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Identification of Smart Energy Indicators for Measuring Smart City : An Indonesian Perspective

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***Abstract**:*
Facing the big number of urban population, the city should implement smart city concept that can help urban citizen to improve their quality of life. A component of a smart city is smart energy. Implementing smart energy concept especially in Indonesia is important due to the urbanization rate is over the average of urbanisation in South Eastern Asia and Asia. This paper is a working paper discuss the variables and indicators of a smart energy coming from existing literatures, ideas from 21 respondents who are business players, experts, and customers' of smart energy in Indonesia. This study finds that there are eight variables and 24 indicators to measure if a energy services has implemented a smart energy concept.

***Keywords**: smart city, smart energy, urban, quality of life, and Indonesia*

1. Introduction

The population of the world is predicted to reach 9 billion, with the urban population to grow between 2.5 billion to 3 billion people in the next 30 years. A growing global population will increase energy demand by 56% in 2040 [i]. Urbanization in Indonesia made the problems of the city is more complex; congestion, flooding, waste, and carbon emissions are some of the problems caused by the impact of urbanization. Smart City is one of the solutions to manage the city to keep comfortable, safe, growing and sustainable. The planning, designing, implementing, and measuring the smart city concept is very important since it can impact positively on several aspects of city life such as how and where people live, fulfill their needs, wants, and demands as well as how people support their lifelong needs in a city. In the smart city concept, there are smart energy parameters that are considered able to handle the problems surrounding energy and environment faced by a city.

Some of the cities in Indonesia has already declared to start as a smart city, such as Bandung, Jakarta, and Surabaya. Bandung is considered as a smart city by Smart City Expo World Congress, the concept of Bandung Smart City has been launched by Ridwan Kamil, mayor of Bandung. Bandung has already made efforts to become a smart city and it had been nominated as the finalist world smart city award by world smart city organisation 2015 in Barcelona compete with six other city; Moscow, Dubai, Buenos Aires, Curitiba and Peterborough. These efforts have utilized a significant amount of money and energy. The efforts should be measured in order to improve it for a better result to achieve better city life.

There are a lot of definitions and concepts of a smart city. A smart city concept from Frost and Sullivan [ii] stated that a smart city is a city that is build on "Smart" and "Intelligent" solutions and technology. The smart city adoption according to Frost and Sullivan at least will lead 5 of the 8 smart parameters, namely: smart energy, smart building, smart mobility, smart healthcare, smart infrastructure, smart technology, smart governance and smart education, smart citizen.

This paper is a working paper discussed the indicators of a smart energy coming from existing literatures, ideas from business players, experts, and customers' of smart energy in Indonesia. The short term objective is to find out the indicators and the long term objective is to help the energy services in creating smart energy which will be adopted by citizen in smart cities in Indonesia as well as other cities in the world. The idea of choosing smart energy is the fact that Indonesia has energy consumption during 2000-2013 is still dominated by gasoline, diesel, kerosene, fuel oil, aviation fuel and avgas. During that period, total consumption of fuel in Indonesia increased from 315 million Oil Barrels in 2000 to 399 million Oil Barrels in 2013 or an average increase of 1.83% per year, while electricity consumption during the period of 2000-2013 experienced An average growth of 6.8% per year [iii]. The existences of energies are needed to accommodate the demand from the citizens. The numbers of population in cities are highly growth, due to the birth rate and urbanization. Especially in Indonesia, the urbanization is the 58% in 2016 and it is over the average of urbanisation in South Eastern Asia and Asia. The population in urban is growing sharply while the population in rural areas decrease [iv].

To ensure smart energy future, cities and utilities must work together - regardless of whether the utility is part of local government or a private investor- owned utility that supplies the city's energy, as written in a Smart Citie Council [v] Cities can't function without energy. It fuels our cars, subways and trains. It cools, heats and lights our homes and businesses. It pumps our water and processes the food we eat. And it powers the technologies that are the foundation of a smart city. [v]. If there is no effort to save the energy, in the near future the availability of energy will become a big problem. The existences of energy consumption not only affect to decrease of energy but also affect the gas emitters which reach 21% gas emission.

2. Research Objectives and Questions

The negative effects of energy consumption should be eliminated wisely; the energy services should be built and managed in a smart way. The services of energy should be smart energies. In order to be able to build smart energies, it is important to identify the indicators of smart energies.

As far as this study doing literature reviews, this study cannot find any convincing indicators to be used for measuring a smart energy directly, especially the one fit with Indonesian characteristics. Citizen's characteristics, social and economic back ground of Indonesia have quite different from other countries. A model or indicators which can be implemented in a country might not be able to be directly implemented well in other countries [vi]. Therefore, the objectives of this study are to find out the variables, indicators, and items which fit to be used for measuring smart energy in Indonesia. In line with the objectives the research questions that want to be answered are: a) Based on the literature result, what are the variables and indicators to measure a smart energy in Indonesia?, b) Based on interview and FGD result, what are the variables and indicators to measure a smart energy in Indonesia?, and c) What items that can be used to measure a smart energy in Indonesia?

3. Research Methodology

In order to achieved the research objectives and answer the research questions, this study applies two steps in identifying the indicators of smart energy, first step is literature review and second step is focus group discussion (FGD) and depth interview. In doing the first step, literature review, this study use primary literature such as articles from journals and conferences proceedings which are available on line in the internet and modern electronic search engines, as well as electronic data bases available in Telkom University campus and other facilities connected to Telkom University campus as suggested by Zikmund, Babin, Carr, and Griffin [vii], Indrawati [viii]. Besides primary literature, this study also uses secondary literature such as books, review articles, indexes and abstracts, and also uses tertiary literature, such as encyclopaedias and dictionaries.

The process of literature review was done by reading all related literatures with the object of this study, compare one literature to others to find out the similarities, contrast one literature to others to find out the differences, criticize the literature to give view and synthesize the literature to compare one to others and finally summarize what the literatures say about indicators of smart energies.

The second step which is done in this study is FGD and interview. FGD was done following the idea of Zikmund, Babin, Carr, and Griffin [vii] who stated that FGD are a very important qualitative research technique and deserve considerable discussion. Through FGD, people are more willing to talk about things when they are able to do so within a group discussion format rather than individual interview. By applying FGD, respondents could feed on each other's comments to develop ideas which might be difficult to express in a different interview format. Therefore, by applying this FGD format, it is hoped that the ideas are more developed and comprehensive. When the targeted respondents are not available for FGD, this study used individual depth interview. Zikmund, Babin, Carr, and Griffin [vii] stated that depth interview is an alternative to an FGD. It is a one-on-one interview between a professional researcher and a research respondent.

The steps of FGD is done through 3 steps following the one already done by World Health Organization—WHO [ix], first deciding participants of FGD by finding the ultimate people from governments, experts, practitioners, and customers or prospective customers of smart energy. Each group is separated in different FGD. Second is to decide and explain the objectives of the current FGD, namely to find out variables and indicators of a smart energy in Indonesia. Third is the suggestions or ideas of a smart energy from the FGD are transcribed and grouped into variables and indicators. Based on the variables and indicators found, a checklist to measure a smart energy was developed. The checklist is a faithful summary of the views expressed by the focus group participants. The checklist is intended to provide a universal standard for a smart energy.

In doing depths interviews, the researchers ask many questions and follow up each answer with probes for additional elaboration. An open ended interview format used to ensure that the information obtained would be related to the objectives on the study. Open-ended questions were prepared and were given to the respondents. The interviewers adusted the sequence of the questions given and added questions based on the responses of the respondents, during the interview the researchers recorded the interview and transcribe edit after the interview finished [x].

To enhance confidence of the information, this study applied both data and investigator triangulation, the data triangulation is done through involving different sources of information and investigator triangulation is done through involving more than one data collectors [viii]. During the interview, this study applied at least two interviewers who make research notes and put the codes on every meaningful statement of interviewees. The interviewers check the interpretation against the interviewees and peer interviewer to reduce bias of a single interviewer and for confirmation of the collected textual data.

The respondents for both FGD and depth interview were selected from 3 different positions, namely from government, business players/ customers or prospective of smart energy, and experts, 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 [xi]. Snowball sampling allows the researcher to generate a larger sample by asking participants to identify their colleagues. Table 1 shows the respondents of this research.

Category	Organizations or Institutions of Respondents	Number
Government	Bandung Government Smart City Team	2
	Jakarta Government Smart City Team	4
	Researcher Chief of Bandung Environment Department	1
Business Player	Smart City Nusantara of Telkom Indonesia	5
	Q-free Indonesia	1
	Telkomsel Smart Cities Group	2
Researchers/ Observers/ Experts	Smart city research group of Bandung Institute of Technology	4
	Lecturers of Telkom University	1
	CitiAsia.Inc	1
Total		21

Table 1: List of Respondent

The collected textual data were processed and analysed following the six steps of analysing textual data from Cresswell [x], namely organizing and prepare the data for analysis, read through all the data, detailed analysis with textual data coding process and segments the text, use the coding process to generate a description of the setting or people as well as categories or themes for analysis, advance how the descriptive and themes are represented in the qualitative narrative and in this research are also in descriptive percentage, and the last step is making interpretation of the data.

In the interpretation of data process also include comparison the meaning of findings from analysing textual data with the information derived from literature or theories reviewed. Through this step this study could conclude that the findings confirm the past information or diverge, and since these qualitative researchers use a theoretical lens, the researchers can form interpretations that call for action agendas for reform or develop a model or achieve innovation of conceptual frameworks [xii].

4. Smart Energy Criteria: Literature Review Result

The literature review that has been done started with finding of the definitions of smart energy and followed by exploring the variable as well as the indicators of smart energy.

4.1. Smart Energy Definition

There are various definitions of smart energy depends upon the point of view of people who define it. The following is a definition of smart energy city of Transform, Technical University of Denmark as written by Per Sieverts Nielsen, Sara Ben Amer, and

Kirsten Halsnæs [xiii] that “smart energy city It describes at the same time the current status of city planning, energy planning tools, and existing energy data.”. Technical University of Denmark also stated that a smart energy city starts with a clear outline of each of the participating cities. The work describes the context in terms of climate, energy assets, ambitions, targets and main possibilities in terms of energy efficiency, flows and energy production.

The second definition of smart energy comes from Frost & Sullivan [ii] that “Smart energy uses digital technology through advanced meter infrastructure (AMI), distribution grid management, and high-voltage transmission systems, as well as for demand response for the intelligent and integrated transmission and distribution of power”.

Third definition come from Alex Palamari, Robert J.Monson, Anton Beck [xiv], they stated that a *smart energy management system* is (SEMS) will focus on the process of development of a system that brings together modern day technology to reduce and eliminate consumer dependence on conventional electrical grid and energy sources.

Addressing energy efficiency means managing the future lifestyle of citizens. In fact, if we look at the impact of technologies related to smart energy systems, it is clear that we are not merely integrating various technological innovation building blocks into the existing systems. From a technological point of view, the main expected challenges are related to ICT are the following: i) technology has to become as transparent as possible to the end users; ii) the dissemination of new technology should be driven not only by industry but also by local and central governments; and iii) the adoption of new technology must be driven by big players, engaging on the front of service innovation, both Small and Medium Enterprises (SME) and start-up.” [xv].

However there is an overall consensus smart energy regarding their usefulness from Pèrez-Arriaga as cited by Cèdric Clastres [xvi]: i) Integrating consumers as active players in the electricity system; savings, achieved by reducing peaks in demand and improving energy efficiency, are one of the ways of reaching the appointed goals, particularly for cutting green house gas emissions. ii) Integrating renewables and energy storage in electricity networks, while optimizing their use and contribution to system services and whole sale markets. iii) Promoting innovation, new energy products and services related to load handling. iv) Enhancing the quality of energy supplied to end users (fewer outages). v) Optimizing the use of new or less recent electrical assets. vi) Anticipating outages, with the necessary upgrading or maintenance of self-adapting networks. vii) Developing information networks, data storage and management, and regulations governing access by the various players (ethics, data confidentiality). [xvi]

Based on the definitions of a smart energy above, a smart energy should be able to control energy resources such as : energy assets, energy production, energy targets, flows of energy, integrating with renewable resources, and main possibilities in terms of energy efficiency with minimum human interference therefore it should be integrated with technological and renewable systems to lowering both cost and energy usage.

4.2. Smart Energy Variables and Indicators

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

Variables/ Sources	City Asia (2016)	Frost & Sullivan (2014)	Paolo Neirotti, et al. (2014)	Gianni andreottola et.al. (2014)	Schneider Electric (2014)	Smart City Council (2013)	Nielsen, et al. (2013)	Cèdric Clastress (2011)	Gabriella Cattaneo (2010)
Active users	√			√		√	√	√	
Access to Energy Services	√			√	√	√	√	√	
Advanced Distribution Management Systems	√	√	√	√	√	√	√	√	√
Data Management	√			√	√	√			
Energy efficiency	√	√		√	√	√	√	√	
Renewable Integration and Management	√	√	√	√	√		√		√
Resilience							√		
Security & Privacy Management System	√			√		√		√	

Table 2: Smart Energy Variabels From The Literature

TABLE 2 shows that according to Frost & Sullivan [ii], the variabels of a Smart energy are advanced distribution management systems, energy efficiency, renewable integration and management. The second literature comes from Gabriella Cattaneo [xvii] which stated that a smart energy have variabel advanced distribution management systems, and renewable integrationand management. The third literature comes from Paolo Neirotti, et al. [xviii] who wrote that the variabels of smart energy are advanced distribution management systems and renewable integration and management. The fourth literature came from City Asia.inc [xix] who wrote that the variabels of smart energy are active users, access to energy services, advanced distribution management systems, data management, energy efficiency, renewable integration and management, security and privacy management systems.

The fifth literature came from Gianni andreottola, et al. [xv] which indicates : users will turn into prosumers and be capable of producing energy on their own, reduced cost and pollution impact, new public lighting with lower ecological impact will be available as pervasive infrastructure for ICT services, smart grids, smart buildings, smart lightning, waste water management. The sixth literature [v] came from Smart Cities Council which stated that there are 7 variabels of a smart energy, namely: instrumentation & control, connectivity, interoperability, secutity & privacy, data management, computing resources, analytics. The seventh literature came from Nielsen, et.al. [xiii] which stated that smart energy variables are resource system integration, access to energy services, resilience, energy efficiency, renewable energy, active user, sustainable economy, and smart governance.

The eight literature came from Ce'deric Clastress [xvi] which stated that smart energy variables are : self-healing from power disturbance events; enabling active participation by consumers in demand response; operating resiliently against physical and cyber attack; providing power quality for 21st century needs; accommodating all generation and storage options; enabling new products, services, and markets; optimizing assets and operating efficiently. The ninth literature comes from Anil Kadam – Schneider Electric [xx] who wrote that the variables of smart energy are flexible distribution, metering management & demand response, advanced distribution management systems, renewable integration and management, and asset management.

Based on those ninth literatures, the indicators of each variables of a smart energy are shown in TABLE 3.

Variables	Definition	Indicators
Active users	Active citizen participation and awareness about smart energy vision of the city	Awareness of the city's Smart energy vision
		Formal& informal hubs and innovation centers
		Self-sufficiency by users
		Engagement from users
		Investment
Access to Energy Services	Citizen access to energy services	Access to affordable energy services
		Level of energy services provided
Advanced Distribution Management Systems	Comprehensive network management solution with monitoring, analysis, control, optimization, planning and training tools that all function on a common representation of the entire electric distribution network	Integrated energy planning
		Development of ICT use (smart meter, public wifis)
		Use of ICT tools in city planning and management. (control room, monitoring room)
		Flexibility and transparency of service providers
		Waste (integration with resource systems)
		Transportation (integration with energy systems)
Data Management	Citywide data management, transparency and sharing policy, access to comprehensive device management (GIS, cloud, innovation platform), analytics.	Consider a cloud computing framework
		Use an open innovation platform
		Have access to a central GIS
		Achieve operational optimization
		Pursue predictive analytics
Energy efficiency	Using less energy for equivalent performance or service and Increasing efficiency in the supply system.	Reduction of energy use
		Increasing end-use energy efficiency
Renewable Integration and Management	Integration of renewable energy availability to become an energy portfolio of commercial, industrial or other types of organizations.	Production of electricity and heat from RES
		Level of Investment in developing RES
		GHG emissions caused by energy & transportation
Resilience	Ability to respond to challenges such as rising energy costs, security of supply and the need to reduce carbon emissions.	Self-sufficiency distributed generation
		Energy price shock
		Availability and prevalence of green jobs in the city
Security & Privacy Management System	Developing a comprehensive security framework mitigates risk by identifying and addressing threats before they can cause damage	Publish privacy rules
		Create a security framework
		Implement cybersecurity

Table 3: Variables And Indicators Based From Literature View

5. Smart Energy Criteria: Based on Interview & FGD Result

In order to make the variables and indicators of a smart energy fit with Indonesia's situation, this study finds out the variables and indicators from Indonesia's government, business players, and experts. Based on the result of interview and FGD with 21 respondents, this study found that the variables of a smart energy are as shown in TABLE 4 below.

Variables	% of Respondents Agree
Active users	88%
Access to Energy Services	94%
Advanced Distribution Management Systems	88%
Data Management	94%
Energy Efficiency	88%
Renewable Integration and Management	82%
Resilience	76%
Security & Privacy Management System	82%

Table 4: Smart Energy Variables Based on Interview and FGD

TABLE 4 shows that 94% of respondents agree that Access to Energy Services and Data Management as variables of a smart energy. 88% of respondents agree that Active users, Advanced Distribution Management Systems, Energy Efficiency as varieble of a smart energy, and 82% of respondents agree that Renewable Integration and Management, and Security & Privacy Management System as variable of a smart energy. And 76% of respondents agree that Resilience as one as variable of smart energy.

Based on the result of interview and FGD with 21 respondents, this study found that the indicators of a smart energy are as shown in TABLE 5.

Variables	Indicators	% of Respondents Agree
Active users	Awareness of the smart energy vision	82%
	Self-suffiency by user	65%
	Investment	82%
Access to Energy Services	Affordable energy services	88%
	Level of energy services provided	71%
Advanced Distribution Management Systems	Development of ICT use	94%
	Use of ICT tools in city planning and management,	94%
	Integrated energy planning,	94%
	Transportation (integration with energy systems).	71%
	Waste (integration with resource systems)	88%
Data Management	Consider a cloud computing framework,	88%
	Use an open innovation platform,	94%
	Have access to a central GIS,	76%
	Achieve operational optimization,	94%
	Pursue predictive analytics	88%
Energy Efficiency	Reduction of energy use,	88%
	Increasing end use energy efficiency.	82%
Renewable Integration and Management	Production of electricity and heat from RES,	88%
	Investment in developing RES.	82%
	GHG emissions caused by energy production & transportation	65%
Resilience	Self sufficiency distributed generation,	88%
	Energy Prices Regulated	65%
Security & Privacy Management System	Security framework.	82%
	Implement cybersecurity	59%

Table 5: Smart Energy Indicators Based on Interview and FGD

6. Conclusion

Referring to the literature review results and interview and FGD result, this study find that both of results suggests the same eight variables, but in term of indicators the findings is a bit different since based on interview and FDG result the indicator of Waste Water Management should be added to Renewable Integration and Management variables, Amount of availability of startup company indicator should be added to Access to Energy Services.

Therefore, model for measuring smart energy in Indonesia is presented in Figure 1.

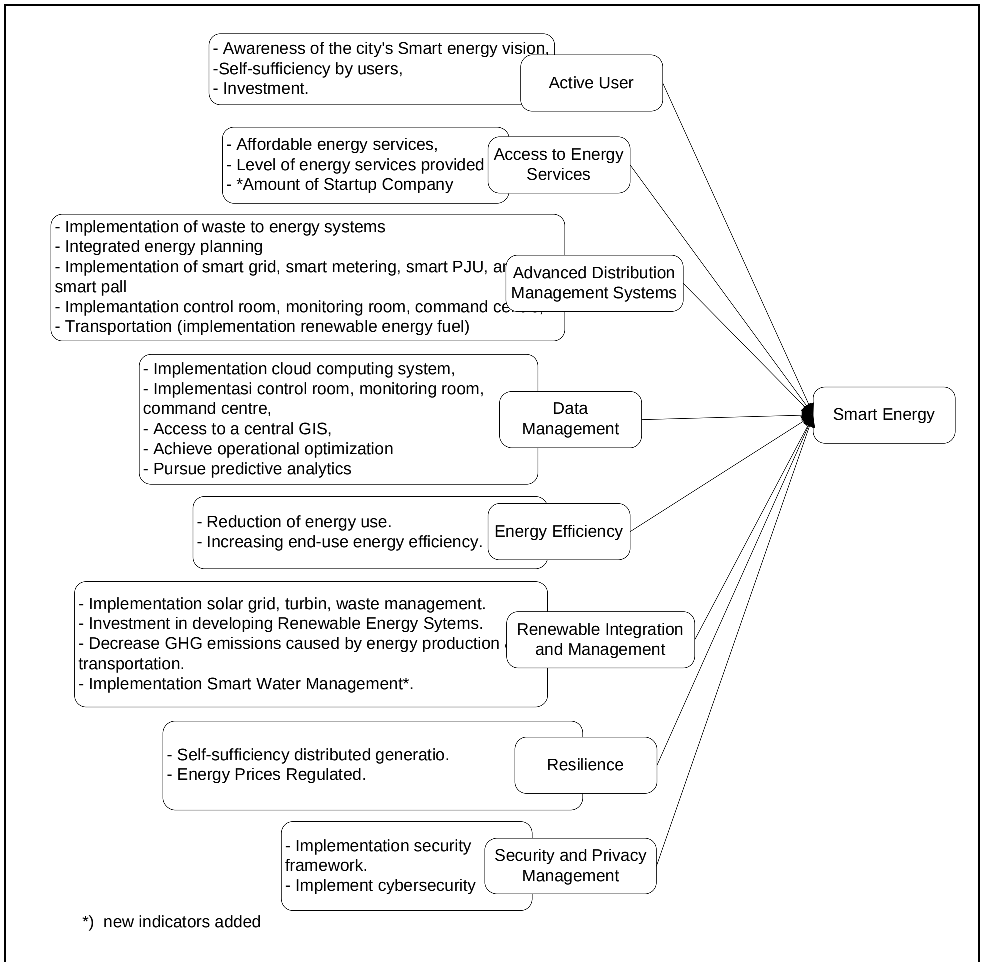

Figure 1: Proposed Model to Measure Smart Energy in Indonesia

The next process that will be done by the writers are testing the variables and items 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 energy implementation in Indonesia.

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