Indicators to Measure a Smart Education: An Indonesian Perspective

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Abstract

In a city just like Bandung where the urbanization is very high, people education becomes a serious area that should be managed in a smart way. Hence, the Major of Bandung already declared to implement a smart education program in Bandung. This study intends to help the Bandung government to find indicator to measure whether the city of Bandung has implemented smart education concept effectively. In order to achieve the objective it is required an identification of variables and indicators that determine whether Bandung has implemented smart education. This study is able to identify smart education variables and indicators obtained from literature studies and interview as well as focus group discussion with respondents who have the expertise and experience in the field of smart education. A new proposed model has been obtained containing variables, indicators as well as statements to measure the rate of smart education implementation in Bandung. The proposed model may be able to be used in other cities.

Keywords

Urbananization, smart city, smart education, Bandung, Indonesia

1. Introduction

About 53% of Indonesian population live in urban areas, such as Bandung, Jakarta, Surabaya, Semarang, Medan, and Batam (*Transformasi Center for Public Policy Transformation*, 2016). At the end of 2030, about 67% of Indonesian population will live in urban areas (Rhamdani, 2015). As consequences of the increasing number of people living in the city, many problems are faced by the cities, such as traffic jam, municipal solid wastes, insufficient clean water, security and safety problems, and city's educational issues. To solve those problems, the cities have been implementing smart cities concept. Bandung is one of a city in Indonesia has been implemented the concept of smart city. Several areas of priority are applied on Bandung smart city program, such as Smart Government, Smart Education, Smart Transportation, Smart, Health Cares, Grid/Smart Energy, Smart Surveillance, Smart Environment, Smart Society, Smart Reporting, Bandung Passport, Smart Payment, and Smart Commerce. Hence, in 2015, Bandung was elected as one of the finalists of six world big cities for World Smart City Awards in November 2015 by the *World Smart City Organization* in Barcelona, in competition with the city of Moskow, Dubai, Buenos Aires, Curitiba, and Peterborough. (www.bandung.go.id).

According to Ridwan Kamil (2015), smart city implementation is the development and management of the city by using communication and information technology (IT) for connecting, monitoring, and controlling various available resources in the city with more effective and efficient ways in providing services to the residents. Related to the usage of IT in smart city or one of Internet of Things (IoT), Director of Digital and Strategic Portfolio Telkom Indonesia, the largest digital company in Indonesia, Indra Utoyo said that IT implementation is predicted to be a trend in the future. The development of IoT will become a great business opportunity for Telkom Group as the largest digital company in Indonesia. Telkom is preparing Living Lab Smart City Nusantara to accelerate the implementation of information technology for local government across the country for presenting smart government as well as Smart Education.

In the smart city concept, there is one of the program called smart education which intended to deal with city's educational issues. Education is an important pillar in implementing smart citizen and consider as one of important factor in smart city concept. Smart Cities Council (2013) stated that "Advances in information and communications technologies (ICT) will transform the delivery of essential health, education and other human services in powerful ways – and smart cities will ride the wave to ensure a better life for their residents"

Despite the big efforts of government and digital industry in Indonesian in supporting smart city and smart education, the information and data related to the implementation of smart city and smart education concept are very limited. It is hard to find variables and indicators used for measuring smart education in the smart city concept for big cities in Indonesia. It is therefore, the objectives of this study is to develop variables and indicators to support educational management in Bandung and other cities in Indonesia.

2. Research Objectives and Questions

Various literature reviews were conducted in this study, mainly related to the definition of smart education in a smart city as well as variables and indicators of smart education. Focus group discussions and in-depth interview were conducted with prominent person in the local government of Bandung and Jakarta, including experts of smart city and smart education. The research questions of this study are as follows:

a) Based on the study literature, what is the right variables and indicators in the implementation of smart education parameters in the Indonesian smart city concept?
b) Based on interviews/focus group discussion, what kind of variables and indicators are used to assessing smart education in Indonesia?
c) What statement from the questionnaire is used to identify the application factors of smart education in Indonesia?

3. Research Methodology

The research method used in this study is qualitative with explorative method. Creswell (2014: 4) stated that :

"*Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data*

typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data."

Qualitative research according to Indrawati (2015: 206) is a research methodology that involving data analysis, such as description, where the data cannot directly be quantified. Quantification of qualitative data is done with the code or category. Furthermore, this kind of research is try to transform an object into a qualifier that can be presented, such as field notes, results of the interview, recording of conversations, photographs, and memo. In summary, qualitative research is the research conducted to get an ideas, perceptions, opinions, or beliefs relating to an object examined where the obtained data may not directly be quantified.

To achieve the objectives, this study was conducted with the following research stages:

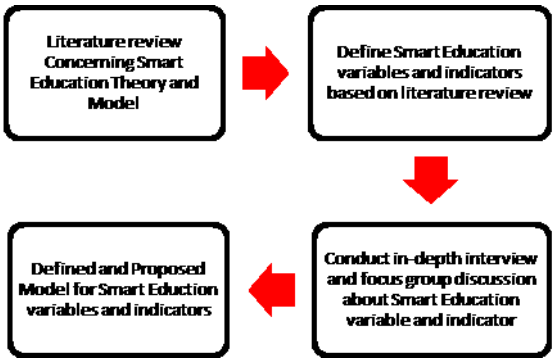

Figure 1. Smart Education Research Stages

Literature review searches relevant theories related to theories of smart city, smart city dimensions, the definition of smart education, variable and indicators of smart education. The next step is filtering all information revealed from the literature review. The result of this stage is to determine the variables and indicators of smart education to be used as the bases of in-depth interview and focus group discussion (FGD) in the research.

In depth interviews and FGD are the process for obtaining information with the purpose of research by asking and face-to-face questions between the interviewer and the informant. At this stage, information is extracted from the resources on the variables and indicators of smart education and confirmed the variables and indicators that have been obtained through literature study.

The respondents for both FGD and in-depth interview were selected from 4 different positions, namely from government, business players, experts, and customers which are chosen by using purposive sampling technique a long with snowball sampling. In purposive sampling technique the sample is selected when the sampling is confined to specific types of people who can provide the desired information, either because they are the only ones who have it or because they conform to some criteria set by the researcher (Sekaran and Bougie, 2010). Snowball sampling allows the researcher to generate a larger sample by asking participants to identify their colleagues.

Table 1. The Respondents of This Research

1)	Goverment	Bandung Government Smart City Team	2
		Jakarta Government Smart City Team	4
2)	Business Player	Smart City Nusantara of Telkom Indonesia	5
		Telkomsel Smart Cities Research Group	2
3)	User	Smart Education users (Teachers, education administrators)	4
4)	Researcher	Smart city research group of Bandung Institute of Technology	4
		Researchers of Telkom University	1
		CitiAsia.Inc	1
		SmartCity Nusantara PT. Telekomunikasi Indonesia, Tbk	2
		IoT Implementation Expert of PT. Telekomunikasi Indonesia, Tbk	1
		TOTAL	26

4. Smart Education Criteria: Literature Review Result

Literature study is a search reference theory activity that is used in a research. Indrawati (2015) mentioned that literature study can be obtained from various reliable sources, such journals, proceedings, expert's opinions, stakeholder's opinions, and text book.

4.1 Smart Education Definition

Deloitte (2015) stated that the smart city is in combined with digital technology, disruptive innovation and urban environment and as a place to attracts new ideas. Smart Cities emerged as a result of many smarts solutions in all sectors, one of them is Smart Education. Smart Cities Council (2013) stated that "Advances in information and communications technologies (ICT) will transform the delivery of essential health, education and other human services in powerful ways – and smart cities will ride the wave to ensure a better life for their residents"

Based on literature study, some variables and indicators were found to define Smart Education, such as mentioned by several researchers and experts, as follows.

1) Bătăgan (2011) mentioned that Smart Systems is a real support to the city development that produces sustainable development in cities. To improved city's quality and performance, it is recommended to involve all parties concerned to implement the system efficiently. Using smart systems also improving the life quality of citizens in education, food consumption, and natural resources that considered limited.

Application of smart education system is: 1) data systems that collects, integrating, analysis and presenting information on main factors, such as presence criteria, knowledge, and judgment to transfer school; 2) clustering education – to involve all stakeholders in the preparation of future generation education; 3) using cloud computing at school, so students have access to connect, resource software, and various storage resources computing.

2) *Smart City Council (*2013) mentioned that service educational system includes in the domain of health and human services. Utilization of technology is expected to facilitate opportunity for all ages and levels to access educational features from public library to computer classes as well as the creation of labor training programme and higher education that supports the implementation of formal education in real world. By the spread of ICT, cities can revolutionize the relationship between students and teachers, as well as schools and learning activities.

3) Research by Frost & Sullivan (2014) with a title "Strategic Opportunity Analysis of the Global Smart City Market", mentioned that on the variables of smart education includes digital policy and services from the government that support the implementation of smart and green solution through incentives, subsidies, promotions, and others. Smart education includes eLearning services for schools, universities, enterprises, and government entities. Smart education in 2020 will have greatest business opportunities among 7 other dimensions of smart city which is 24.6% of market needs in smart city industry.

4) A Study by Deloitte (2015) with a title "Smart Cities - How Rapid Advances in Technology are Reshaping Our Economy and Society" mentioned that in the domain of smart education, possible education to be implemented in smart city is an education that support virtual learning, digital, augmented reality (AR) that changed the way students' learn. Education that equipped with rich data and analysis, will help teachers in adjusting their learning and counselling activities for the success of the students. The focus of teaching learning process have changed from digital content to learning the real-world experimental where most of the students, teachers and experts connected – the world open the way for learning.

5) Research done by Supangkat (2015) mentioned that technology used in the process and ICT products used to solve problems in education and learning activities in Indonesia. To formulate strategy for the utilization of optimal and proper learning technology, it is important to consider the existing condition. *Smart city* heavily supports utilization of technology for improving government performance and citizen welfare as well as cut off government spending. Smart city also produce technology and encourage communities, participation and business investment, in the field of education, smart city expected to be synergized with the education office at local government level.

6) Research of citiAsia. Inc. (2016) shows that development of digital technology has to be used for improving learning and education quality, starting from how to register to the school up to the teaching and learning process, evaluation of the students, as well as the use of technology in the form of applications and systems for managing. By developing smart school applications, school managements are becoming more efficient, starting from recording the attendance of the students and teachers until organizing school finance. The applications and systems was used as a tool to make academic evaluation, payments, and campus management more effective efficient, as well make the

process of education available for more people. The chance of giving education to everybody is possible. The education can be given not only for those who have financially and physically strength, but also for people who have limitations in term of economy and also physic, including for the disable. The concept in smart education in a smart city must ensure that education opportunity for disable group is similar with those people in public schools. The existence of digital technology as a part of smart education also provides opportunities to every local government to improve access to the community to acquire knowledge through the digital library or facilitate a knowledge exchange management for community.

4.2 Smart Education Variables and Indicators

Based on the literatures related to smart education, this study makes a table to summarize the smart education variables as shown in TABLE 2.

Table 2. Smart Education Variables Based on Literatures

No	Variable	Batagan (2011)	(2013)	Frost & Sullivan (2014)	Deloitte (2015)	Supangkat (2015)	CitiAsia (2016)
1	*Digitization of Education*	X	X		X		
2	*Adaptive learning & Counseling*				X		
3	*UnBundling of Education*				X		
4	*Personalization of education*				X		
5	*Life long Learning*				X		
6	*Corporate Universities*				X		
7	*Virtual Classrooms*	X	X	X			
8	*Computer-based Training*			X			
9	Infrastructur	X	X			X	X
10	Facilites: Hard and Software, HR		X			X	
11	*Sistem Paltform & Connection & Data Management*	X	X	X	X	X	
12	*Learning Tipe*		X				X

Based on Table 2, this study found six variables that should be used to measure smart education, namely: Digitalization of Education, Virtual Classroom, ICT Infrastructure, Facility, Connection & Data Management, and Learning Type. The six variables were chosen from references that have been reviewed in this study. These variables are chosen since the variables are mentioned by two or more references.

The indicators to measure each variables of smart education, based on the literatures are shown in TABLE 3.

Table 3. Smart Education Indicator from Literatures

No	Variable	Definition	Indicator	Reference
1	*Digitalization of Education,*	*Integration of applications for educational systems, to improve quality and performance in the field of education.*	*1) Data systems that collect, integrate, analyze and present information; 2) Education Cluster; 3) Using Cloud Computing*	Lorena Batagan (2011), Smart City Council (2013), Deloitte (2015)
2	*Virtual Classroom,*	*A Web-based learning environment that utilizes information and communication technologies especially social learning networks, for learning and classroom management that contain accessible and interchangeable digital content.*	*1) eLearning services for schools & universities; 2)Interoperability system.*	Lorena Batagan (2011), Smart City Council (2013), Frost & Sullivan (2014)
3	*ICT Infrastructure*	*How well the availability of ICT infrastructure has reached or been used by the community.*	*1) Fixed Broadband Availability (wireline), 2) Mobile Broadband Availability (wireless)*	Lorena Batagan (2011), Smart City Council (2013), Suhono Supangkat (2015), CitiAsia (2016)
4	*Facilities*	*Availability of Devices (Hardware& Software), Sensor, HR, and System Storage that support the application of smart education.*	*1) Implementation of Software & Hardware, 2) Integration of Sensor, 3) Teache* r, 4) *Using cloud computing.*	Smart City Council (2013), Suhono Supangkat (2015)
5	*Connection and Data Management*	*Data management, transparency, and rules in data exchange. Implemented access to comprehensive equipment such as cloud computing, innovation platform, and analytical systems.*	*1) Connect devices multi-service communications, 2) Implement a security framework, 3) Use an open innovation platform, 4) Pursue predictive analytics.*	Lorena Batagan (2011), Smart City Council (2013), Frost & Sullivan (2014), Deloitte (2015), Suhono Supangkat (2015)
6	*Access to Education Services,*	*Access to education services applied to support citizen competence.*	*1) the equality of the population in the education service, 2) % of students completing formal education*	Smart City Council (2013), Suhono Supangkat (2015), CitiAsia (2016)

5. Smart Education Indicators: Interview and FGD Result

The founded variables and indicators from existing literature used then was assessed through in-depth interview and focus group discussion (FGD) with prominent respondents, in order to make the variables and indicators fit with Indonesia's situation (Indrawati, Murugesan, Raman, 2010). The respondents are selected from government, business players, experts, and society. Based on the result of interview and FGD with 26 respondents, this study found that the variables to measure a smart education are as shown in TABLE 4 below.

Table 4. Smart Education Variables Based on Interview and FGD

Variable of Smart Education	*Percentage*
Digitalization of Education	88%
Virtual Classroom	72%
Infrastructure Availability	96%
Facility	84%
Connection and Data Management	88%
Learning Type	64%

Table 4 shows that majority of respondent agree with the proposed variables that resulted from literature study. The results shows that all variables are above the threshold value (more than 60%). It is therefore, in the implementation of smart education measurement, these variables should be used.

Based on the result of interview and FGD with 26 respondents, this study also found that the indicators of a smart education are as shown in Table 5.

Table 5. Smart Education Indicators Based on Interview and FGD

Smart Education Variables	Smart Education Indicators	Percentage
Digitalization of Education,	*Data systems that collect, integrate, analyze and present information*	92%
	Using Cloud Computing	84%
Virtual Classroom,	*Learning services for schools & universities*	76%
	Interoperability system	76%
Infrastructure Availability,	*Fixed Broadband Availability (wireline)*	84%
	Mobile Broadband Availability (wireless)	84%
Facility	*Implementation Software & Hardware*	84%
	Integration of Sensor	72%
	Number of teachers	72%
	Using cloud computing	72%
Connection and Data Management	*Connect devices multi-service communications*	80%
	Implement a security framework	64%
	Use an open Innovation platform	84%
	Pursue predictive analytic	68%
Learning Type	*Formal, Non-Formal, Inklusif (disable)*	72%
	% of students completing formal education	68%

From 17 indicators being assessed, there are 16 indicators above threshold value. Other indicators are under threshold value so we do not use it for the *proposed model* of this research. Result of this study is a *proposed model* for measuring smart education of a smart city.

6. Conclusion

Based on the results of in-depth interviews and FGD, among 60% - 92% of respondents agreed towards smart educational variables and indicators that proposed by this study. With the background of all respondents are experts in smart city, particularly in smart education, this study assumed, with the percentage of agree above 60% (> 60%) so the variables and indicators are valid for the implementation of smart education. Proposed model for measuring smart education variables and indicators is presented in the TABLE 6 below.

Table 6. Table Proposed Variables and Indicators to Measure Smart Education

Smart Education Variables	Smart Education Indicators
Digitalization of Education	*Data systems that collect, integrate, analyze and present information*
	Using Cloud Computing
Virtual Classroom	*Learning services for schools & universities*
	Interoperability system
ICT Infrastructure Availability	*Fixed Broadband Availability (wireline)*
	Mobile Broadband Availability (wireless)
Fasility	*Implementation Software & Hardware*
	Integration of Sensor
	Number of teachers
	Using cloud computing
Connection and Data Management	*Connect devices multi-service communications*
	Implement a security framework
	Use an open Innovation platform
	Pursue predictive analytic
Learning Type	*Formal, Non-Formal, Inklusif (disable)*
	% of students completing formal education

Based on the research results from Table 6, a diagram of proposed model for measuring smart education is presented below.

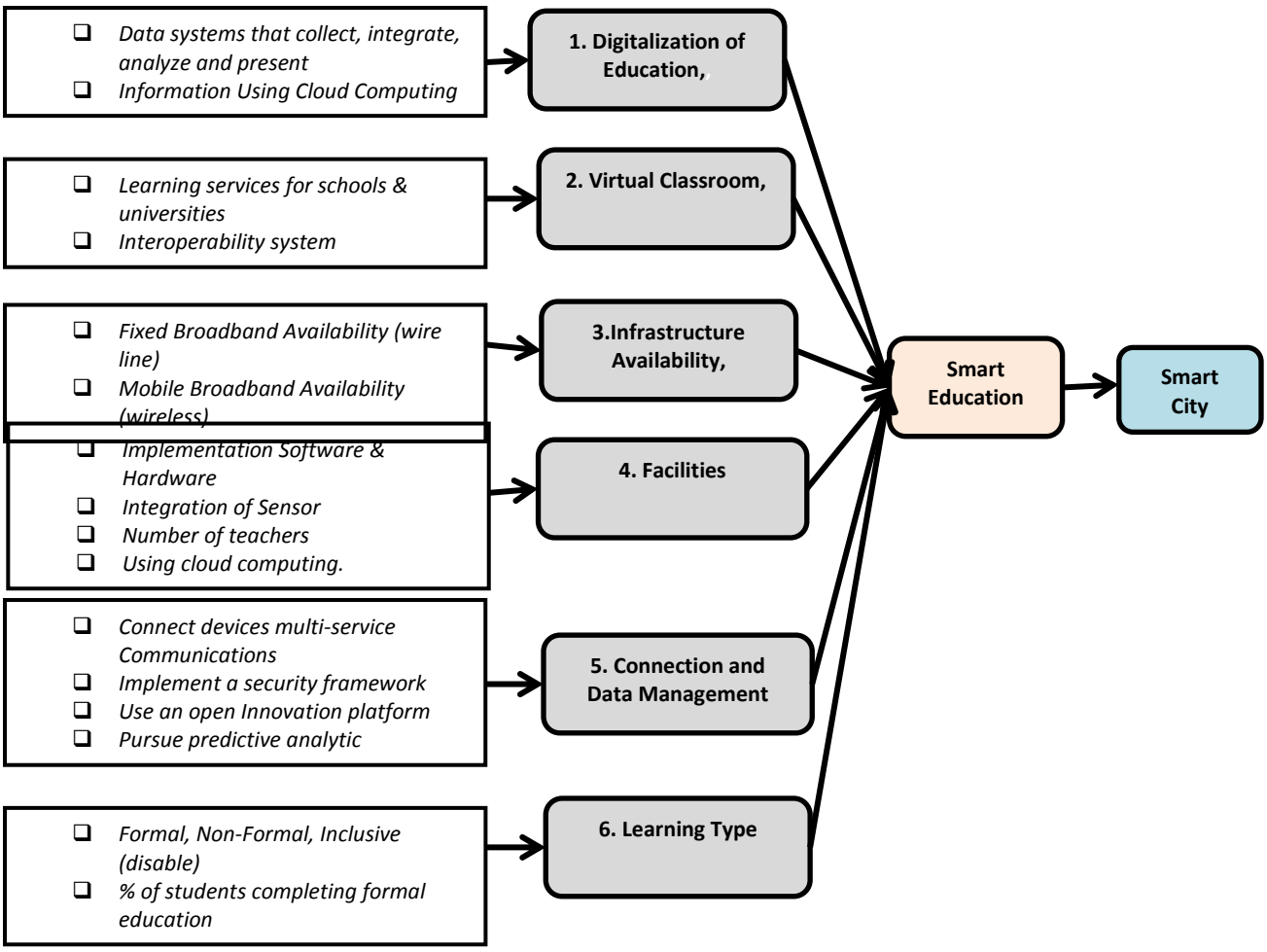

Figure 2. Proposed Model to Measure Smart Education

The next process that will be done by the writers are testing the variables and indicators through a pilot test. Once the measurement tool is valid and reliable, it will be used to collect main data to test if the proposed model can be applied to measure the level of smart Education implementation in Indonesia.

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Biography

Indrawati was born in Indonesia and received her master degrees from Padjadjaran University (UNPAD), Indonesia, majoring in Management. She received her Ph.D. in Faculty of Management, Multimedia University (MMU) Malaysia. Indrawati's research interests include Adoption of Services based on Technology, Competitive Intelligent, Innovation, New Product Development, New Product Acceptance, Creative Industry, , E-commerce, and Smart City. She has published more than 300 articles in newspaper, tabloid, magazines, national (in Indonesia) and international proceedings and journals, as well as books. Several of her articles have got awards in several events, such as: the eight best articles on the 4th International Conference on E-Commerce with Focus on Developing Countries (ECDC), Kuala Lumpur Malaysia on 3-4 November 2009, the best paper on Smart Collaborations for Business in Technology and Information Industries (SCBTII) Conference, Bandung Indonesia August 15th -16th 2016, and the best paper on International Seminar and Conference on Learning Organization (ISCLO) 2016, Bandung Indonesia, October 26th 2016.