How to Measure the Performance of a Smart City

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Abstract

The main objective of the smart cities initiative is to allow manage their assets efficiently, betting on innovation and creativity, as a way to promote sustainable and inclusive urban development. When talking about an emerging and promising area like smart cities, the topic of performance measurement has gained more relevance. The performance of smart cities involves measuring the progress of a territory, with regard to its ability to provide a better quality of life for its citizens. It is necessary to understand the territorial specificities, and to know how far technologies can be useful in these territories for a sustainable transition. It is in this context that the present study is based, which aims to assess which technologies the citizens of the urban territory in the province of Santa Elena in Ecuador, understand as striking, in order to measure the intelligent performance of that city. For that, a survey was made, and the results and conclusions presented in this study.

Keywords

Smart Cities, Sustainability, Territorial Intelligence

1. Introduction

In the age of digital transformation, cities are undergoing numerous changes, visible in the number of projects implemented in recent years by Municipalities, leading to the infiltration of technologies in cities. ¡Change is inevitable!

Although the digital transformation goes beyond the incorporation of technologies, the mentality and culture of citizens in adapting to these changes must be, properly instilled. With this technological transformation, cities overcome the challenges of the past and conquer the future. The technological resources used as a means to provide different services efficiently and improving the quality of life of citizens, transform them into smart cities.

The use of the smart concept captures innovative digital transformations, driven by new

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technological resources. However, other social factors besides smart technologies are fundamental for smart cities.

We can view cities like repositories. These repositories hold and store the different data, and it is through the analysis of this data set, that cities can become more intelligent, in city governance, and in the lives of citizens.

After all, ¿which cities can be under the smart "hat"? ¿How can this measurement, be made? ¿How can we measure the performance of a smart city, or a smart territory?

The paper is structured into five sections. After this brief introduction, we will make a presentation of smart cities in the second section. The third section describes the research method used, as well as the population covered, as well as the research structure. Subsequently, in the fourth section, the main results of the study are discussed. The work ends with the conclusions and the projection of future works.

2. Smart Cities

The concept of the smart city has come to dominate both academic literature and the public policy agenda. There are several projects in the design and implementation worldwide, with characteristics, motivations, levels of maturity, governance models, and diverse sources of funding, although the motto is always the use of information and communication technologies to facilitate urban life [1].

Although a universally accepted concept of smart city is not clear, there are a number of aspects referred with a greater or lesser focus on the definition of smart cities. These aspects are the concern with the environment, the use of information and knowledge technologies and urban and sustainable development [2].

But how can you define smart city? International Data Corporation defines a smart city as a city that has declared its intention to use information and communication technologies to transform the modus operandi into one or more of the following areas: energy, environment, government, mobility, buildings and services. The ultimate goal of a smart city is to improve the quality of life of its citizens, ensuring sustainable economic growth [3].

Another opinion, which gives priority to people, emphasizes that if a smart city does not mobilize the intelligence of its citizens, then it is not very smart. If so, it is only the implementation of technical systems. When we add people, everything becomes more complicated [1, 4]. People do not just have a way of being, and we cannot control their opinions, desires, and concerns, among others. This increases the level of complexity, so smart means being able to deal with a scenario that is much more complex than what you can create in a laboratory to develop a technology and install it in the city.

2.1. Criteria that define a smart city

According to the IESE Business School, several criteria that define a smart city, namely: human capital; social cohesion; the economy; governance; the environment; mobility and transport; urban planning; international connections; and technology [5].

Human capital: attracting and retaining talent in different areas should be one of the goals of a smart city. There is an international consensus that access to culture and the level of education

are important parameters for measuring human capital. For this reason, indicators such as the percentage of the population with secondary or higher education, number of universities, schools, museums and art galleries, in addition to the population's spending on leisure, are taken into account. In the ranking, the champion city of human capital is London.

Social cohesion: the ranking considers as social cohesion the degree of coexistence between groups of people with different incomes, cultures, ages and professions. Factors such as immigration, community development, care for the elderly, efficiency of the health system, public inclusion and security are assessed. Indicators such as crime, health, unemployment rates and income distribution, among others, are taken into account. The winner is Helsinki, the capital of Finland.

Economy: here everything that can promote the economic development of the territory is evaluated, such as local plans for industry, innovation and entrepreneurial initiatives. The indicators for calculating the ranking include the city's GDP, productivity and the time needed to start a business, among others. Americans stand out in this category: New York leads, and five other cities in the United States are among the top 10 (Los Angeles, San Francisco, Houston, Dallas and Chicago).

Governance: in this criterion, the ranking takes into account the efficiency, quality and stability of state interventions. The cities' economic reserves, certifications that prove the quality of their services and the perception of corruption are among the indicators in the calculation of the index. The champion city of governance is Bern, the capital of Switzerland. Europeans, by the way, own the best indicators in this regard: five other cities in the continent are in the top 10 (Geneva, London, Helsinki and Zurich).

Environment: growing sustainably is the main concern of those who stand out in this category. The UN defined this issue when it said that it refers to development that meets the needs of the present without compromising the ability of future generations to meet their needs. Pollution and carbon dioxide and methane emission rates, in addition to access to drinking water for the population, are among the indicators taken into account. Reykjavik, the capital of Iceland that occupies the 5th place in the general ranking, is the champion in the environment.

Mobility and transport: there are two main challenges in this regard: facilitating movement in cities and expanding access to public services. The coverage of metro systems, bicycle sharing systems, average commute time and traffic rates are the main indicators. Paris is at the top in mobility, followed by London, Seoul, New York and Shanghai.

Urban planning: sustainability is the key word to define the criteria for urban planning. Indicators such as the percentage of the population with access to basic sanitation, number of people per household and number of buildings built in the city are considered here. New York, the general champion of the ranking, also leads this category. Toronto, Paris, Vancouver and Chicago are close behind.

International connections: the global impact of a city is measured by this aspect. Its brand and international recognition through strategic tourism plans, in addition to the ability to attract foreign investment, are decisive aspects. Some of the indicators used in the survey are the number of airports, hotels and conferences and congresses based in the city. In this criterion, Paris stands out as an international leader. It is in international connections that São Paulo has its best performance, occupying 28th place.

Technology: access to technology is treated as a decisive aspect to improve the quality of

life of the population. The main indicators are the percentage of households with access to the internet, broadband and mobile telephony, in addition to the city's score in the Innovation Cities Program, which measures the city's level of innovation. Asians stand out in this category, with Hong Kong in first place and another four in the top 10 (Singapore, Dubai, Abu Dhabi and Seoul).

2.2. ISO 37120

Defining what smart cities are, and measuring levels of sustainability, quality of life and well-being are still not widely accepted. However, the first step in this direction seems to be taken, the publication of the ISO 37120: 2014 standard, which is the first ISO (the International Organization for Standardization) benchmark with indicators for cities, measuring the capacity to provide services and quality of life [6, 4].

The ISO 37100 International Standard series helps communities to adopt strategies to become more sustainable.

The standard will complement ISO 37120:2018, Sustainable cities and communities - Indicators for urban services and quality of life, which outlines the main measures to assess the provision of services and the quality of life of a city. Together, they form a set of standardized indicators that provide a uniform approach to what is measured and how this measurement should be performed, which can be compared between the city and the country [7].

The standards also provide guidance to cities on how to assess their performance in order to contribute to the United Nations' Sustainable Development Goals, the global roadmap to a more sustainable world. The ISO technical committee that developed the standard said that ISO 37122 defines indicators, as well as methods and practices that can make a rapid and significant difference in their social, economic and environmental aspects. Sustainability [8].

3. Research method

The unprecedented rate of urban growth creates an urgency to find smarter ways to manage challenges [9, 10]. Much, has been written, and said in recent years about smart cities, as well as the different projects implemented by cities, to become more intelligent. However, little has been said about what citizens understand by smart city and what projects they consider most important, to digitally transform the city where they live. It is these projects and their definition that allow measuring the performance of this city with regard to the smart concept [10].

To empirically characterize the opinion of citizens about smart cities, it was considered appropriate to apply the survey technique, since it provides a clear, straight and objective answer to the questions presented to respondents. Besides, since the aim was to characterize several people considered, it was considered that this number made the adoption of alternative investigation techniques unfeasible or discouraged.

Some advantages are considered over this type of data collection technique, such as: the possibility of reaching a large number of people; guaranteeing the anonymity of responses; allowing people to respond at the time that seems most appropriate to them; and does not expose those questioned under influence of the questioner.

Figure 1: Development survey phases

To carry out the survey we considered three possible ways of realization: traditional mail (paper physical support), electronic mail or telephone contact. In order to achieve the greatest possible number of responses, in the shortest possible time, with a high degree of reliability, coupled with the fact that the length of the questionnaire does not imply a large expenditure of time, we opted primarily for electronic mail.

The development of the survey comprised four distinct phases. In the first phase, the objectives were identified and the target audience was defined. In the case of the second phase, the electronic survey was carried out, and implemented. The third phase corresponds to the planning and logistics of the means necessary to carry out the survey. Finally, in the fourth phase, the results were interpreted and the present study was elaborated (Figure 1).

3.1. Population

The target audience, in the first instance, could be all citizens of Ecuador, which would make this work completely unworkable. The focus of this work was the cities of the Province of Santa Elena, which is one of the 24 provinces that make up the republic of Ecuador, located in the west of the country, on the coast. Its administrative capital is the city of Santa Elena, the largest and most populous city in the Province. Santa Elena Province occupies a territory of about 3,696 km, being the third smallest province in the country by extension. It limits to the north with Manabí, to the east with Guayas, and to the west and south with the Pacific Ocean along a maritime strip of about 150 kilometers.

According to the demographic projection of the INEC for 2020, there are 401,178 inhabitants in the Province, being the fourteenth most populated province in the country and the least populated in the coastal region [11]. The Province of Santa Elena have three cantons, Santa Elena, La Libertad and Salinas, with their respective urban and rural parishes. According to the latest territorial ordinance, the province of Santa Elena will belong to a region also included by the provinces of Guayas, Bolívar and Los Ríos, although it is not officially established, called Coastline.

Due to the massive use of WhatsApp in Ecuador, the online survey was sent hereby to the 800 citizens who were the target of this study. We obtained a response from 481 of the respondents, which corresponds to a response rate of 60%.

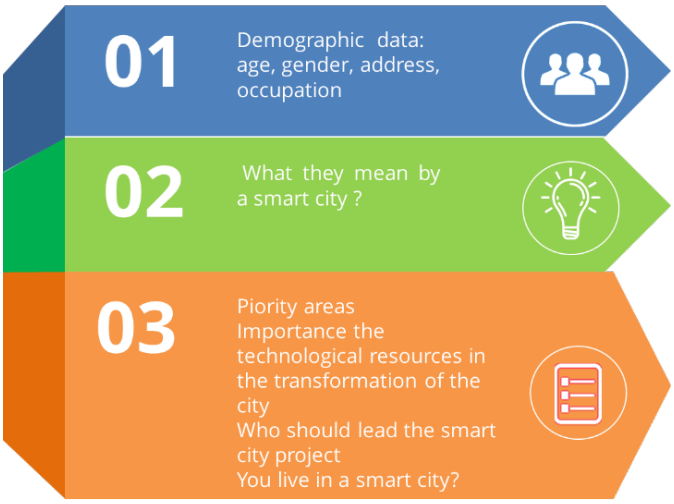

Figure 2: Survey groups organization.

3.2. Structure

The survey structure resulted from the literature review on smart cities. This study gave rise to a considerable number of questions that could be asked, however, taking into account that the objective was to get as many answers as possible, it was decided to limit it to a smaller number and focused on more general questions..

The survey questions are individually answered and confidential in nature, and were organized into three groups (Figure 2).

The first group corresponds to the characterization, which includes demographic issues (age, gender, address, occupation).

While the second group is related to the main question of this study, which is to know what they mean by a smart city?

The third group intends to understand which areas they consider to be the most priority (health, education, security, mobility and environment, economy, municipal management, among others), and within these which are best implemented in their city. Other question, was whether consider the technological resources important in the transformation of the city, and which ones considers most pressing. Another question raised in this group was, who should lead the smart city project. To finish the question, they consider themselves the city where they live smart.

4. Results and Discussion

Some authors believe that the focus should not be on technology, but on people. As Ratti [12] says, citizens first. Therefore, instead of focusing too much on hardware installation and control, it is important to encourage people to take actions in a bottom-up dynamic. If we can develop the right platforms, people can be protagonists in urban transformation.

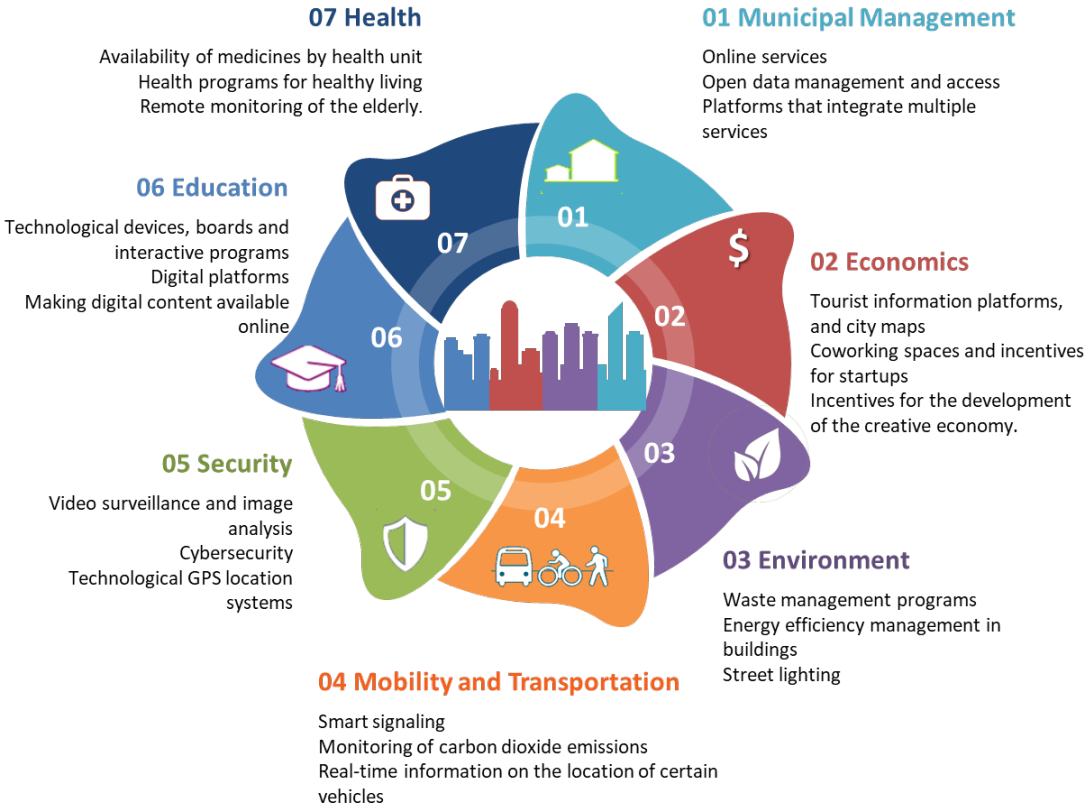

Figure 3: Technological solutions to implement by area.

With greater or lesser priority in technologies, it must exist. There are areas of intervention that without technological resources would not be considered a smart concept, and would not contribute to the better quality of life for citizens who live in these cities or who visit them.

The data of respondents on which technological resources / projects they consider pressing, to implement, and which promote a true digital transformation, obtained the following results presented in Figure 3. These results are divided by area of activity: (1) municipal management; (2) economics; (3) environment; (4) mobility and transport; (5) security; (6) education; and (7) health.

The results presented were taken from several responses considered and grouped into three projects by area, that is, those that were most indicated.

The interaction and participation of citizens in coastal cities, with municipalities, is a constant. The way it is done, can be changed with resources to information and communication technologies. Figure 3 presents some of the technological solutions to be implemented in these areas.

In the area of municipal management, technological innovation creates opportunities for the economic development of cities, sustained by improvement and creation of online services, by managing and access to open data, and by developing platforms that integrate the various

services.

For the case of the economic area, the need to implement technological solutions was diagnosed at the level of three projects: tourist information platforms, online reservations and city maps; co-working spaces and actions to encourage startups; and to create incentives for the development of the creative economy.

Environmental sustainability is today one of the major challenges for cities. In this sense, the following technological projects should be implemented: programs for waste management; energy efficiency management in buildings; and street lighting.

The disorderly growth and the consequent lack of city planning affect the mobility of citizens in these cities, in this sense the following solutions must be implemented: intelligent traffic lights; monitoring of carbon dioxide and noise emissions; and real-time information on the location of certain vehicles.

Technological resources in the area of security, contribute to the creation of more protected urban environments, making cities safer for those who live there, as well as for those who visit them, and the following projects must be implemented: video surveillance and image analysis; cybersecurity; and technological location systems using GPS.

Technological resources must be present and properly exploited in the area of education. Digital interaction between teachers, students and their families has to be a reality these days. The following needs have been detected: technological devices, interactive whiteboards and interactive programs; digital platforms; and making digital content available online.

Although the area of health is transversal to the different age groups, the elderly population deserves a greater emphasis here, being essential the implementation of the following projects in the area of health: availability of medicines per health unit; health programs for healthy living; and remote monitoring of the elderly.

Based on the results of the survey, it is necessary to proceed meticulously in order to understand, in fact, what to measure and how to measure.

First, it is necessary for a municipality to understand its territorial, cultural, historical, structural and organizational specificities. This includes a summary of the main processes and stakeholder interests and concerns. Second, municipalities have to ask themselves how technology can be useful in their sustainable transition process. When this point is clear, the vision has to be transformed into more operational objectives.

When results are defined, municipalities have to develop a plan or strategy to define how these results will be achieved. In short, they have to choose what means (for example, money, human resources) are introduced into the organization, the activities in which they will be used and the achievements that will result from these (s) activities/ processes.

When defining the long-term vision, that is, the intended results and the consequent plans for achieving them, it is also crucial that municipalities work as closely as possible with groups of stakeholders.

5. Conclusion

The study presented was based on the elaboration of a survey addressed to 800 citizens of urban areas in the province of Santa Elena, Ecuador, of which we obtained the response of 481,

which corresponds to a response rate of 60%. This survey aimed to find out what respondents understand by smart city and what technological resources they consider most urgent, to see implemented in their city, in order to verify a true digital transformation.

With this work, we tried to contribute to a greater knowledge, with regard to the opinion of the citizens about smart cities and we hope that the results presented contribute to future works, on the theme versed.

Nowadays the use of the smart concept captures innovative digital transformations, driven by new technological resources. However, other social factors besides smart technologies are central to smart cities.

The focus of this work was the technological component; this fact can be considered as a limitation. Other components could have been addressed in more depth, namely the human and institutional component, although it was considered that addressing these components simultaneously could cloud the results.

Among the future works to be carried out, the study of the human component is highlighted. To what extent do citizens adopt attitudes and a smart culture, what measures are being implemented that change certain behaviors, so that citizens can fully enjoy these digital transformations, which provide them with a better quality of life.

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