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Smart City Indicators: A Systematic LiteratureReview

Fredy Purnomo, Meyliana, Harjanto Prabowo
Bina Nusantara University, Doctoral of Computer Science,
Jakarta, Indonesia.
fpurnomo@binus.edu

Abstract— Smart city is currently a trend for major cities in the world and also most cities in Indonesia. The city as center of human civilization cannot be separated from problems related to excess capacities and matters of convenience. The more and more people are moving from the rural to urban areas has increasinglypose new problems in the city. The city needs to change in order to sustain in the future. There are needs of a strong indicators as the support for a city, in terms of the physical environment, social, people, infrastructure, education and ICT infrastructure. In this paper we discuss on a systematic literature review ofstudies related to smart city. Systematic literature review has three stages, introduction stage, demographic analysis stage and analysis of the results. The final results reveal important indicators in smart city based on the conclusions of previousstudies.

Index Terms— Smart city; Systematic literature review.

INTRODUCTION

Smart city is currently a trend for major cities in the world and also most cities in Indonesia. Half of the world's population is currently residing in cities, and it is expected that this number will rise to 70 % by 2050 [1]. The city as a center of human civilization cannot be separated from problems related to excess capacity and a matter of convenience. More and more people are moving from rural to urban areas which have increasingly pose new problems in the city.
Definition for smart city is "when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" [2].
Smart City also refers to: "a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self decisive, independent and aware citizens" [3]. These six characteristics is shown in Figure 1.
According to Colldahl [1]:
Smart Economy refers to the overall competitiveness ofa city through innovative spirit, productivity and flexibility of labor market.
Smart People setting up the human capital and social interaction between people via affinity for life - long learning, participation in public life, creativity and flexibility.
Smart Government encourages participation of citizens
in governance through participation in decision making and transparent governance.

- Smart Mobility, prepares transportation and infrastructure to support local ICT accessibility, ICT infrastructure, sustainable, innovative and safe transportation systems.
- Smart Environment maintains natural resources throughthe attractiveness of natural condition, environmental protection and sustainable resource management.
- Smart Living improves the Quality of Life by providingcultural facilities, good health conditions, good housingquality and social cohesion.

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According to Ridley, "The first thing you must do is conduct a comprehensive literature review. It is important to explore the field in which you are going to do your research and gain awareness and understanding of current work and perspective in the area so you can position your own research clearly on the academic map of knowledge creation. An essential aspect of academic research is that it has connectionswith the work of others." [5].
The purpose of the literature review is to locate the researchproject, to form its context or background, and to provideinsights into previous work [6].
Literature review should extracts and synthesizes the main points, issues, findings and research methods which emerge from a critical review of the readings [7].
Systematic Literature Review is a method to conduct deep literature reviews. There are three stages, the first stage is the introduction that includes the limit scope, determining the research question, the search process which involves the selection of literature sources and keywords, inclusion andexclusion criteria for sorting paper type and performed the data extraction form of papers selected to be explored further [8].
The next step is to carry out the study based on demographics to determine the trends and characteristics : (1) publishing outlets, (2) most prolific authors, (3) most productive institutions, (4) authors ' academic backgrounds,
publication trends, (6) background of authors, (7) university affiliation based on country, (8) researched industries and countries, (9) researched institution size. The final part will discuss the findings and final results as ananswer to the research question.

SYSTEMATIC LITERATURE REVIEW

A. Introduction Stage

Scope for this research is to summarize potential indicators for implementing smart city. The research question is "What are potential indicators in implementing smart city model?"
Search process includes the selected sources and keywords. Selected sources are: (1) Science Direct (www.sciencedirect.com) , (2) ACM Digital Library (dl.acm.org) , (3) IEEE Xplore (ieeexplore.ieee.org) and (4) Google Scholar (scholar.google.com) . Keyword have been focused on "smart city", "model" and "indicator" with the synonym possibilities as shown in Figure 1.

Table 1 Synonym

Word	Synonim
Smart City	Smarter City Ubiquitous City
Indicator	Index
Model	Plan Design

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So as to have the possibility of queries based on keywordsas follow:

- (“index” OR “indicator”) AND (“plan” OR “design”OR "model”) AND (“smart city” OR “smarter city” OR"ubiquitous city”)
- (“index” OR “indicator”) AND (“smart city” OR “smarter city” OR "ubiquitous city”)

Exclusion Criteria as shown in Figure 2, are needed toremove paper that are not suitable to the criteria,

- Published year before 2004
- Duplicating papers
- Deep technical issue (IoT, modelling)
- Government Regulation Issues
- Energy Issues

Figure 2: Inclusion Criteria

Data extraction process was started in September 2015 and examined 301 papers with search by keywords from the list above against the sources of literature. After reading the abstracts there are 177 papers which become candidates and after thorough readings and based on exclusion criteria there were 30 papers selected for review with the details as shown in Table 2.

Table 2 Selected Paper Details

Source	Studies		
	Studies Found	Candidate Studies	Selected Studies
Science Direct	155	51	11
ACM DL	67	66	7
IEEE XPlore	41	35	3
Google Scholar	38	25	9
Total	301	177	30

B. Demographic Analysis

Publishing Outlets consist of many journals and conferences discussing the smart city topic. Among them is the Journal of Technological Forecasting and Social Science (# 1), Journal of Cities (# 2), Procedia of Computer Science, Journal of Futures as well as several conferences like IEEE International Conference on Systems, Man, and Cybernetics (www.ieeesmc.org) and the International Conference onIntelligent Environments (www.intenv), with a total of 17 journals and 11 conferences.

There are 87 authors who contributed in the 30 papers. Mostprolific authors, namely Alberto De Marco from Politecnico diTorino (Italy) and Mei-Chih Hu from National Tsing Hua University (Taiwan) wrote as much as 2 papers. Professor Alberto De Marco, PhD is an Associate Professor of Project Management in Department of Mangement at Politecnico di Torino, Italy, and his main role is the coordinator of the Smart City Finance & Technology Program [16][17]. Professor Mei- Chih Hu is a Professor in Institute of Technology Managementin National Tsing Hua University, Taiwan. She was also the Associate Editor in Technological Forecasting and Social Change Journal [18] [11].

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Most productive institutions are Politecnico di Torino (Italy)with 10 papers, Sunway University (Malaysia, 4 papers), Universidade Nova de Lisboa (Potugal, 4 papers), and the University of Naples Federico II (Italy, 4 papers). In total there are 45 institutions involved in paper writing about smart

city topic. The Politecnico di Torino is an engineering public university based in Turin, Italy. This university has a Master Degree that offers Master of Science in ICT for Smart Societies (international.polito.it).

Highest authors academic background is in computer studies department (47 % with 41 authors), followed by Science and Technology (37 % with 32 authors) and Economy and Business (16 % with 14 authors). Most fields are computer science/informatics, business administration, smart city, management and production engineering.

In publication trends between 2013 and 2014 there was an increase in the intensity of the discussion of the topic of smart city, while for 2015 yet all published (data taken in December 2015). The trend of discussion of smart city will increasingly become a hot topic of research.

The background of authors of the paper's contributors in 30 papers are about 77 (89 %) of academic professors in a university and 10 (11%) researchers of independent institutions or the industry. Most of researchers are from research institutes like China Electronics Standardization Institute and Korea Research Institute for Human Settlements and Telecommunication / ICT Industry like Ericsson Research Sweden, Siemens Austria and Romania. Smart city needs in the future will increasingly covers multi-discipline areas therefore experts from various fields of academia, industry, government and community are much needed.

University affiliation based on country total's contribution from 22 countries, 45 institutions and 87 authors, with Italy (7 institutions, 23 authors), China (4 institutions, 6 authors),

Korea (4 institutions, 6 authors), US (4 institutions, 5 authors) and Turkey (2 institutions, 5 authors) as the five largest contributor countries. Distribution of authors according to the continents: Europe 54 authors, Asia 23 authors, America 8 authors and Africa 2 authors. There are no authors from Australia.

Researched industries and countries focused on cities as a large institution. Most discussed countries and cities in the paper are Italy (5 papers), China (3 papers), US (3 papers) andBrazil, Europe, Korea, Spain and Turkey, each respectively two papers. Distribution of papers according to the continent: Europe 16 papers, Asia 9 papers and America 5 papers. There are no papers from Africa and Australia.

Demographic Analysis

Findings and final results for smart city indicators obtained after the extraction of the 30 papers are mapped to the domain of indicators drawn from Six Characteristics of Smart City. Data from Table 3 shows that the highest indicator is Smart Environment (87 indicators) and the lowest is Smart Economy(55 indicators).

Table 4 described each of the 3 major indicators of the domain based on Six Characteristics of Smart City.

According to the results, Systematic Literature Review conducted has successfully answered questions related to indicators in the implementation of smart city. Generally thereare 12 main indicators, namely:

Public Transportation System [9]
Environmental Sustainability[9]
Social and Cultural Plurality [3]
Education System and Facilities [10]

1. ICT Infrastructure [11]
2. Healthcare Services [12]
3. Entrepreneur and Innovation [10]
4. Social Security and Safety [13]
5. Economy Vitality and Planning [9]
6. ICT and E-Government [14]
7. Housing Quality [15]
8. Transparent Government and Open Data [3]

Table 3
Most frequently used keywords

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Keyword	Paper Source				
	ACM DL	Scholar	XPlore	SciDir	Total
Smart Economy	11	16	10	18	55
Smart Environment	22	19	11	34	86
Smart Government	16	18	12	23	69
Smart Living	17	21	11	23	72
Smart Mobility	18	23	10	26	77
Smart People	16	19	11	22	68
Total	100	116	65	146	427

Table 4
Most 3 indicators

Six Characteristics	Most 3 Indicators
Smart Economy	• Entrepreneurship and Innovation (14) • Economic Vitality and Planning (13) • Productivity(6)
Smart Environment	• Environmental Sustainability (25) • Monitoring Pollution Degree (7) • Energy Management (7)
Smart Government	• ICT and E-Government (13) • Transparent governance & open data (12) • Participation in decision making (6)
Smart Living	• Healthcare Services (18) • Social Security and safety (15) • Housing Quality (12)
Smart Mobility	• Public Transportation System (33) • ICT Infrastructure (19) • (Inter)national accessibility (5)
Smart People	• Social and Cultural Plurality (15) • Education System and Facilities(11) • Creativity (6)

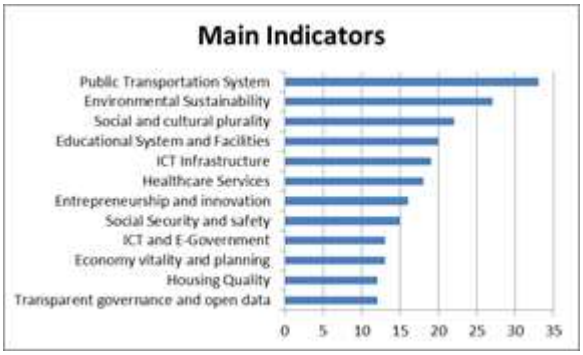

Figure 3: Main Indicators in Smart City

CONCLUSION

Systematic Literature Review conducted research is capable of generating the development trend in the Smart City, especially on indicators which are generally regarded as the main factors in deciding the development of the city. For the future, the Systematic Literature Review can be done to cities with a certain scale both large cities, towns and small cities.

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