Smart Water Readiness Index: A Bandung City Perspective

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Abstract- City management in the future, of course, will be increasingly complex due to the rate of population growth, urbanization, the limited number of natural resources, and other factors. One solution to deal with this problem is the application of the smart city concept, namely a city development model that has high effectiveness and efficiency functions with the support of technological developments. Smart city consists of many dimensions, one of which smart water, which is mostly initiated by cities including the city of Bandung. The purpose of this research is to confirm the model and get the index value of smart water readiness in the city of Bandung. The water cycle (raw water resources, production, distribution, consumption of clean water and waste water collection and treatment) plays an integral part of the urban system, which affects every pillar of urban society and its functions, produces energy ,supports tourism ,ensures the realization of environmental health and humans, and ultimately can trigger the development of the local economy (ITU-T, Smart Water In Cities,2014).Indirectly increasing convergence such as encouraging urban growth.[1]

According to its population, Bandung ranks fourth in metropolitan cities the largest in Indonesia and the first in West Java. Based on data from the City Statistics Agency Bandung (bandungkota.bps.go.id) Bandung city has an area of 167.31 km² with a population of 2.47 million people, a density of 15,713 people / km² [2]. this population density certainly raises the problem as well as the opportunity of structuring the city. This is demanding Bandung city government to make development efforts and urban development smarter way.

This research is a mix method research, namely explorative research in the form of data retrieval using analytic data and descriptive research through data search to obtain an index. Descriptive data collection was carried out by searching for best practice data and secondary data which were confirmed through interviews with informants. This resources person was chosen to use the quadruple helix concept: government, business player, researches/expertise in the field of smart water and water service users. Analytical data carried out relates to indicators that have the highest and lowest levels, with the aim of comparing data taken broadly with selected data taken. This research found the index of readiness of smart water in the city of Bandung is number 51,05, where this value indicates that the level of readiness of smart water in Bandung City is bad, there are still many short comings. The highest index obtained is water quality and the lowest index, which is dam protection.

Index Terms- Smart city, Smart Water, Water Cycle, Index.

I. Introduction

According to its population, Bandung ranks fourth in metropolitan cities the largest in Indonesia and the first in West Java. Based on data from the City Statistics Agency Bandung (bandungkota.bps.go.id) Bandung city has an area of 167.31 km² with a population of 2.47 million people, a density of 15,713 people / km². this population density certainly raises the problem as well as the opportunity of structuring the city. This is demanding Bandung city government to make development efforts and urban development smarter way**.**

Bandung as one of the major cities in Indonesia, initiated the concept of smart cities management. There are ten priority areas that applied to the Smart City of Bandung: governance, education, transportation, energy, health, environment, security, society, finance, and trading [3]. Smart water is a dimension of smart city.

Water cycle (raw water resources, production, distribution, consumption of clean water as well wastewater collection and treatment) plays an integral part of the urban system,, which is affect every pillar of urban society and its functions, produce energy, support tourism, ensure the realization of environmental and human health, and finally can trigger local economic development (ITU-T, Smart Water in Cities, 2014) indirectly increases convergence as it encourages urban growth. According to The United National 54% of the world's population currently lives in urban areas. It is estimated that the population urban areas will increase from 3.6 billion in 2011, to 6.3 billion in 2050, where 90% increase in population concentrated in Asia and Africa (World Urbanization Prospects: The 2014 Revision, Highlights). ITU-T, Smart Water,2014,notes there are 4 risks that will arise, namely: the risk of shortages (including drought),the risk of water inadequate risks of overload (including flooding) and the risk of damaging system resilience water. To address these risks the water management authority must focus on:[4]

1. Raw water management : the diversion of raw water needed to facilitate maintenance and distribution of the population of this city.
2. Manage water supply: availability of water needs for various sectors in urban environments, including residential, commercial and industrial.

3. Drainage management: provision of urban drainage through pipelines is important to maintain public health and prevent flooding.
4. Waste water treatment: the provision of wastewater treatment is needed to ensure environmental protection.

II. RESEARCH OBJECTIVES AND QUESTION

Objective this research is to measuring readiness index smart water in Bandung fulfillment of requests for adequate water supply and sanitation is one of the challenges faced urban government in this case the city of Bandung. The research questions of this study are as follows:

1. How does the secondary data from best practices related to variables and indicators to measure Bandung smart water readiness index?
2. How does the secondary data from Bandung related to variables and indicators to measure Bandung smart water readiness index?
3. In accordance to the experience, feeling, and insight of respondents, as well as based on secondary data of Bandung and best practices, how much are the values of variables and indicators to measure Bandung smart water readiness index?
4. Based on the index in point 3. how is the level of readiness of Bandung related implementation of smart water?
5. Based on the index ranks obtained, how the results of the comparison of analytic data with the assessment of smart water index?
6. What can be done by stakeholders of Bandung in order to implementing the city of Bandung as a smart city in terms of smart water variables?.

III. THEORITICAL FOUNDATIONS

Smart Water can be characterized as a system with "automation",, fast response times or the ability to capture information in real-time, the ability to transmit data between locations and data processing facilities, and for data to be interpreted and presented to utilities and end users (OECD, 2012). Smart water combines both innovation, ICT and water management (non-technology). With Smart Water Management (SWM) can monitor water resources, diagnose problems, improve efficiency and accelerate coordination to provide sustainable water supply (ITU, 2014 ; Heland et al., 2015) can be illustrated as shown in Fig 1.[5]

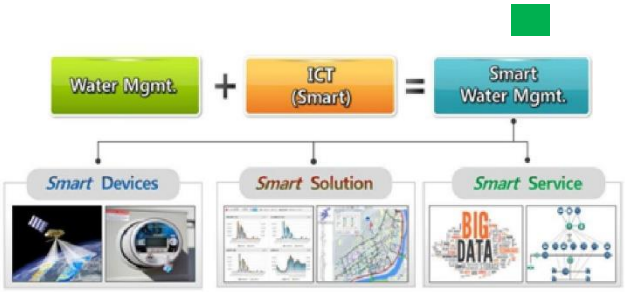

Figure 1 : The Concept of Smart Water Management According to ITU 2014 & Heland, et al. 2015

SWM (Smart Water Management) is a future-oriented water management strategy capable of integrating and managing the entire process of the water cycle from the analysis of the current situation for purification, distribution, and the use and recycling of water resources in a scientific and systematic manner.

There are two main points that are the priority of developers who run the smart water concept:

1. Smart Water Distribution Management.

SWDM (Smart Water Distribution Management) is an infrastructure created to manage all the head water distribution of all urban residents in accordance with their individual needs.

2. Smart Water Management System

SWMS (Smart Water Management System) is a system created to measure and regulate all water distribution automatically using software/hardware and the internet. This system will attach data to facilitate the government in analyzing and managing data as part and actions in disaster management such as flood or drought.

From several definitions regarding smart water, it can be concluded that smart water is a water service that is assisted by information and communication technology and policies that support better service.

IV. RESEARCH METHODOLOGY

This research was conducted with a mixed method approach. Mixed method involves combining or integration of qualitative and quantitative research and data in a research study [6] . Qualitatively, this research was conducted to explore so that an understanding of knowledge or phenomena or symptom can be obtained more clearly in order to determine the variables and indicators that can be used to assess the readiness of smart water in Bandung City. Quantitatively, this research measures the value of smart water readiness by using variables and indicators according to the model used. With these measurements, it is expected that this study can describe the characteristics of the implementation of smart water in Bandung City. Briefly the characteristics of this study can be seen in Table 1.

Tabel 1.Research Characteristic

No	Characteristics	Type
1	Method	Mix Method
2	Purpose	Exploration –description
3	Type of investigation	Ethnographic
4	Involvement of researchers	Not intervening in data
5	Unit of analysis	Individual
6	Time	Cross Sectional

So this research that being used in this research is mix method, an explorative research through data retrieval using descriptive research and data analytic in finding data related to readiness index.

Whereas to achieve its objectives, this research was carried out in stages such as in Figure 2.

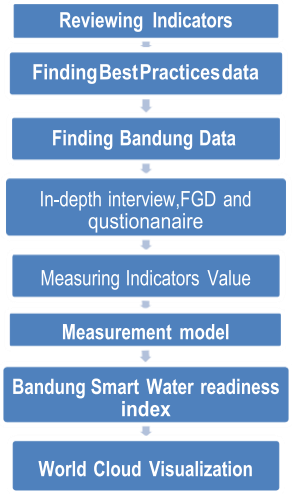

Fig 2: Reseacrch Stages

Based on Figure 2, the stages of this research are as follows:

1. Reviewing the smart water readiness indicators produced in the study.[7]
2. Search for best practice data on the application of smart water in other cities, in this case Singapore, Netherlands, Taiwan and Korea. Best practice data is obtained from journal articles, Singapore government websites, Taiwan government website, Korea government website and Netherlands websites company websites that have links to smart water , news portal websites and others.

In Singapore there is an organization that deals specifically with environmental issues, namely the NEA (National Environment Agency). And to deal with water issues, there is also an organization which is responsible, namely PUB (Public Utilities Board). PUB (Public Utilities Board) deals with everything related to water supply, from piping, drainage to the water recycling process. Water resources in Singapore are limited. Water resources in Singapore are divided into 4 types namely rainwater, imported water from Johor Bahru, desalination or seawater refining and NEWater. Singapore also conducts research to treat dirty water into clean and drinkable water.[8]

3. Search for data on the application of smart water in Bandung by collecting documents and interviewing parties related to smart water.
4. Conducting interviews, FGDs and distributing questionnaires to obtain opinions and values from the speakers regarding all indicators in the model used, based on the process of comparing best practice data with Bandung data and what they feel or know.
5. Calculate the value of each indicator based on the value that has been delivery by the respondents.
6. Validity testing, carried out for each indicator on the model used, with the aim to test whether the model used can really be used to measure the index of readiness for smart water or not.
7. Calculating the value of smart water readiness in Bandung City based on valid indicators.
8. To get an overview of people's perceptions of smart water programs in Bandung City, represented as word clouds, that is, collections of words organized in space-optimized compact layouts in which font size encodes the frequency (or other relevance) value . [9]

Population determination in this study used the Quadruple Helix model approach.According to [10], the quadruple Helix model is a collaborative model of innovation environment where users, companies, universities and public authorities work together to produce innovation. This innovation can be anything that is considered useful for partners in innovation cooperation. Meanwhile, the respondents of this research are show in Table 2:

Table 2.Lists Of Respondets

No:	Category	Respondent	QTY
1.	**Government**	**Departement of communicatios and informatic Bandung,Regional Water Suplly Company Bandung(PDAM Tirta Wening),River Public Works Citarum,Depart ment of enviroment**	**14**
2.	**Business Player**	**Team smart city PT.Indosat ,Tbk,Team smart city PT.Lintasarta,Tbk,,Private drinking water process**	**4**
3.	**Expert/Researcher/Observers**	**Expert from water industry,lecture**	**5**

		from Telkom University,Telkom smart city,lecture from Bandung Institute of Technology	
4.	**Users**	**College student,user from indusrty home,clean water users in the city of Bandung,employee and haouse wife**	**7**

V. SMART WATER MODEL

Based on previous study that was conducted ,smart water model can be summarized as show in figure 3:

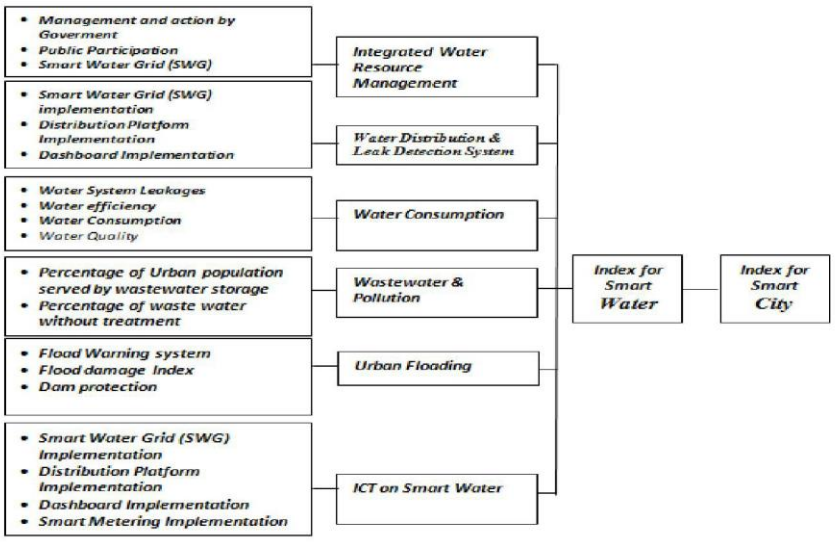

Figure 3 : Smart Water Model

Based on the frame work, there are 6 research variables that will be confirmed to the respondents, where each variable is basically sourced from theories, references, as well as previous research. Table 3 presents operasional variables obtained from literature studies related to the concept of smart water.

Table 3.*Operasionalisasi Variabel*

Variabel/Dimensi	Indikator	Sumber
Integrated Water Resource Management	*Management and action by government; Public participation; Smart Water Grid (SWG)*	van Leeuwen et al. (2012), Smartcities Council, (2013), Gye Woon et al, (2014), ISO 37120:2014, Hyun Dong
Water Distibution & Leak Detection System	*Smart Water Grid (SWG) Implementation; Distribution Platform Implementation; Dashboard*	van Leeuwen et al. (2012), Smartcities Council, (2013), Gye Woon et al, (2014), Hyun
Water Consumption	*Information of Sufficient water to drink Implementation; Water system leakages; Water efficiency; Water Consumption; Water Quality.*	van Leeuwen et al. (2012), Smartcities Council, (2013), Gye Woon et al, (2014), ISO 37120:2014, Hyun Dong (2014), Seung Won et al.
Wastewater & Pollution	*Percentage of urban population served by wastewater storage; Percentage of waste water without treatment; Percentage of waste water with primary treatment; Percentage of waste water with secondary treatment;*	van Leeuwen et al. (2012), Smartcities Council, (2013), ISO 37120:2014
Urban flooding	*River improvement; Emergency Action Plan (EAP) rate; Emergency outlet; Flood warning system; Flood damage index; Dam protection;*	van Leeuwen et al. (2012), Smartcities Council, (2013), Gye Woon et al, (2014)
ICT Implementation	*Implementation Smart Water Grid (SWG); Implementation Distribution Platform, Implementation Dashboard,*	Smartcities Council, (2013), Gye Woon et al, (2014),Hyun Dong (2014), Seung Won et al.

VI. SMART WATER READINESS INDEX RESULT

To measure readiness index, secondary data from best practices and Bandung are prepared first. Secondary data is to used to provide information from respondents during the assessment process. Secondary data are taken from the results of literature reviews such stakeholder service report on the implementation of smart water in the city Bandung, newspapers, and information from the official website of the city government.

The measurement of the smart water readiness index in this research was conducted by collecting and calculating the value given by each speaker. Based on the results of interviews, FGDs and questionnaires distributed 31 respondents, the readiness index for smart water in Bandung City can be seen in table 4.

Table 4.Bandung Smart Water Readiness Index Result

Variabel	Indicator	R value	r tabel value	Validity
Integrated Water Resource Management	IRW1	0,524	0,361	Valid
	IRW2	0,800	0,361	Valid
	IRW3	0,929	0,361	Valid
Water Distribution & Leak Detection System	WD1	0,933	0,361	Valid
	WD2	0,715	0,361	Valid
	WD3	0,914	0,361	Valid
Water Consumption	Cons1	0,815	0,361	Valid
	Cons2	0,577	0,361	Valid
	Cons3	0,317	0,361	No Valid
	Cons4	0,826	0,361	Valid
Wastewater & Pollution	WP1	0,218	0,361	No Valid
	WP2	0,804	0,361	Valid
Urban Floading	UF1	0,746	0,361	Valid
	UF2	0,846	0,361	Valid
	UF3	0,441	0,361	Valid
ICT On Smart Water	ICT1	0,963	0,361	Valid
	ICT2	0,824	0,361	Valid
	ICT3	0,963	0,361	Valid
	ICT4	0,932	0,61	Valid

Table 5: Bandung Smart Water Readiness Index Result

Kariabel	Indicator	Index	Kategori
IWR1	Management and action by Goverment	62,63	Very Bad
IWR2	Public Participation	58,83	Very Bad
IWR3	Smart Water Grid (SWG) Implementation	49,65	Very Bad
WD1	Smart Water Grid (SWG) Implementation	50,18	Very Bad
WD2	Distribution Platform Implementation	50,98	Very Bad
WD3	Dashboard Implementation	48,54	Very Bad
Cons 1	Water System Leakages	52,89	Very Bad
Cons2	Water Efficiency	56,06	Bad
Cons3	Water Consumption	61,08	Bad
Cons4	Water Quality	63,98	Bad
WP1	Percentage of Urban Population Served by wastewater strotage	61,05	Bad
WP2	Percentage of waste water without treatment	55,65	Very Bad
UF1	Flood warning system	56,24	Very Bad
UF2	Flood damage Index	51,23	Very Bad
UF3	Dam Protection	43,76	Very Bad
ICT1	Smart Water Grid (SWG) Implementation	50,08	Very Bad
ICT2	Distribution Platform Implementation	50,33	Very Bad
ICT3	Dashboard Platform Implementation	48,40	Very Bad
ICT4	Smart Metering Implementation	48,80	Very Bad
Indeks		51,05	Very Bad

Based on Table 5.The index of readiness for smart water in Bandung City is 51,05 or in other words the readiness of smart water in Bandung is very bad. Smart water in Bandung needs improvement in the future so that the city of Bandung can be at the same level as the City of Singapore.

Citizens of Bandung city has been active in social media to simplify the line of communication with the community. Therefore, this research also performing World cloud illustration to find out the public perception of Bandung City related to smart water with utilizing data on social media Twitter that can be seen in Fig.4

Fig 4: Word Cloud Illustation

VII. CONCLUSION

The following are conclusion from the results of the research that has been done:

Smart water secondary best practice data in Singapore, Taiwan, Korea, Netherlands was obtained from journal articles, Singapore, Taiwan, Korea and Netherlands government website, company website that has links to smart water in Singapore, Taiwan, Korea and Netherlands, news portal websites and others. All indicators of smart water readiness have been obtained by each of the best practice data. Bandung secondary data related to variables and indicators of smart water readiness were obtained from interview with parties considered competent, the official website of the Bandung city government (www.bandung.go.id), website smartcity.bandung.go.id, website portal news, journal articles and others. From the search results, an overview of each smart water indicator in Bandung City is obtained.[11],[12].

Smart water readiness index in the city of Bandung as a whole is 51.05.This value was obtained from the results of interviews and questionnaires with a total of 31 speakers who were divided into 4 parts, namely, Government, Business People, Researchers and the community/users. This index value is declared very bad, and needs a lot of improvement. New pipeline development infrastructure, affordability to the community or users, water quality and water costs and technology are factors that need to be improved jointly by the government and stakeholders. The highest value is found in the Cons3 indicator "Water Quality" with a total index of 63,98 which is considered bad, and necessary. Meanwhile, the lowest value is found in the UF3 indicator " Dam Protection" wt an average number of 43,76 were rated very bad and still needed a lot of improvement.

SUGGESTION

Suggestions for the Government

1. The regional government in this Case The Regional Water Company (PDAM Tirta Wening) must build a new pipeline because the existing piping is old. Infrastructure of the new pipeline helps local governments in distributing clean water to areas that have not received clean water.
2. The regional government must build an integrated wastewater treatment plant.
3. The regional government must look for alternative new raw water resources. It needs new innovations with new technology.
4. In accordance with Bandung City Regulation No.03 of 2012 concerning the management of groundwater, it is necessary to have a clear policy regarding the rules and penalties for the use of ground water.
5. Local governments and stake holders such as regional water companies must open themselves to developing technology in countries such as Singapore, Taiwan, Korea and the Netherlands. The use of technology helps work and become a solution to leakage in the city of Bandung.

Suggestions for Business People

Businesses people are expected to collaborate with the government in creating the technologies needed to implement smart water in Bandung in accordance with existing needs and can also discuss with the government or government about the technology system on smart water that is used so that the level of water leakage in Bandung city declined.

Suggestions for researchers

Researchers are expected to collaborate with the government in creating the technologies needed to implement smart water in Bandung according to existing needs and also be able to discuss with the government about water management policies in Bandung and technology implementation. Because of the level of water leakage in the city of Bandung This is quite large. About 40% more. Therefore business people can collaborate by creating technologies.

Suggestions for the community/users

The community/users is expected to be involved in maintaining and maintaining water resources in Bandung. Public participation in this community is still bad. So the community is expected to guard and get involved in water use. The community in this case tends to be indifferent to water management in the city of Bandung. This is reflected in one of the behaviors of people who tend to throw garbage into the river. Likewise the community is expected to be involved in the efficient use of water. Efficient use of water can help the availability of raw water in Bandung

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