Indicators for Smart Cities: Bibliometric and Systemic Search

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Abstract. With the advent of the new Information and Communication Technologies (ICTs), and the accelerated development of the urban centres, a debate arose on how to use ICTs in order to improve the development of cities in order to make them "intelligent", what the doctrine has been calling smart cities - SC. Having this in consideration, this paper aims to search for the existence of studies analysing indicators for smart cities. The operationalisation of this work followed the structure of an original paper and focused in bibliometric and systemic analysis. This kind of work is useful as guideline for the development of projects, indicating new trends for future research and identifying the methods of research used in each area. From the research that was done it may be verified that studies referring indicators for smart cities are rather incipient, and for that reason it may be foreseen an opportunity for the development of new researches.

Keywords: Indicators · Smart cities · Bibliometric search · Systemic search

1 Introduction

The advent of Information Society revealed an unavoidable tendency of the XXIst century of sophisticating the participation - of any citizen connected to the Internet. Considering this it looks quite timely to have a debate on the context and perspective of public policies now based in data coproduced between Public Authorities and Citizens. In this sense, since the 90s, the debate on smart cities has arisen.

Nowadays, studies in this domain refer mainly to the construction of indicators that allow to measure the level of maturity of governments in the use of the Technologies of Information and Communication - ICTs in order to improve the life of people in the cities.

Having this in consideration, this study intends to research the instruments developed in order to assess the performance of smart cities, in a context of networked government. This way, aiming at being of help for researchers that start their studies on indicators for smart cities, it was adopted as methodological strategy the systemic and bibliometric analysis, through a systematic research in five data bases that took place in the month of May 2016 for the identification of studies in this domain, between 1990 and 2016.

For this, the work was structured in five chapters, including the introduction. The second chapter is aimed at a contextualization in the scenario of public administration

and its approach to the new technologies; in the third chapter it is referred the structures of open government; and in the fourth concepts and characteristics of the indicators, as well as the methodology are presented; at last, final considerations and the opportunities for further work are referred.

2 From New Public Management to New Public Service

Between the end of the XXth century and the first decade of this century, with the advent of Internet and ICTs the society witnesses a real technological revolution. The growing insertion of Internet in different domains and activities became a world tendency, including in sectors of public administration that, in reply to the fiscal crisis of the 70s and to the need of turning the administration more efficient and fast, adopted in the 90s the Theory of New Public Management (NPM).

Aiming at the reduction of costs and the struggle against corruption, it must be noticed that these directives of NPM meet the purposes of governments, of using Internet and have as operationalization mechanism the precepts of Electronic Government-GE (public administration in the net, available 24 h a day, 7 days a week, 365 days a year).

In reply to NPM, the Theory of New Public Service (NPS) arises, from the idea of Janet and Robert Denhardt, in the beginning of the 90s [1]. In this approach, the role of the Government shifts from rower to driver, acting as a motor in front of the Market forces. NPS looks for inspiration in the democratic theory, mainly from the concern with the connexion between citizens and their governments [2].

In this sense, the full viabilization of the proposals of NPS requires a society which is politically articulated in the model of a multicentric society reflecting the multidimensions of Human condition [3].

These principles are also Keys for a paradigm that started arising in the beginning of the XXI century, called Open Government, which intends to "operate the democratic governance through social co-responsibility in conception and implementation of public policies" [4].

The way decisions are made and how citizens interact towards public purposes and the implementation of public policies are related to what Denhardt [2] calls governance in the net; that is the following approach.

3 Governance in the Net, Open Government and Smart Cities

As observed in the previous chapter, NPM tried to restrict the focus of administration towards technical issues and it was unavoidable that issues on the relation between theory and administrative practice would arise. Due to this factor, the theory of NPS was unveiled by a relation with the subject of governance referring to the exercise of power in the networked society [2].

As it is easily observed, one of the main challenges of governance in the network is to articulate the traditional and hierarchical government (up-bottom) with the requirement of organized networks in horizontal lines [2].

In this sense, the issue that is presented in doctrine is how the governance in the network may contribute for the strengthening of democracy? The reply to the questioning has support in the idea of Open Government [4] and Iberian American Chart of Open Government - CIGE [5].

In this direction goes the discourse on the co-production of the public welfare, whose debate started in America in the years 70 and 80 [6]. In the beginning the debate was centered in the vision of citizens as direct users/clients of Public Administration. But nowadays, the debate gets a new dimension that goes beyond the perspective of the one way State (main agent or provider) and destine.

To this study it is particularly interesting the approach concerning the co-production, understood as the one in which there is an effective participation of the citizen in the production and fiscalization of public services [1, 3, 7].

From the above referred approach, it must be observed that ICTs do create options, do open opportunities and recreate, since the 90s, the ways for managing the administration and, consequently, for urban management. The strategies of thinking on Technologies for improving the life in modern cities are now called "smart cities" [8].

It is rather complex to define a smart city, once that its significance and context describe alternative approaches, schools of thought and researchers who deal with this phenomenon. From the doctrine, a smart city may be considered as: "a city with a good performance in a prospective way in economy, people, governance, mobility, environment and life, built upon the intelligent combination of donations and activities of auto-decision, of independent and conscious citizens" [9]. Aware of this framework, in this study it was adopted a minimal definition, understanding a smart city as the one which incorporates the use of ICTs for improving the life in the cities. Thus being, observed the phenomenon and presented the concept, we go on to the study of the indicators.

4   Indicators of Performance

In this chapter, the approach falls on the study of the indicators, which may be translated in concrete measures of the dimensions and concepts, such as smart cities (above referred) [10, 11]. These may be characterized as (a) concept or dimension; (b) numerical expression capable of being quantitatively measured the dimensions to which these are referred [11].

Concerning the typology, the doctrine classify the indicators in two ways: (a) descriptive and analytical [11], (b) reflexive or formative [12].

Among the above referred typologies, it was chosen the reflexive indicators as a variable smoldering (not observable in a direct way, for it refers to attributes such as personality, intelligence, happiness) but on the other side the formative indicators are factors of construction of the concept (for instance, level of education) [12]. In this perspective, the subject of Smart Cities may be inserted as a Formative Indicator, in which Intelligence is measured by their dimensions and these, respectively, by their indicators.

The use of indicators in the context of smart cities is the focus of the study undertaken here and, for this, will be now be presented the methodological procedures.

4.1 Methodology

With the purpose of helping the searchers that begin their studies on Indicators for Smart Cities, this paper has focused in the bibliometric and systemic revision. The bibliometric revision consists of a quantitative technique of search having as aim the target of classifying and measuring the productivity of authors in a determined key field [13].

On the other side, systemic revision adopts as its main base the literature of certain subject and, from that, proposes a summary of the evidences through the application of critical methods of appreciation and synthesis of information [14]. In this sense, we have followed a guide for the systematic revision, in this way: 1 – to define a query; 2 – to identify the databases; 3 – to establish criteria for the selection of papers; 4 – to direct and to compare the searches; 5 – to apply criteria for the selection of papers; 6 – to analyse critically and to evaluate the studies; 7 – to prepare a summary; 8 – to presented a conclusion with the effects of the intervention [14].

According to the above exposed steps, this paper adopted the following search question: which studies have approached the subject: "Indicators for smart cities"; for this it was performed, during the month of May 2016 a search in five databases (Scopus, Science Direct, Springer, Scielo, Google Acadêmico) and it was elected as descriptor the following key word "Smart City Indicators".

It must be registered that the search was restricted to the Works published between 1990 and 2016 and had as instrument of recollection the *EndNoteweb* (for the exporting of the references and papers available in the databases).

For the selection of the papers it was performed the reading of the titles, followed by the Reading of the summaries and, finally, the Reading of the entire text [15]. It must also be stated that texts whose contents did not match to the search query were excluded, as well as those that were not available in the databases.

4.2 Results of the Searches in the Databases

In accordance to the search performed in the databases (Scopus, Sience Direct, Google Acadêmico, Scielo e Springer), from a total of fifty two identified papers after the application of the search strategies, this study ended up with only three identified papers: Scopus, Science Direct and Google Scholar one paper each; in Scielo and Springer there were no papers identified (Table 1).

As it may be noticed, while Scielo did not present any result, the database that presented a higher number of results after the application of the search strategies was Google Scholar with 43 (forty three) papers. After reading the title, a total of 33 (thirty three) papers were selected and, in the following step (reading of the summary) 19 (nineteen) papers remained. In the end, after reading the full papers, only 3 (three) were selected. As detailed below.

Table 1. Results of the research after the application of the methodological principles

Databases	Papers after the application of search strategies	Papers after reading the title	Papers after reading summary	Papers after reading full text
Scopus	2	2	1	1
Science Direct	4	4	2	1
Google Scholar	43	25	15	1
Scielo	0	0	0	0
Springer	3	2	1	0
Total	52	33	19	3

Source: elaborated by the author Marciele Berger Bernardes.

4.2.1   Bibliometric Analysis

This item is directed to the tracking[1] of citations in Academic Journals. For this, it was used the bibliometric analysis, which helps exploring and organizing the papers, in the specific case about Indicators for Smart Cities.

The measuring of the prestigie of the source and of the total of citations received by the journal was performed considering the tools of Scopus (SCImago Journal Rank-SJR) and Web of Science (*Journal Citations Reports*- JCR), as analysed next.

The paper "Definition methodology for the Smart city" [16] was published in the journal "Energy" of Science Direct and evaluated by JCR; according to the information, this journal had in 2012 an impact factor of three comma sixty five percentual points (3,65%) and received twenty four (24) citations.

Next, it was performed the bibliometric analysis of the paper "Beneath the smart city: dichotomy between sustainability and competitiveness" [17], which was published in the journal "Taylor and Francis" of Scopus and was evaluated by SJR. This journal had in 2015 an impact factor of zero comma thirty five percentual points (0,35%) and until the period of this evaluation the said paper did not receive any citations. In front of the results now presented and willing to consider the parameters of the bibliometric analysis, this paper was not selected for the next phase, that is the systemic analysis.

Finally, the work of [9] refers to an extract of conference and, although the searches in the databases of Scopus and Web of Science were performed, it was not identified any analysis of this paper with the tools of JCR and SJR. It must be registered that such material referred to the book "Smart cities: Ranking of European medium-sized cities" of the said author [9]. The referred book could not be evaluated neither, referring to the impact factor, because it was not located by the tools of SJR and JCR. However, it was identified in Google Scholar that the said book received a total of 513 citations to the present date (May 2016) which evidences its importance as source for any study on the subject of "Indicators of Smart Cities". Considering that, the said paper was selected for the systemic analysis.

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[1] It must be referred that this step of the current study was operated with the precious help of Maria Cristina Fernando Gonçalves, the person in charge of the Documentation Services at Universidade do Minho.

4.2.2 Systemic Analysis

The systemic analysis consists of the proposition of a summary based in the critical analysis of the selected searches. Thus being, in this chapter it is proposed a summary of the works of [9, 16], which present similarities and differences.

Concerning the specificities, while an Indicator was developed with a focus in the dimension "sustainability" [16], being applied to measure the performance of the italian cities, the other was based in six dimensions (economy, environment, government, life, development, people) [9] each one conjugating an ecology of signification, being employed to evaluate the development of seventy five european cities.

Considering the similarities, it was found common between the two analysis the development of Rankings established upon Indictors of comparison between european medium sized cities. Besides that, they converge in the sense that it is understood that an agrément on cities evaluation is not easily identified, that meaning that evaluating cities is a complex task, being that it enters in inter-disciplinar domains (architecture, engineering, law, philosophy, sociology, geography among others) and, sometimes, generic concepts (for instance, which are the relevant indicators for proposing a rating of Brute Happiness). Thus being, it is recommended that, in order to achieve a broader veracity, the collected information must be based in open and transparent data.

Regardless of these considerations, both texts support the idea that it is possible to replicate the metrics of evaluation of cities in other urban centres, since the peculiarities of each region are considered, specifically (for instance, a planner soil allows the development of strategies of urban mobility, as the use of bykes, in Amsterdam, Netherlands). However, how to apply this in cities with a more rugged relief? There are more urban centres with wifi covering the most part of the city, such as Barcelona/Spain; however there are more rural regions in which Internet is of difficult access, slow and expensive. It must not be forgotten that there cities classified as Historic Heritage of Mankind, such as Guimarães (Portugal), where no after how much the investment in ICTs in order to reach the most quarters with wifi system, there still are "blind points" in which there is no network, due to the existence of historical buildings).

Besides this, the selected papers recommend the contínuos evaluation of the cities, which will serve both for managers to (re)define their government programs and public policies as also for their monitoring of the programs and to enhance the local development, awakening the interest of investors.

As it is noticed, it is a common point between the analysed searches the need of employing the indicators serving for governments and citizens, resulting in a true interconnection between ICTs and social control. It is in this scenario that the directives of co-production of the public welfare, studied in the previous chapters, will be replicated.

5 Final Considerations

This study aimed at research the occurrence of works addressing indicators for smart cities, in the context of networked government.

In this sense, the adopted methodology was based in bibliometric and systemic revision, which appeared as important resources considering the accelerated growth of

information. These studies help to synthetise, to classify and to manipulate the evidence available in literature on indicators for smart cities and may be of help for professionals and researchers in their daily work.

Besides that, the publication of studies based in this methodology, as well as others synthesizing research results, is a step more towards practice based in evidence, thus helping to find occult patterns and to evidence future research opportunities, arising from the understanding of the state of the art in a determined field of research.

After this research it became clear that the building up of methodologies for the evaluation of the development of smart cities and the proposal of rankings are still incipient. Further studies with this focus are required, having the indicators of quality of life and popular participation as transversal domains. Studies with this focus will be a contribution for the building up of guidelines for public policies that must not be exhausted within electoral cycles but rather inserted in the programs of town and country planning.

This way, we may conclude that it is widely debated the use of indicators in the context of New Public Management, having as main focus efficiency measures and the internal efficiency of Public Administration. But it must be understood that while advancing towards a New Public Service or even, in a broader sense, towards networked democratic government, based in popular participation and a wider social control, the landscape is already quite different. Thus being, these domains open broad ways for future research.

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