of public services.

In large cities where the tools and principles of Smart Cities have already been applied, a considerable improvement in the quality of life of the inhabitants has been observed, as a result of the identification of specific problems, behavioral trends, citizen connectivity and intelligent management.

One difficulty for the implementation of Smart Cities, which has been overcome, especially in the period from 2010 to 2020, is the quality connectivity of citizens. The inaccessibility, due to economic and

social factors, to smart and connected devices, although still persists, was gradually decreased in this period, mainly due to technological advances and the popularization of smart devices, such as smartphones.

The use of technology by the population, especially smart devices, contributes to the functioning of a Smart City through the collection of sensitive personal data. Although it is the driving force for the operation of a smart city, the data collection mechanism is also the instrument that requires the most security, since it is the storage of strictly personal data. Thus, data security policies are extremely important to ensure that such information is handled only by authorized institutions.

Therefore, connectivity in the urban environment, in addition to contributing to the quality of life of the population, contributes to environmental and energy sustainability, with the optimization of the consumption of natural resources and the preference for the use of renewable energy sources, reducing carbon emissions, in some situations. Thus, smart practice in cities, even if small, is responsible for a set of events that provide a significant improvement in the quality of life of the inhabitants, a factor that is pointed out as the main objective of implementing smart cities.

It was precisely in the context of population growth in large cities, aggravated mainly in the second half of the twentieth century, which impacted with numerous urban problems, such as social inequality, congested traffic, violence, deficiency in the provision of basic services such as sanitation, electricity, drinking water, among others (CÂMARA DOS DEPUTADOS, 2021), that the need to use technological means to coordinate the functioning of a city emerged, as well as notions of a connected space that would in the future be designated as a Smart City.

Thus, the management of the provision of basic and essential quality services to a constantly growing population has become a challenge for municipalities and governments, with the need for new administrative techniques for the maintenance and functionality of public services.

In the same period, accompanied by the vertiginous growth of the population, the planet observed a technological advance in an equally short period of time. Allied to this, large cities have used technological tools as support to coordinate and manage the entire urban and social functioning of a city. With the passage of time, not only governments own and produce urban management mechanisms, private companies, in partnership with municipalities, develop intelligent systems and work together with public institutions for the technological functioning of large urban centers.

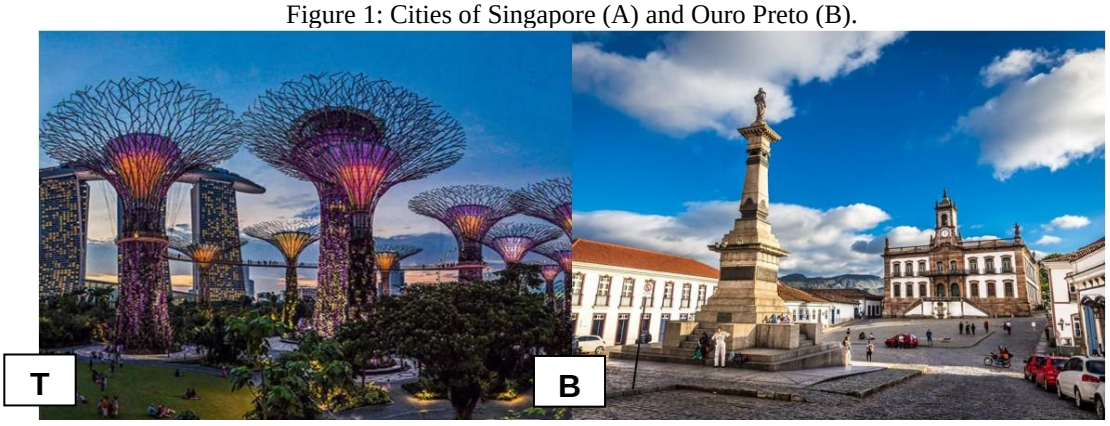
The term "Smart Cities" emerged in the 1990s to define means of technological coordination of densely inhabited urban spaces. There is no well-defined conceptualization for the expression, however the use of advanced technology methods as a way to coordinate, manage and apply solutions to specific or constant problems, as well as diagnose and anticipate behaviors and situations of inhabitants of a given city is a consideration close to what a smart city actually delivers to the population.

Although this technology is used in most cases by the public sector, initially, it is developed in short by the private sector, with IBM being one of the main companies developing technologies for Smart Cities, which defines Smart Cities as the one that uses all available means of information to understand and govern operations, improving the use of scarce resources (COSGROVE et al., 2011). Another technology giant, producer of systems for Smart Cities, Cisco Systems, characterizes a smart city as one that uses scalable Information and Communication Technology (ICT) solutions to increase efficiency, reduce costs and improve quality of life (FALCONER; MITCHELL, 2012).

The use of technological principles and the application of the Internet of Things in the daily life of cities, and its consequent use in essential urban services and in their maintenance and optimization characterize a Smart City, especially the technological design implemented by Asian cities to solve environmental and sustainability problems in the midst of air pollution and environmental crises (CHAMBER OF DEPUTIES, 2021), however, it is not only technology that defines a city as smart or not. A set of practices and services, combined with efficient management and quality infrastructure, culminate in a smart and connected urban space.

Apparent modernity or even technological aesthetics alone do not characterize a Smart City. While the modern and developed city-state of Singapore, located in Asia, is a reference in management and intelligent operation (HIROKI and CARDOSO, 2016), the Brazilian and centennial Ouro Preto, located in Minas Gerais, established in 2017, a public-private participation agreement to become the first historic smart city in Brazil (OURO PRETO, 2020). which has already carried out some implementations such as adjustments in the public lighting system, replacing conventional lamps with LED ones (Figure 1).

Figure 1: Cities of Singapore (A) and Ouro Preto (B).



Fonte: EXAME (2015). Fonte: UOL (2021).

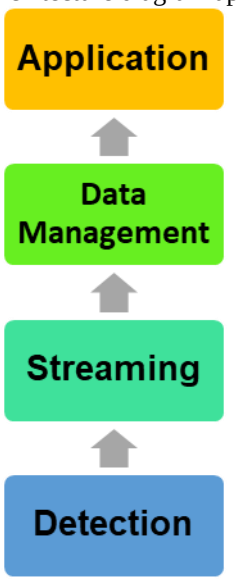
3.2 CONNECTIVITY IN A SMART CITY

The functioning of a smart city is basically through connectivity. Through connected citizens, data and prognoses are elaborated according to behavioral trends, and treated in order to provide a higher quality in the provision of services and the consequent improvement in the quality of life of residents.

In an analysis of various types of data analysis and processing methodology, as well as systems operating in Smart Cities, Silva et al. (2018) defined the "bottom-up" architecture as the most common and most used. A process in the "bottom-up" architecture begins with data collection (input), which is when the information actually enters the system, with this, segmented structures are generated based on previous information (system module), so that the analysis product is carried out only in the last phase of this process, also called knowledge (BALLARD AND BROWN, 1982).

The graphic scheme of a bottom-up structure is presented according to the literal translation of the term, "bottom up" (Figure 2). According to Silva et al. (2018), the way architecture is used in Smart Cities, there are four layers: the initial layer is called the Detection Layer, there are also the Transmission and Data Management layers, respectively, and finally, the Application (knowledge) layer.

Figure 2: Bottom-up architecture diagram applied in Smart Cities.



Source: The Author (2022).

3.3 DETECTION LAYER

The Detection Layer, or Entry Layer, makes it possible to provide information to the system. In it, smart devices and sensors capture data and information (DESHPANDE, 2004).

According to Bandyopadhyay et al. (2016), the detection layer collects climatic and environmental data (humidity, temperature, pressure, light, etc.), camera images, and geolocation positioning of sensors of interest through a GPS signal. In addition, this layer enables the grouping of various physical devices and

infrastructures, which can provide an increase in the number of devices connected to the smart city network (SILVA et al., 2018), since the greater the range of capture devices and sensors, the smarter the city will be and the more effective the application of services to residents will be (KIM et al., 2012).

3.4 TRANSMISSION LAYER

The Transmission Layer connects the data source (Discovery Layer) to the data management (Data Management Layer). According to Silva et al. (2017), this layer is the backbone of the architecture of a Smart City, as it represents the convergence of various communication networks, which is realized in different types of wired, wireless and satellite technology.

Examples of communication technologies are: Bluetooth, Zigbee, Zwave, Near Field Communication (NFC), 3G, 4G and 5G network, wi-fi, etc.

3.5 DATA MANAGEMENT LAYER

The Data Management Layer, or also called Data Management, is termed by Silva et al. (2018) as the brain of any smart city.

In this layer, a series of activities related to manipulation, organization, analysis, storage, and decision-making occur (SILVA, 2017). With data collection, at the time of data analysis and fusion, this layer combines discrepant data in order to detect behaviors and deviations, and to reinforce the accuracy for the application, so that the decision made is not based on a single source (HALL, 1997).

3.6 APPLICATION LAYER

Of all the layers of the system's architecture, the Application Layer is the only one that communicates directly with the citizen in the form of a tangible (physical) solution, which can be applied in the daily life of the population.

The operation of the "bottom-up" methodology is internal, and only managers and technicians have knowledge about the collection and processing of data and information, therefore, the population of a smart city will only have contact with the product of this information in the Application Layer, so the correct treatment of data and its application has to be carried out efficiently, because the citizen's perception of the quality of the services provided is the parameter used to determine the efficiency of the service (SILVA et al., 2018).

3.7 SMART SOCIETY

For the design of a smart city, it is very important that its inhabitants are also intelligent, and that they contribute by providing data and information to the functioning of the city. However, additional actions,

which the administration of the urban space does not have jurisdiction over, can be taken by the community in order to enhance the results of a Smart City, especially with regard to measures to conserve the environment and reduce environmental pollution.

The implementation of techniques in homes and homes, called "green buildings" provides a reduction in the carbon footprint, for example. In this model of environment, actions are implemented to optimize energy consumption by residents (EICHHOLTZ et al., 2010).

The context of green buildings belongs to a larger term, called smart buildings. While the first is focused on actions in the order of energy and reduction of carbon emissions, the second has more defined technological and connectivity principles, however it also has characteristics of green buildings. In smart buildings, connectivity components and smart devices control lighting, manage security through surveillance cameras, perform tasks, and even use network sharing to improve the quality of life of residents (KHAN et al., 2017).

In addition to smart individuals, smart businesses also contribute to a connected society. The use of technological devices and intelligent software enables inventory management and increased productivity, for example (JABBAR et al., 2016).

4 INFRASTRUCTURE OF A SMART CITY

The information collected and processed enables the practical application in the daily life of an intelligent community, where in fact the processed results are visible to the population. Services such as transport, health, energy, education and sanitation examined intelligently enable a higher quality in the provision of services and a greater optimization and management of the resources applied.

4.1 TRANSPORTATION

Intelligent transport is related to the possibility of connections of its components and their consequent communication and the pointing out of events with potential for intervention in its operation.

According to Naumov et al. (2006) in a smart city, modern means of transport, especially private vehicles, are connected by a navigation tool. This integration enables global communication between different modes of transport, improving the mobility of citizens. Since the Vehicular Ad hoc Networks (VANETs) network mechanism, which consists of a self-organizing road traffic network (SIMAS, 2013), increasingly used, has led to the development of the intelligent transit system.

In addition to the vehicle-to-vehicle connection, intelligent transport systems issue alerts about accidents, information about congestion on avenues, available means of transport and alternative routes for passengers. The system also informs safety and security measures for pedestrians, such as protected bike lanes, sidewalks, train and subway networks, buses, and public transit (MAHANTY et al., 2016).

Several studies for the improvement and innovation of traffic and intelligent urban transport proposed by researchers are likely to be used in large urban centers, such as time management (punctuality) and fuel consumption of rail transport (MAZZARELLO and OTTAVIANI, 2007); congestion in the railway system (CORMAN et al., 2012); efficient road traffic management (FOSCHINI et al., 2011 and VASIRANI et al., 2009); security (DURBIN et al., 2001) and application of RFID (Radio Frequency Identification) devices in parking lots, car rentals, taxis and app cars, as well as passport control at airports (SILVA et al., 2018).

The integration of means of transportation, in addition to providing a higher quality of life for the population, represents a shorter travel time and consequently a lower environmental impact if considered a smaller and more effective movement, due to the fact that it reduces the emissions of gases that contribute to the greenhouse effect.

4.2 HEALTH

The lack of health professionals in the face of population growth presents an insufficiency in the provision of services and in conventional practices. As part of the solution to this problem, intelligent health systems have been developed, in which through sensors, ICT, cloud computing and smartphone applications allow a doctor-patient interaction. Through these mechanisms, and with a detailed medical record of a given patient, health professionals have access to a dossier of vital information of these citizens. Since the medical history of patients enables agility in urgent and emergency care, especially with regard to medications with restrictions or medical particularities, assisting in real-time decision-making for the performance of necessary medical procedures.

4.3 ENERGY

According to UN projections (2014), the urban population is expected to correspond to about 66% of the world's population in 2050, when a large part of the resources and supplies will be allocated to urban centers, an example of which is the projection that cities will consume about 75% of the energy produced (MOHANTY et al., 2016).

Energy consumption in a smart city seeks to achieve the principles of a concept called Smart Energy. This concept combines two other definitions of conscious energy: green energy and sustainable energy. While the first term is characterized by the minimal impact on the environment in energy consumption, the definition of the second is related to the preservation of non-renewable energy sources for use today and in future generations (MIDILLI et al., 2006 and CHU et al, 2012).

Therefore, smart energy is one that uses renewable energy sources to meet population demand while using and promoting the sustainability of non-renewable energy sources, providing an attenuation of harmful effects on the environment, such as reducing the carbon footprint, for example (LUND, 2014).

In addition to smart cities, alternative energy sources have become popular as an energy supply option. The use of alternative energy plants in smart buildings, for example, enables the emergence of an energy ecosystem, making the building even smarter. In addition, in some cases the plant is not limited only to an isolated establishment, there is the possibility of sharing energy through networks.

Another smart tool used in Smart Cities is the management of energy consumption, especially at the residential level. Smart devices through programmable algorithms detect comfortable energy consumption (BOYNUEGRI, 2013). Residential energy management, if analyzed at the urban level, enables a significant reduction in consumption by providing sustainability in non-renewable sources and prioritization for green energy sources.

4.4 EDUCATION

The proposal of a smart pedagogical and educational plan, implemented not only in essentially smart cities, but in general in smart schools and universities.

Smart education is a project that breaks the traditional teaching paradigm. Which, according to some researchers, is plastered and outdated to the present (BITTENCOURT, 2003).

According to Kim et al. (2012), migration from the conventional education system to a smart plan is necessary. And its modeling must involve the use of technological devices in the teaching environment and be flexible, with a central focus on the student and their learning, thus having a personalization and customization of the teaching experience.

A principle of intelligent education is content restructuring, which aims to make students able to solve real problems regardless of their area of specialization (ELANGO, KULCHARATYOTHIN, 2018).

The experience of using technology in the classroom, in addition to providing technical knowledge regarding the technology addressed, enables greater learning performance and a sense of belonging on the part of students. Learning technologies, such as cloud-sharing content platforms, online learning and e-learning sites, and physical spaces such as smart libraries and knowledge and innovation hubs are characterized as important tools for the realization of smart teaching.

4.5 SANITATION

Basic sanitation in smart cities is treated in a way that causes minimal environmental impact and provides a better quality of life for the population. Technological tools and well-developed routines permeate the fields of water supply with drinking water, sanitary sewage and tailings disposal.

The supply of drinking water to the population, even if carried out correctly according to current regulations, requires punctual maintenance in the network due to possible leaks and residential diversions. According to research by BNDES (2017), the use of devices in pipelines using the principle of Internet of Things makes it possible to identify leaks and measure water demand by schedules, providing water savings and reducing waste. Such actions, if applied, enable a reduction of up to 50% of leaks and savings of 5% considering the conscious management of consumption by time slots.

The correct treatment of waste is of paramount importance for the functioning of a large city, and even more necessary in the case of a Smart City. Waste handling is treated as a natural sub-activity of an intelligent society. However, efforts to dispose of waste intelligently also require community participation. Once the process begins with collection, which has a fundamental role for the population, followed by disposal, recycling and recovery. This process and its management is fundamental for the sustainability of smart societies, since inappropriate disposal leads to health problems for human health and the environment (RATHI, 2006; SHARHOLY et al., 2008).

5 INFORMATION SECURITY

The large urban data collection system stores extremely sensitive personal information, which, like any other data storage system, is subject to various cybersecurity threats such as data leakage, for example (PAPADIMITRIOU & GARCIA-MOLINA, 2011).

The use of information is a big cog, being the main responsible for the functioning of a Smart City. Thus, it is evident that the handling of data is indispensable for the organizational scheme of a smart city to actually work. In other words, the sending of information by citizens reveals personal data which must be kept secure by the servers. Therefore, it is important that privacy and data security policies are developed by smart municipalities. Such commitment is characterized as one of the main challenges for the management and implementation of smart cities.

6 MATERIALS AND METHODS

To start the field research, a physical schedule of activities will be prepared in order to organize the time and strategies for the development of the research activities, in this schedule the meetings with the master's student's advisor will be carefully introduced in order to obtain the guidelines and delivery of the goals planned to sequence the research. Several bibliographic readings will be carried out for the deepening and development of the field research.

In the first phase of the research, a questionnaire will be produced for data collection through interviews with city residents, private companies, public offices and local authorities, in these interviews will be collected data on the main urban problems such as lack of urban infrastructure, empty spaces,

deficiency in the water treatment and sanitary sewage sectors, Efficiency of the municipality's electricity consumption, urban mobility and the factors that directly influence the development and quality of life of the population, etc.

In the second phase of the research, the physical and financial provisions for the implementation of the digital infrastructure will be verified, the verification of the municipality's interests in prioritizing vertical services, such as: health, education, leisure, transportation, tourism, among others...

Finally, in the third phase, the implementation of the city's connectivity will be verified, to facilitate the communication mechanisms between citizens and the public and private sectors, promoting an intelligent interaction, in order to obtain an organizational and planned structure to improve the quality of life of the population.

Subsequently, the analysis of the collected data will be carried out, with the objective of investigating and evaluating the positive and negative points diagnosed in the urban environment and continuing with the development of the research.

The research will be concentrated around two main axes, namely: [1]The verification and discussion of the implementation of digital infrastructure to make the city smart and accessible to citizens and public and private sectors, facilitating the interaction mechanism for storage and processing of important data for the adequacy of physical spaces promoting transformations in economic development, facilitating the promotion of urban and sustainable development of the city.

[2]The verification and discussion of the implementation of intelligent services that will enhance the improvement of the quality of life of the population in the urban space in a planned, strategic, organized and intelligent way.

Subsequently, based on the bibliographic readings, literature review, data collection and analysis and discussion of the research results, the conclusive arguments will be made and presented to the advisor to obtain more information to complete the research.

7 RESULTS AND DISCUSSIONS

From the exploratory character of the field research, it is intended to obtain positive results in relation to the implementation of the [1]digital infrastructure and the [2]connectivity of the smart city, considering that these are the two main requirements for the implementation of a smart city, after the verification of the entire structure, the project will develop to the practical field where they will be observed through intelligent mechanisms connected to computers, smartphone and tablet that will have the purpose of capturing and storing important data for the urban and sustainable development of the municipality.

After verifying the data collected, the studies will be developed through various analyses with the objective of organizing and planning the urban space, with emphasis on a solid structure capable of predicting and avoiding future problems.

The digital platform will establish, throughout the "Smart City", the availability of data for the interaction of the city with the citizens and, within this perspective, the aim is the integral development in a planned and intelligent way, in order to promote an organized and sustainable environment, with the promotion of interaction between all citizens, in order to contribute to the improvement of the quality of life of the city and future generations.

With all the data obtained, the research will have encouraging results and thus will lead to its final planning to emphasize the conclusive arguments consolidated through the studies developed in the practical field.

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