

Smart City Indicators Model: A Literature Review

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Abstract: The city has an ever-increasing problem in its spatial planning over time. To be able to prevent it is needed city management through the concept of sustainable planning concept known as Smart City. City considered Smart City can have various innovations in solving problems in the city while improving the welfare and tranquility of its citizens with the support of ICT. But it seems that the concept of Smart City still has not provided an understanding let alone meaningful change. This study aims to identify various indicators of 6 (six) characteristics or dimensions as an effort to improve understanding of what factors are involved in the application of Smart City. The research method used is literature review with synthesis technique through 6 articles related to Smart City indicators study. The results showed that 45 indicators were categorized into Smart Economy (10), Smart Environment (8), Smart Government (6), Smart Living (9), Smart Mobility (6) and Smart People (6).

Keywords: Smart City, Characteristic, Indicator, ICT, Synthesis, Model.

1. Introduction

Smart city is a new concept related to the development, implementation and implementation of technology applied to an urban area as a complex interaction among various systems inside. Here the word city is used to refer to the city as the center of the country or region, where all the centers of life are (government, commerce, education, health, defense, etc.) and also the population in the city is relatively more than other regions (e.g village/sub urban). The city becomes the attraction of people to settle. According to (Cohen, B., 2012) Smart City is a broad approach, integrated in improving the efficiency of the operation of a city, improving the quality of life of its population, and growing its regional economy. Cohen further defines Smart City by weighting the environmental aspects into: Smart City uses ICT smartly and efficiently in using resources, resulting in cost and energy savings, improved service and quality of life, and reduces environmental footprint-all of which support innovation and the economy environmentally friendly. Other experts such as (Kourtit, K., Nijkamp, P., 2012) stated that Smart City is the result of intensive knowledge development and creative strategies in improving socio-economic, ecological, and urban competitive power. The emergence of Smart City is the result of a mix of human capital (e.g, educated workforce), infrastructure capital (e.g high-tech communication facilities),

social capital (e.g open community networks) and entrepreneurial capital (e.g creative business activities). A strong and credible government with creative and open-minded people will increase local productivity and accelerate the economic growth of a city. In other words, Smart City is a simple system that uses digital technology to improve performance and welfare, and to reduce the cost and resource consumption, as well as to engage more effectively and actively with its citizens.



Fig. 1. Six Characteristics of Smart City Model (Giffinger, 2007).

Based on some literature, there are 6 (six) characteristics in Smart City (Colldahl, C., Kelemen, J., 2013) (Caragliu, A., Del, B., Nijkamp, P., 2011); (Priano, F H., Guerra, 2014) as follows:

1. Smart Economy related to improve business life, to facilitate and generate faster finding of business services, to participate in urban development, to increase gross domestic product, and to create jobs.
2. Smart Environment designed to enhance the sustainability, clean energy, clean air and clean waterfront. By reducing air pollution, water pollution, and CO2 emissions, environmental conditions can help to develop a smart city. These developing sustainability and managing resources are dependent on technology as the core concept of smart cities.
3. Smart People can create a smart economy, smart education, and smart transportation. Many indicators can measure smart people such as level of education, academic and technical degrees and additional training, as well as the ability to communicate in more than one language.
4. Smart Living enhances the quality of life. Therefore, smart living is defined by providing a better life for citizens through health care, safety, quality of housing, social cohesion and other activities in society.
5. Smart Mobility concerned about the movement of people or goods around the cities and from one location to another and around the world supported by safe transportation system and ICT accessibility
6. Smart Government related to various stakeholders is engaged in decision-making and public services. Information and communication technologies (ICT)-mediated government. Smart Government is fundamental in bringing smart city initiatives to citizens to keep the decision and implementation process transparent.

Although the concept of Smart City has been discussed quite a bit, the

development of Smart City still seems to have not brought a clear and consistent understanding, so the various researches on the application of the Smart City concept in various cases are expected to provide a clear and consistent picture of the Smart City implementation concept. Unfortunately, The Studies of Smart City Indicators related to Smart City implementation are also very rare. Most of the study only emphasizes the role of ICT or IOT (Internet of Things) in Smart City System. In fact, Smart City Indicators is very important to be used to plan and even evaluate Smart City implementation and this is a challenge to identify or synthesize indicators from Smart City since there is no consensus or agreement about them. Therefore, this research will formulate a number of indicators from Smart City into six Smart City characteristics, Smart Economy, Smart Environment, Smart Government, Smart Living, Smart Mobility and Smart People.

2. Research Methodology

Smart City is now a trend for big cities around the world including in Indonesia. Many cities are competing to apply it. As mentioned earlier, there are six characteristics that are the dimensions of Smart City: Smart Economy, Smart People, Smart Government, Smart Mobility, Smart Environment and Smart Living. In this research will be proposed factors or indicators of Smart City characteristics (dimensions) obtained through literature review. Factors or indicators are generated through a synthesis process involving several studies related to the Smart City indicator model. The purpose of this study is to identify various indicators that can be categorized into six characteristics of Smart City. Thus, studies related to Smart City indicators or factors that exist beyond these six characteristics will not be examined in this study. The list of identified indicators can be used later to measure Smart City's implementation level. In other words, the review literature will extract and synthesize topics or key issues related to the research domain of Smart City Indicators.

The method of collecting secondary data is done through searching and filtering mechanism of the articles or related studies presented in Figure 1. The mechanism of the article search process in this study is taken from various journal articles and conferences from reputable databases such as Scopus and other sources such as Google Scholar to enrich research so that obtained a broader understanding again related Smart City Indicators with the criteria of articles that have been published in the last 10 years. When searching, there are two keywords used in this research namely "Smart City" and "Indicator". Both of these keywords are chosen to refer to this research domain is Smart City Indicators.

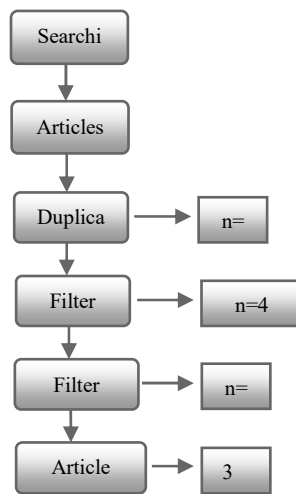


Fig. 1. Stages of Searching and Screening Studies.

The stages of the search and filtering process begin with accessing reputable electronic databases of Scopus and Google Scholar. The study found a number of 20 articles related to the study domain of Smart City Indicators. Then the next step is to do or read the article to find any duplication of the articles. Based on the search, found there are 6 similar articles so there are only 14 articles that become candidates for the study. Then the abstract and title screening process is done to ensure that the study is relevant to the research domain of Smart City Indicators. Of the 14 candidate articles, only 10 candidate articles are relevant to the main research issues so that 4 articles must be excluded again because they are not related. The last is the process of filtering the content of the entire article which includes the body of papers and conclusions. At this stage the article is read repeatedly to search for studies related significantly to the domain of research. As a result, there are only 6 articles that are closely related to the research focus to be involved in the next synthesis process. The 6 articles obtained consist of 3 journals and 3 conferences.

3. Result & Discussions

Searching results and screening articles that have been conducted related to Smart City Indicators model in this study can be presented in Table 1 as follows:

Table 1. Study of Smart City Indicators Model Based on Six Characteristics.

No	Resources of Study	Indicators
1.	(Purnomo, F., Meliana, Prabowo, H., 2016)	Smart Economy: Entrepreneurship and Innovation, Economic Vitality and Planning & Productivity ^[1] Smart Environment: Environmental Sustainability, Monitoring Pollution Degree & Energy Management Smart Government: ICT and E-Government, Transparent Governance and Open Data & Participation in decision making ^[1] Smart Living: Healthcare Services, Social Security and safety & Housing Quality

		Smart Mobility: Public Transportation System, ICT Infrastructure & Accessibility Smart People: Social and Cultural Plurality, Education System and Facilities & Creativity
2.	(Pan, J., Lin, 2011)	Smart Environment: Infrastructure, Innovation Ability & Sustainability ^[1] _{SEP} Smart Business: IT Industry, Information & Innovativeness Smart Citizen: ICT Adoption, Digital Learning, Comfortability & Health Care ^[1] _{SEP} Smart Government: Public Security, Convenience & Governance
3.	(Batagan, L., 2011)	Smart Economy: Productivity and Flexibility of The Labour Market, Integration In The (Inter) national Market, Economic Competitiveness, Use of on-Line Solutions For Sell or Buy of Products, Quality of Production, Quantity of Production, Production Diversity & Research and Development Smart Environment: Natural Conditions, Environmental Protection, Level of Pollution & Sustainable Resource Management Smart Government: Political Participation, Public Services, Transparent Governance, Political Strategies & Perspectives Smart Living: Cultural Facilities, Health Conditions, Individual Safety, Housing Quality, Education Facilities, Touristic Facilities, Healthcare systems & Social Cohesion Smart Mobility: Local accessibility, Availability of ICT-infrastructure & Transport systems Smart People: Education Systems, Social Interactions Regarding Integration and Public Life, Innovation & Creativity
4.	(Lazaroïu, G., Roscia, 2012)	Smart Economy: Innovative Spirit, Entrepreneurship, Economic Image & Trademark, Productivity, Flexibility of Labor Market, International Embeddedness & Ability to Transform Smart Environment: Natural Condition, Pollution, Environmental Protection & Sustainable Resource Management Smart Government: Participation in decision making, Public Services, Transparent Governance & Political Strategies and Perspectives ^[1] _{SEP} Smart Living: Cultural Facilities, Health Conditions, Individual Safety, Housing Quality, Education Facilities, Touristic Facilities & Social Cohesion Smart Mobility: Local accessibility, ICT-infrastructure & Transport systems Smart People: Level of Qualification, Social & Ethnic Plurality, Flexibility, Creativity, Open-Mindness & Participation in Public Life
5.	(Abbas, 2017)	Smart Transportation: Normal Tariff & Transportation System Smart Environment: Air Pollution, Air Quality, Water Pollution, Sanitation Service, Dirty and untidy area & Noise and Light Pollution Smart Economy: Poverty, Unemployment & Growth Rate Smart Living: Housing, Health Insurance, Average Age &

		Low Crime
		Smart People: Education Attainment & Society
6.	(Susanti, R., 2016)	Smart Environment: Integrate with Walking Routes, Solar layouts, Provide Shelter, Street Connectivity, Employment Density & Number of Building
		Smart Living: Improved Public Transport, City Traffic Management, Vehicle Efficiency Improvement & Safety life

Based on Table 1 above it can be shown there are 6 studies that are significantly related to the research domain is Smart City Indicators. If studied further, there are some indicators that have a Smart City model but not in other Smart City model. This can happen because the research focus of each study is different from one another. As an example of a study conducted (Susanti, R., 2016) emphasizes the indicators for residential density in Indonesia.

Meanwhile, (Pan, J., Lin, 2011) proposed Smart City Indicator in its research based on IT capability and potential to enhance competitive advantage in business. Therefore, in these section synthesizes the entire study identified so as to provide a more complete picture of Smart City Indicators. The result of Smart City Indicators synthesis in this research can be presented in Table 2 below:

Table 2. Synthesizing Smart City Indicators for Smart Economy.

No	Resources of Study	Smart Economy									
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
1.	Purnomo et. al (2016)	√	√	√	-	-	-	-	-	√	-
2.	Pan et. al (2011)	√	-	√	-	-	√	√	-	-	-
3.	Batagan (2011)	√	√	-	√	√	√	√	√	√	√
4.	Lazaroïu & Roscia (2012)	√	√	√	√	-	-	-	-	√	√
5.	Abbas (2017)	-	√	√	-	√	√	-	-	√	√
6.	Susanti et. al (2016)	-	-	-	-	-	-	-	-	-	-

A1=Productivity; A2=Entrepreneurship; A3=Innovation; A4=Competitiveness; A5=E-Commerce; A6=Quality of Production; A7=Product Diversity; A8=RnD; A9=Flexibility; A10=Transformation of Business Model

Table 3. Synthesizing Smart City Indicators for Smart Environment.

No	Resources of Study	Smart Environment							
		B1	B2	B3	B4	B5	B6	B7	B8
1.	Purnomo et. al (2016)	√	√	√	-	-	-	-	-
2.	Pan et. al (2011)	√	-	-	√	-	-	-	√
3.	Batagan (2011)	√	√	-	√	√	√	-	-
4.	Lazaroïu & Roscia (2012)	√	√	-	√	√	√	-	-
5.	Abbas (2017)	-	√	√	√	√	√	√	√
6.	Susanti et. al (2016)	√	√	-	√	-	-	-	√

B1=Sustainability; B2=Pollution Monitoring; B3=Energy Management; B4=Innovation Ability; B5=Natural Condition; B6=Environment Protection; B7=Sanitation Service; B8=Integrated Infrastructure

Table 4. Synthesizing Smart City Indicators for Smart Government.

No	Resources of Study	Smart Government
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		C1	C2	C3	C4	C5	C6
1.	Purnomo et. al (2016)	√	√	√	-	-	-
2.	Pan et. al (2011)	√	-	-	√	√	-
3.	Batagan (2011)	√	√	√	-	-	√
4.	Lazaroiu & Roscia (2012)	√	√	√	-	-	√
5.	Abbas (2017)	-	-	-	-	-	-
6.	Susanti et. al (2016)	-	-	-	-	-	-

C1=E-Government; C2=Open Data; C3=Participation in Decision Making; C4=Public Security; C5=IT Governance; C6=Political Strategies

Table 5. Synthesizing Smart City Indicators for Smart Living.

No	Resources of Study	Smart Living								
		D1	D2	D3	D4	D5	D6	D7	D8	D9
1.	Purnomo et. al (2016)	√	√	√	-	-	-	-	-	-
2.	Pan et. al (2011)	√	√	-	-	-	-	-	-	-
3.	Batagan (2011)	√	-	√	√	√	√	-	√	-
4.	Lazaroiu & Roscia (2012)	√	√	√	√	-	-	-	√	√
5.	Abbas (2017)	√	-	√	-	-	√	√	-	-
6.	Susanti et. al (2016)	-	-	-	-	-	-	-	-	√

D1= Healthcare Services; D2= Social Security and Safety; D3= Housing Quality; D4= Education Facilities; D5= Touristic Facilities; D6=Health Insurance; D7=Low Crime; D8=Cultural Facility; D9=City Traffic Management.

Table 6.b Synthesizing Smart City Indicators for Smart Mobility.

No	Resources of Study	Smart Mobility					
		E1	E2	E3	E4	E5	E6
1.	Purnomo et. al (2016)	√	√	√	-	-	-
2.	Pan et. al (2011)	√	-	√	-	-	√
3.	Batagan (2011)	√	√	-	√	√	√
4.	Lazaroiu & Roscia (2012)	√	√	√	√	-	-
5.	Abbas (2017)	-	√	√	-	√	√
6.	Susanti et. al (2016)	-	-	-	-	-	-

E1= Public Transportation System; E2= ICT Infrastructure; E3= Accessibility; E4= Normal Tariff; E5= Vehicle Efficiency; E6=Street Connectivity

Table 7. Synthesizing Smart City Indicators for Smart People.

No	Resources of Study	Smart People					
		F1	F2	F3	F4	F5	F6
1.	Purnomo et. al (2016)	√	√	-	-	-	-
2.	Pan et. al (2011)	√	-	-	-	-	√
3.	Batagan (2011)	√	√	√	-	-	-
4.	Lazaroiu & Roscia (2012)	-	√	-	√	√	-
5.	Abbas (2017)	√	-	√	-	-	-

6.	Susanti et. al (2016)	-	-	√	-	√	-
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F1= Education System; F2= Creativity; F3= Social Interaction; F4= Level of Qualification; F5=Open-Minded; F6=ICT Adoption

In Table 2, 3, 4, 5, 6 and 7, we can show the synthesis process of the entire study into six Smart City characteristics, Smart Economy, Smart Environment, Smart Government, Smart Living, Smart Mobility and Smart People. The result of Smart City indicator synthesis obtained for each characteristic in a row is Smart Economy has 10 (ten) indicator that is Productivity, Entrepreneurship, Innovation, Competitiveness, E-Commerce, Quality Of Production, Product Diversity, RnD, Flexibility and Transformation Of Business Model. Smart Environment consists of 8 (eight) from Sustainability, Pollution Monitoring, Energy Management, Innovation Ability, Natural Condition, Environment Protection, Sanitation Service and Integrated Infrastructure. Smart Government has 6 (six) indicators namely E-Government, Open Data, Participation in Decision Making, Public Security, IT Governance and Political Strategies. Smart Living consists of 9 (nine) indicators: Healthcare Services, Social Security and Safety, Housing Quality, Education Facilities, Touristic Facilities, Health Insurance, Low Crime, Cultural Facility and City Traffic Management. Meanwhile for Smart Mobility obtained 6 (six) indicators are Public Transportation System, ICT Infrastructure, Accessibility, Normal Tariff, Vehicle Efficiency and Street Connectivity. Smart People from synthesis results also have 6 (six) indicators that are Education System, Creativity, Social Interaction, Open-Minded and ICT Adoption. Overall synthesis results for six characteristics obtained a total of 45 indicators for Smart City. The overall indicator in Smart City that has been generated in this study has the same level of importance.

It means nothing is more important and less important. All indicators are equal both in one characteristic and with other characteristics. The 45 proposed Smart City indicators need to be adopted to support the successful implementation of Smart City. This Smart City indicator can also be used to evaluate or measure the conditions of application of Smart City especially in Indonesia.

4. Conclusion

Literature review has been done by searching and filtering some articles related to Smart City indicators where a total of 6 (six) articles relevant to the research domain are analyzed and involved in the process of qualitative synthesis. This research proposes 45 indicators of Smart City that are categorized into six characteristics: Smart Economy (10), Smart Environment (8), Smart Government (6), Smart Living (9), Smart Mobility (6) and Smart People (6). This research still needs empirical verification in the form of validity and reliability test to support the acceptance of all Smart City Indicator that have been identified.

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