

Analysis of smart city indicators based on prisma : systematic review

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Abstract. This study aims to conduct a review of Smart city literature specifically related to Smart city indicators from various cross-studies. The method used is a systematic literature review consisting of five stages, namely defining eligibility criteria; define the source of information; literature selection; data collection and item selection with synthesis techniques. The results of the study showed a set of indicators consisting of 43 indicators classified into 8 categories of Smart City. Smart city indicators and categories are contributions from this research to fill the literature gap theoretically and help cities monitor their performance overtime.

1. Introduction

In the past few years, the Smart City concept emerged as a new trend in answering various issues related to urban development in the future. The problem presented is related to the estimation that by 2020, the population who will live in the city will reach 80% of the world population [1]. With the rate of urbanization increasing steadily, it is predicted that the population in urban areas by 2050 will reach 6.5 billion. In fact, if traced back, the urban population only accounted for 32% of the world's total population in 1950, far below the rural population which reached 68%. Around 2007 after almost 6 decades, the new city population exceeded the rural population. The illustration below shows the trend of increasing urbanization as follows:

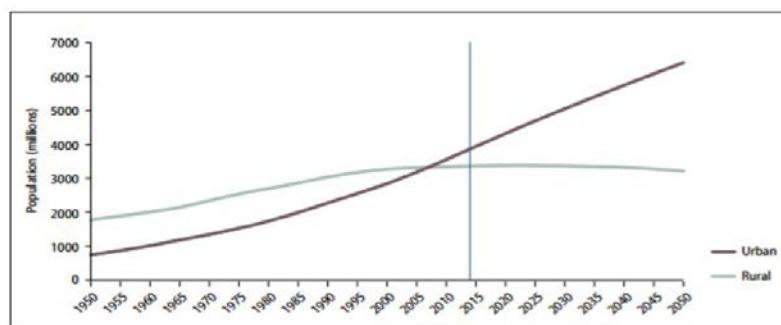


Figure 1. Population Growth of urban and rural in the world 1950-2050[2]

Figure 1 above illustrates the distribution of populations in both urban and rural areas. Since 2015, future population trends appear to have a growth base in urban areas compared to rural areas. Of course this requires a right solution in answering the problems related to the high rate of population growth, especially in urban areas[3]. The solution is related to various aspects or sectors such as economics, environment, transportation, infrastructure, ICT,

settlement, health, education, social and many more[4]. Each sector is part of a puzzle, which when assembled into a complete puzzle, called Smart city.

The Smart city concept has been used widely but is understood differently. The Smart city concept is still developing until now where many terms about the Smart city concept can be found in the literature. For example, some Smart city concepts, namely intelligent city, digital city, high-tech city, innovative city [5–7]. The Albino Study (2015) suggests that there are more than 25 definitions of Smart city [5]. But unfortunately there is no absolute concept about Smart city. There is no agreement regarding the Smart city concept so far so people can use it differently. Nevertheless, it can be said that most researchers, government institutions, private even citizens agree that the main element in smart city is ICT (Information and Communication Technology)[8].

This is evident that since 1990, the concept of smart city was introduced when the development of cities will change significantly with the existence of technology, innovation and globalization[9]. The use of technology is believed to have an impact on the construction of a city. Therefore, almost all smart city concepts or definitions today are always related to ICT as a key element for the success of an urban development. ICT has become a fundamental asset in a Smart city. Without the use of ICT, the idea of developing Smart City has lost its meaning. This is because ICT has an important role in solving urban problems, especially related to the services of citizens' needs such as administration, education, health, housing, transportation, security so as to create an integrated, smarter and more efficient service[10].

Although ICT is an important element in the development of Smart city, some researchers see ICT as just an input outside of other elements. Angelidou (2014) stated that the concept of Smart city is not only related to ICT, but also human-based and collectivity [11]. European Parliament (2012) also acknowledges that the concept of Smart city is not as simple as the application of a technology [12]. Smart city development is actually a multi-disciplinary that involves all parties such as the government, suppliers, policy makers, academics and society as well as various aspects or sectors of life. Beretta (2018) states that Smart city is an integration between ICT and human and social capital [13]. The Smart city perspective can be seen more broadly which is an interrelation of many aspects such as energy, mobility, materials and people[6]. Al Nuami (2015) also stated that the development of Smart City must involve various aspects of Smart city from different perspectives, namely infrastructure, human, IoT, intelligence management of resources and facilities such as roads, ports, natural resources, communication, environment and governance [14]. Tok et. al (2014) cited several indicators of Smart city development including living, mobility, environment, people and governance [15].

Unfortunately, the Smart city concept is only understood at a narrow level of definition, which is limited to only the use of ICT technology. Lack of literature on aspects or indicators that are multi-disciplinary in particular related to the development of Smart city. This study aims to review the smart city literature by using a systematic review approach to fill the gap above, especially indicators of Smart city development from various cross-studies. This research from the theory side can enrich the body of knowledge from Smart city literature by integrating various globally significant studies. In practical terms, this research contributes to policy makers to be more concerned with aspects of Smart city development.

2. Methodology

In this study an exploration and analysis of indicators that measure the performance of Smart

city was carried out. Studies of smart city indicators have been carried out by previous researchers but are spread in various scientific proceedings and journal articles. The method used in this study is a systematic review that aims to identify, evaluate and interpret the results of research that is relevant and related to a particular topic to be studied [16]. Systematic review is also a synthesis of primary research that presents clear topics and problems but is accompanied by critical thinking[17]. Through systematic reviews, the results of primary studies or research are integrated (synthesized) and packaged to present more comprehensive and balanced facts for policy makers. Therefore the selection or selection of relevant primary studies is very important in the process of systematic review.

In this study, a systematic review process was carried out following the stages in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyzes), a protocol reporting guidelines developed to optimize the reporting of systematic reviews that can be presented in Figure 1 below:

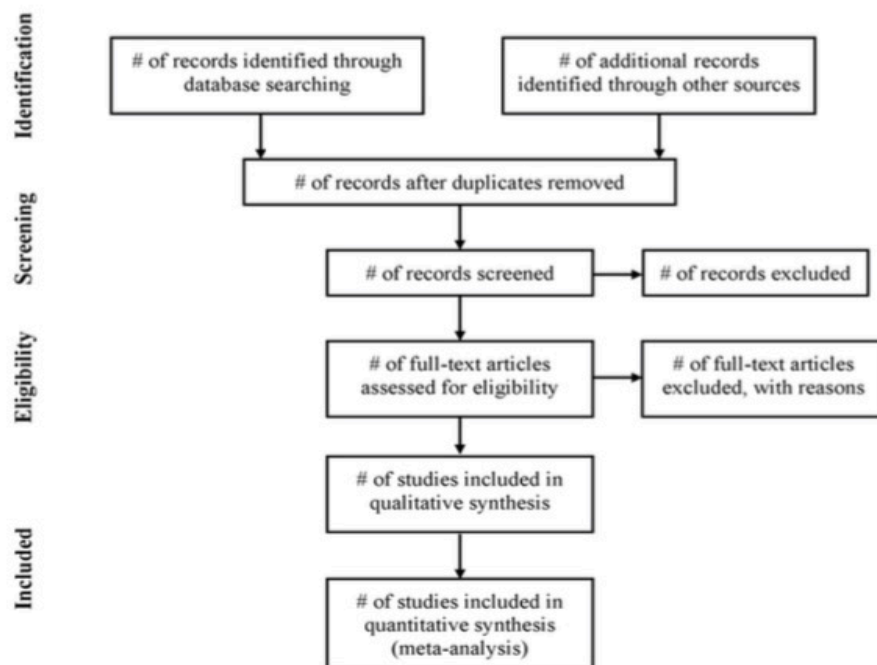


Figure 1. PRISMA Phase Diagram[18]

Based on Figure 1 above, it can be seen that there are 4 (four) main phases of PRISMA but in general PRISMA consists of 5 (five) stages as follows: 1) Defining eligibility criteria; 2) Defining information sources; 3) Selection of literature; 4) Data collection; and 5) Selection of data items [18]. Determination of eligibility criteria is very important to obtain primary studies that are truly relevant to this study.

3. Result and Discussion

Based on the PRISMA reporting guidelines described earlier, the analysis process begins with the first stage, namely determining the eligibility criteria from the literature. There are 3 (three) inclusive criteria (IC) in this study. The first criterion (IC1) is an article must be original research that has been reviewed and written in English. The second criterion (IC2) is an article published after 2014 (last five years). The third criterion (IC3) is the type of article

in the form of a journal and the fourth criterion (IC4) is that the article aims to investigate smart city performance indicators.

Next, the next step is to define information sources as the basis for literature search. In this study, literature searches were carried out on online databases that have large repositories for academic studies such as DOAJ, ProQuest and Google Scholar. In addition, literature searches are also conducted on reputable online databases such as ScienceDirect (Scopus) to guarantee the quality of articles. In addition, a search of the reference list of articles included in the inclusion criteria was also conducted to find out whether there were other studies that were relevant to this study.

After the database information source is determined, the next stage is the selection or selection of literature. The selection of literature is based on the keywords used in this study, namely ("key factors" OR "success factors") AND "smart city". Based on these keywords and the first inclusion criteria (IC1), screening or selection of articles is carried out based on the title, abstract and content and conclusions. Articles obtained from search results are also filtered out whether there are duplicates to be issued, articles that are not significantly relevant to the topic of this research will not be involved at a later stage. The results of filtering articles can be presented in Table 1 below.

The next stage is collecting data manually consisting of database sources, author, article title, year of publication and type of article (journal or conference) based on the second inclusion criterion (IC2), namely article publication after 2014 and third inclusion (IC3), namely type of journal article.

Table 1. Summary of Selected Study

No	Source	Author	Title	Publication Year	Type of Article
1.	Science Direct	Seunghwang Myeong [19]	A Study on Determinant Factors in Smart City Development: An Analytic Hierarchy Process Analysis	2018	Journal
2.	Science Direct	Aapo Huovila, et. al [20]	Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when?	2019	Journal
3.	Science Direct	Hsiaoping Yeh [21]	The effects of successful ICT-based smart city services: From citizens' perspectives	2017	Journal
4.	Science Direct	Elvira Ismagilova, et. al [22]	Smart cities: Advances in research—An information systems perspective	2019	Journal
5.	Science Direct	Sheshadri Chatterjee, et.al [23]	Success of IoT in Smart Cities of India: An empirical analysis	2018	Journal
6.	Science Direct	Samad Sepasgozar, et.al [24]	Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies	2019	Journal
7.	Science Direct	Harish Kumar, et. al[25]	A policy framework for city eligibility analysis: TISM and fuzzy MICMAC- weighted approach to select a city for smart city transformation in India	2019	Journal

8.	Science Direct	Gunjan Yadav, et. al [26]	Developing a sustainable smart city framework for developing economies: An Indian context	2019	Journal
9.	Science Direct	Kamila Borsekova [27]	Functionality between the size and indicators of smart cities: A research challenge with policy implications	2018	Journal
10.	Science Direct	Francesco Schiavone, et. al [28]	Business model innovation for urban smartization	2019	Journal
11.	Science Direct	Jung Hoon Lee, et. al [29]	Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco	2014	Journal
12.	Science Direct	Liyin Shen, et. al [30]	A holistic evaluation of smart city performance in the context of China	2018	Journal
13.	DOAJ/ProQuest/Google Scholar	Aidana Siuryte [31]	An Analysis of Key Factors in Developing a Smart City	2016	Journal
14.	Google Scholar	Shah Manan, et. al [32]	Assesment of Critical Success Factors for Smart Cities Using Significance Index Method	2016	Journal
15.	DOAJ/Google Scholar	Abdulaziz Aldegheishem [33]	Success Factors of Smart Cities a Systematic Review of Literature from 2000-2018	2019	Journal

Based on Table 1, a total of 15 articles related to Smart city indicators were obtained in the data selection process. The entire article comes mostly from journals (14) and conferences (1) where the data base source is also mostly accessed from Science Direct (12 articles) and the remaining 3 articles from DOAJ/ProQuest /Google Scholar. Then the data selection phase uses inclusion criteria 4 (IC4) where the data chosen to answer this research question is a Smart city indicator.

The data selection phase is done by synthesis techniques, namely by integrating all Smart city indicators from various cross-studies that can be presented in Table 2 below:

Table 2. Synthesis of Smart City Indicators

Category	Cross Study														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Smart Governance															
Availability of E-Government/Service Integration	V	V	V	V	V	V	V				V	V		V	V
Participation by Social Media	V	V	V	V					V	V		V			V
Open Data/Open Government	V	V		V			V		V		V	V			V
Supportive Government Policy/Regulatory	V	V	V				V	V			V				
Enhancement of public-private partnership	V	V	V				V	V			V			V	
Smart Environment															
Waste Management		V		V			V		V	V		V		V	V
Air Pollution		V		V			V		V	V		V		V	V
Green Area/Space		V		V					V	V		V		V	V
Water Quality		V		V			V		V	V				V	V

Based on Table 2 above, it can be seen from the synthesis results that there are 8 categories and 43 indicators of Smart City. The eight categories are Smart Governance, Smart Environment, Smart Mobility, Smart People, Smart Economy, Smart Living, Smart Infrastructure / Technology and Smart Energy. Aldegheishem (2019) in their research conducted a systematic review of Smart city indicators and found 12 Smart city categories, namely Smart Governance, Smart Environment, Smart Mobility, Smart Economy, Smart Living, Smart Infrastructure / Technology, Smart Energy, Smart Building, Smart Hospitals, Smart Safety and Smart Education [33]. In the process of synthesizing Smart city indicators, four categories, Smart Building, Smart Hospitals, Smart Safety and Smart Education were included as indicators, not categorized as overlapping. For example Smart Hospitals is part of Smart Living with Healthcare services and patient e-Monitoring[22,26,28]. Likewise, Smart Safety is also an indicator of Smart Living, in the form of Public Safety[22,32,33].

A total of 43 indicators or factors that constitute contributions from this study can be used to help cities in setting their targets and monitoring their performance in the development of Smart city over time. Consequently, cities regularly use indicators to quantify their targets and systematically monitor the progress towards their goals.

4. Conclusion

According to the result and analysis, there are a number of conclusions that can be taken, namely that a set of performance indicators from Smart city has been produced using a systematic literature review. The entire indicator can be categorized in 8 (eight) dimensions, namely Smart Governance, Smart Environment, Smart Mobility, Smart People, Smart Economy, Smart Living, Smart Infrastructure/ Technology and Smart Energy. The contribution of this study theoretically can fill the literature gap related to Smart city indicators; can practically provide information to city managers to get an overview of Smart city performance. However, so that Smart city performance information is more useful, it is necessary to select a small number of indicators called Key Performance Indicators, given the explosive amount of data in cities. Therefore, the next research suggestion is to select and validate 43 indicators by involving expert knowledge so that misuse does not occur.

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