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Critical Mapping of Indicators for Smart Cities Evaluation

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Critical Mapping of Indicators for Smart Cities Evaluation

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Abstract. Sustainable urban development is extremely important, if not imperative, for city managers and policy makers. Nowadays, the use of Information and Communication Technologies announces assertive, sensitive and economic solutions. This research aims to introduce smart city indicators based on critical and updated diagrammatic digital analysis regarding issues such as mobility, transportation, environment, housing, governance and security faced with concepts as innovation, sustainability and others. In order to achieve this goal, it is offered an original and relational mapping of indicators created from information collected in different sources such as texts by well-known authors such as Guimarães [1], Greenfield [2], Weiss [3] institutional websites such as Brazilian Smart Cities Network [4], Urban Systems [5] publications and legal regulations such as NBR ISO 37122 [6]. Thus, this relational mapping will highlight graphically and visually the relations between the types of technologies available and how they have been used and applied. In a nutshell, we offer a diagrammatic approach oriented to create a useful indicator analysis guide based on available technologies, populations' needs and, more importantly, hope to provide better understanding about smart cities rankings and indicator regarding the well-being of people interacting with urban infrastructure, in special with mobility and urban devices.

1. Introduction

The popular model of smart cities emerges as an urban planning optimization tool and, according to Fariniuk [7], promises to solve many problems using small, ubiquitous and sophisticated technologies. Some of these problems refer to municipality's responsibilities such as better access to public services, financial transparency and community participation in city projects [4]. In this sense, the analysis of smart solutions must consider how technology is incorporated by planners in order to commit sustainable, assertive, economic and participative development.

There are many metrics to evaluate cities intelligence or "smartness". One of them is presented by Weiss [3] as the range of public policies to foster the communication between different actors involved in public development. These actors include both local and global members such as civil, commercial, political and institutional actors. Digital solutions structured online are important and very useful tools to provide better communication. However, we must remember that, even in a connected and very well-structured network, the efficiency of its services must be evaluated by the perspective of the population. This is a critical aspect to define and establish metrics, indicators and rankings to smart cities. Greenfield [2] argues that many indicators are intentionally created to support and legitimate private interests that have no connection with public interests. The abundance of indicators used to classify smart cities is not helpful. It is possible to identify more than three hundred aspects [1] and each one may be oriented by different views of the same technology or service it comprises. To exemplify this variability, Fariniuk



[7] comments that academics tend to adopt holistic concepts, planners tend to value society impacts, technicians tend to privilege operational efficiency and private sectors tend to value innovation and profit.

The purpose of this paper is to depurate this vastness of indicators and identify patterns or points of convergence between them. It is important to clarify that we will not include the manifold of indicators but only the ones associated with architecture and urban planning studies such as mobility, urban infrastructure and urban devices.

There are companies such as Urban Systems which offer specialized consultancy to public institutions and develop their own indicators to rank each one of its clients. This initiative creates a sort of competition between cities but only in specific items and not in a broader view of its civic qualities. On the other hand, the International Organization for Standardization recently published a new document to define references in order to avoid this multiple and diffuse understanding of smart cities. The ISO 37122 [6] was developed as a complete set of indicators to measure the progress towards a smart city.

Using visualization techniques, we present a panoramic overview of the most important themes discussed in the smart city publications. Our purpose is to identify levels of importance and interest among authors from different nationalities.

2. About indicators and rankings

Indicators are metric techniques used to evaluate many aspects of a city, including infrastructures and services developed by the public administration in order to manage the urban life. They are very useful to public administrators evaluate whether their policies are effective or not and if their financial resources are being well distributed. The indicators aim to reveal the impact of public actions in the context of the city. Each one of indicators can be very specific in the analysis of urban space and services, and that is why we find a huge number of different propositions.

It is very clear that the use of the term smart city and consequently the application of indicators as a comparative tool between cities can be affected by market practices. The construction of the smart city concept and indicators can be used to provide benefits to the commercial connection between administrators and tech companies. In this case a problem emerges: the citizens' welfare is forgotten and left out of the urban concerns. Greenfield [2] argues that many distortions may infiltrate in the quantification of urban processes. The actors whose performances are subject to measurements can consciously adapt their behavior to produce favorable results.

Indicators must be considered in their own context of mediation because the same indicator can stop being useful depending on what location or date it was made from [8]. It is also important to consider that indicators are shaped according to the concept they are linked to; the more subjective the phenomenon, the more measurement effort required. This is particularly relevant because there are no clear boundaries for the smart city concept, so each institution has an assessment perspective [7].

In the process of recognition and evaluation of smart cities the discourse of managers is often used to highlight the process of democratization and strategic increment, and it may hide invisible aspects and manipulations that meet the interests of specific groups. Thus, good examples of smart cities must consider the public return of the investments in terms of quality of service assurance, urban space experience improvement and quality of life.

Rankings are made according to specific indicators. They are used to compare different cities, to classify and qualify them as an instrument that supports a competition between cities. Nevertheless, Fariniuk [7] alerts that we must be careful not to reduce nor simplify the city complexity in a few numbers or indicators. Many aspects must be observed in the use of indicator as tools for establish city rankings.

According to Giffinger et al. [9], rankings are a relevant tool to measure competitiveness between cities because they convey an urban profile and define a global and certificated image to the city. Beyond the imagistic purpose, rankings can aid territorial management identifying strengths and weaknesses aspects as well as defining subsequent development strategies. For the authors, therefore, rankings have

the benefits of attractiveness, competitiveness and the learning effect. However they should be carefully considered to avoid self-affirming mechanisms or to provide detachment from the reality of the city [7]. There are many awards for smart cities with several categories that bring to light the best solutions for institutional and political arrangements, services and policies. In Brazil, one of the most popular rankings is coordinated by the consultant company Urban Systems [5] titled Smart Cities Connected Ranking. In the year of 2018, they evaluated 700 Brazilian cities using 11 indicators: mobility, urbanism, environment, energy, technology and innovation, economy, education, health, safety, entrepreneurship and governance [10]. In this case, the ranking was an instrument to map and to expose the results of many solutions implemented in the urban life by municipalities.

3. Smart City methodological approach

The large number of indicators used to identify and classify smart cities produces a confusing interpretation scenario and compromises the sharp understanding of what smart cities are or should be considered. The complexity of information creates divergences between which criteria should be used to classify and compare these new technological mediated conditions in contemporary urban spaces. The idea here was to analyze articles, papers, thesis, brochures selected by their relevance in the scope of indicators to smart cities, then to compare their perspectives and finally map the most common concepts used to explain and define smart cities. Using graphic visualizations, we made a map oriented by a group of previously selected keywords and then sought statistically for connective patterns in their use over the texts.

This approach was useful because it allowed evaluating statistically many keywords relations into all the publications in a short period of time. The inspiration in the use of visualization techniques was Deleuze's idea that we must adopt new models of interpretation of reality that goes beyond the surface of discourse. The diagrammatic view of complexity purposed by the French philosopher helps to expose inner relations and deeper intentions in the background of a complex scenario of definitions. Considering the importance of discourse for planner, politicians and businessmen, it is crucial to create a repertoire of visualization techniques that allows people to identify the most and least interesting areas where smart technologies are being applied.

The diagrammatic mapping of concepts adopted here was conceived as a simple informational system that aims to reveal the relations between what is called "axes" and "concepts" by smart cities literature. The "axes" comprise the areas where smart city technology would be applied in architecture domain such as: mobility, transport, environment, housing, governance and security. In the middle of the "axes" column is placed the most attractive concept: technology. Many more areas such as health, entertainment and economy are mentioned in the texts reviewed, but our research adopted a filter that embraces only areas in relation with architecture and urban planning activities. In the right side of the diagram is placed the "Concepts" column. "Concepts" are words that represent global themes that gravitate around the smart city discourse, such as: intelligence, intelligent, smart, resilience, sustainability, innovation and ecology. Our intention is to investigate the intensity of connection between "axes" and "concepts" in different authors.

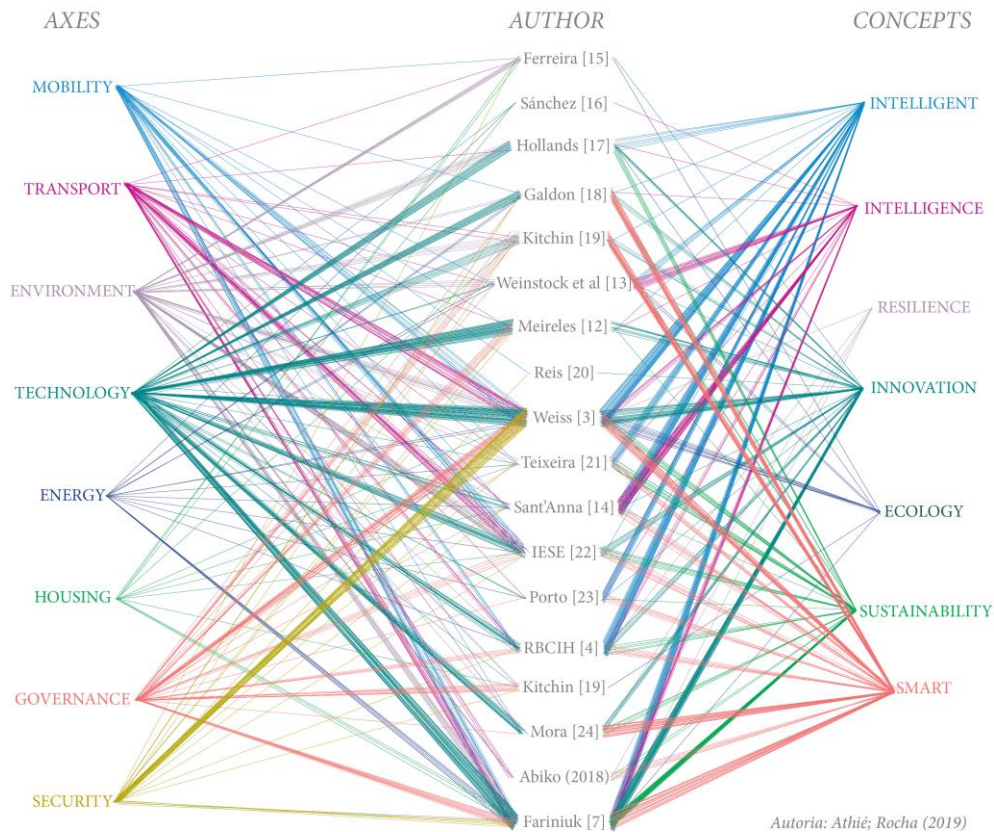
Language and discourse are crucial aspects in the information society. As pointed by Athié & Rocha [11] many senses can emerge from the smart cities phenomenon including the total informatization and control of the cities, the commodification of city's services and spaces, the problem-solving tech utopia and many other misunderstandings considered "smart" in the realm of a city life. We must remember that in the era of post-truth, the insistent repetition of a false idea can "convert it" to truth. In this sense, it is very important to prevent ourselves from epic technological narratives that emerge in the smart city discourse and present it as a product to be installed in the physical city.

4. Smart City cartography

Before starting the analysis of the diagram is important to reinforce that this mapping is a considerable reduction of the scope of smart cities and it is indicated in the first place to architects, urban planners or individuals involved in these areas. Because of this choice many other axes and concepts such as social

capital, social cohesion, economy, health often presented in the literature of smart cities are not collected nor computed here. We understand that digital technology has an impact on almost all fields of urban experience, and it is a subject articulated with many other professions. However, the main goal of this diagram is to clarify to architects what level of knowledge is being required in the relation technology and city, and what sort of expectancy the government manifests in the digital urban life.

Figure 1. Diagrammatic visualization relationship of smart city concepts, authors and axes.



Source: Authors

Many considerations can be made based on the diagram. First, it is important to explain that each line represents a range between one and four times the word was quoted. So, if a word has three lines it means that it was quoted between nine and twelve times, and so on.

The dense concentration of lines connected with “technology” shows that this is the main word in smart city theory. For most authors the idea of smart cities is totally linked with digital resources. It means that there is a collective conscience that assumes that the updated city of the future would be progressively digitalized, and this seems to be what will define its smart condition. Maybe the digital world would be the point of rupture from smart cities to sustainable cities and human cities, definitions that still exist very interlinked, or the smart digital city will be the path to acquire more sustainable or human cities. We believe that digital technology can be more economic, more practical, and more democratic; provide faster services, better organizations; and then contribute to set the bases for a healthy urban life. However, we cannot affirm that this will be the inextricable truth to every city in the world, and that all analog life should be replaced. Against many evangelists of smart city use to say, the implementation of digital repertoire should respect the identity, context and the democratic access to all

citizens. Finally, the map shows clearly that there is an established common sense that intuitively connects smart cities to digital information and communication systems.

Innovation is a concept with an intensity of connections as strong as technology and the reason of it is the motivation produced by the new systems of information and communication to redesign very fast the way things are done and create a new and more reliable urban experience. As we can see on the left side of the diagram the smart city literature approaches pretty much all domains of urban life (mobility, environment, housing, etc.), including the ones were left out in this analysis (health, economy, etc.). Considering that smart city is not only a concept, but also a business, the infiltration of digital systems in every domains of city life is commercially a very promising market. However, we highlight three main axes where the influence is bigger and the configuration of lines has a strong intensity: mobility, transport and governance. It seems that technologies such as sharing systems, communication systems, downloading/uploading systems, geographic systems, are finding in the mobility and administration problems its best application and the results can be seen more often in the daily life. On the other hand, problems related to energy, security and housing have not gotten very significant results yet, and the intensity of those axes connections in the diagram are much lower than the others.

Security is a domain affected by surveillance systems and other mechanisms of control such as cameras, sensors, automation systems and all sort of monitoring tools. Even with many technological applications security issues are not the most relevant in smart city literature. Housing and energy are also at a second level of relevance. Housing issues do not appear very frequently in the smart city discourse maybe because of the difference of scale. Anyway, it is common to hear about smart buildings and smart houses in the literature.

Although the concept of smart city is constantly found associated to sustainability, it seems that there is not a belief that energy problems will be solved by the information and communication systems. The concepts area of the diagram shows the significant relevance of sustainability for almost all authors. On the other hand, the ecology concept is not very relevant, and it is briefly mentioned. This is also true to resilience concept.

5. Conclusion

The diagram helped to verify the connections, the intensity and the relevance of specific areas of knowledge in the smart city discourse. It was designed as a statistic graphic panorama of concepts, words and themes that gravitate around smart cities. The main point was to create a legible and updated visualization of the relevance of important issues to urban studies and policies.

The diagram showed that the three areas with most relevance for smart city technologies of communication and information are: mobility, transportation and governance. There is plenty of information in the texts reviewed about how technology is transforming the mobility experience in large urban spaces. It is possible to affirm that this topic is central in smart city discourse.

At the same level of relevance comes governance. The communication and information technologies are becoming the mainstream to public urban administration. Services, infrastructures, equipment, databases, and all the interaction between citizens and city government are becoming digital. Public administration in cities is very much interested in reconfiguring itself using technology in order to obtain more control of the city finances, share projects with the population and reduce cost of maintenance through automation and self-services systems. At the same time, there is an expanding number of companies interested in selling all sorts of systems and services to this enormous public market.

Although new smart city regulations are becoming available such as ISO 37122/2019, they are still configured by a large panorama of indicators. We believe that it will take more time until specific domains of the urban reality became selected by the technological development, just like it is happening with mobility and governance.

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