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The Implementation of Garuda Smart City Framework for Smart City Readiness Mapping in Indonesia

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Urbanization trend leads to increasing of urban population that cause several problems for the cities due to limitation of physical structure that are no longer able to support the growth of urban population. The term Smart City has been used by urban planners and development scholars as part of the Smart Growth Movement. There is still no standard about definition of smart city in the world, therefore, for Indonesia context we define smart city as a city that have good capability to manage all resources effectively and efficient to solve all city problem using innovative, integrated, and sustainable solution by delivering good city services to improve quality of life. Many cities in Indonesia have smart city-related initiatives, but currently there is no reference that can be used to evaluate the city's achievements in implementing the smart city initiatives. In carrying out this study, we use Garuda Smart City Framework 2 (GSCF 2) tools which indicators include digital government as part of the measurement apart from sustainable indicators such as economy, social and environment and enabler indicators such as technology/infrastructure, people and governance. Through this measurement, it was expected that the cities know their position and hopefully they can understand how to move toward smarter and more sustainable city.

Key Words: GSCF, measurement, reference model, smart city

1. Introduction

In 2008, global urban population exceeded the rural population for the first time(1). The same trend occurred in Indonesia where the urban population increased from 49.8% in 2010 to 53.3% in 2015 (bps.go.id). This urbanization's trend leads to the increase of energy demands, waste and water services in and around the cities, which calls for more environmental care(2). In Indonesia, urbanization causes large land conversion from agricultural areas into industrial estates or from water conservation areas to roads, creating an environment problem(3). These problems emerge due to limitation of physical structure that are no longer able to support the growth of urban population. As the number of people growing, city problems become more complex and finally its causing conventional solutions no longer able to solve the problems. The city need innovative, effective, and integrated solution as a smart solution.

Since the late 1990s' the term Smart City has been used by urban planners and development scholars as part of the Smart Growth Movement, which focused on a new paradigm of intelligent urban development(4). Smart city initiatives also came from IBM, Information and Communication Technology (ICT) companies, which introduced that concept as smarter cities for prosperous and sustainable fu-

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ture. The IBM's concept defines cities as built on six core systems: people, business, transport, communication, water and energy[5]. These core systems are interconnected and interdependent with one another. In understanding how these systems work, ICT becomes one of the key element in understanding and controlling city operation and development. It is also highlighted that ICT is one of the main characteristic of smart city since it helps city stakeholders to use of their resources better[4].

The smart city literature shows that there is still no standard about definition of smart city[6]. Therefore, for Indonesia we define a working definition on smart city, which is adjusted according to Indonesian context. We define smart city as a city that have good capability to manage all resources effectively and efficient to solve all city problem using innovative, integrated, and sustainable solution by delivering good city services to improve quality of life. Each municipal government has their own characteristic that is unique and special, as well as the potential of its resources to make its position to be important and special as well. The municipal government responsible for managing, developing and serving the community has established a strategic plan for city government development. Many cities in Indonesia have smart city-related initiatives but currently in Indonesia there is no reference that can be used together to evaluate the city's achievements in implementing the smart city initiatives.

Measurement of the city is very important for the city to know the state of a city. The Waseda-IAC for instance, developed e-government ranking to assess e-government among countries[7]. This 2015 e-government ranking is arranged by including 9 main indicators and 32 sub-indicators and took one-year of survey. In carrying out this measurement, we used the Garuda Smart City Framework 2 (GSCFF 2) which include "digital government" as one of many indicators that cover sustainable indicators such as economy, social and environment and enabler indicators such as technology/infrastructure, people and governance. Through this measurement, it was expected that the cities know their position and hopefully they can identify their weakness and finally can improve their city into smarter city.

2. Garuda Smart City Framework 2

Garuda Smart City Framework (GSCF) is developed by Smart City and Community Innovation Center (SCCIC), Institute of Technology Bandung, Indonesia. GSCF adopted by Association of Indonesian Smart Initiative (APIC) as a model for Indonesia Smart City[8]. GSCF is a comprehensive framework that consist of Smart City Model, Measurement Model, Development Cycle, Collaboration Model, and other components. The last version of GSCF is GSCF 2.2. The complete components of the framework can be seen in Fig. 1.

Fig. 2 show the model. In this model, Smart City represented as 3 layers: (1) resources, (2) enablers, and (3) services. Services grouped into 3 layers: (1) Service Domain, (2) Service Cluster, and (3) Service Items. Smart City Service (Service Item) is a real service deliver to citizen. This service can be delivered by the government, non-government, or collaboration among them. Resources are something available in the city as sources, for example people, environment, natural resources. Resources can be enhanced become enablers. Enablers are enhanced resources or something that created to be an en-

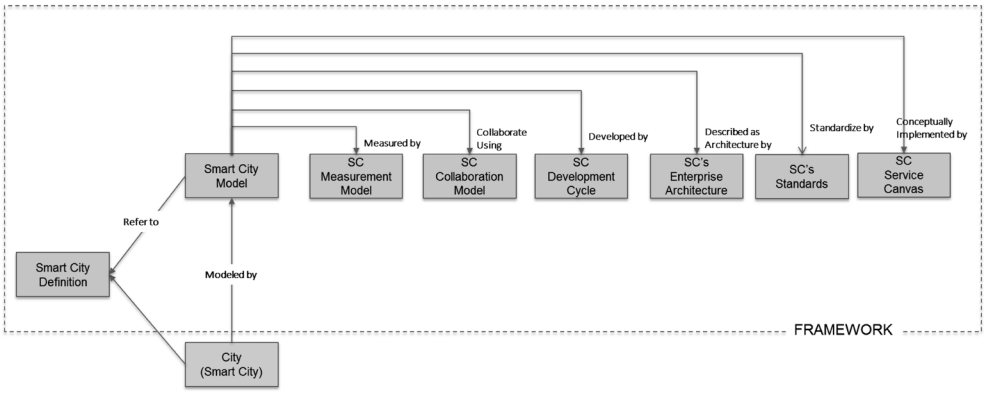

Fig. 1. Garuda Smart City Framework (GSCF)'s components[10]

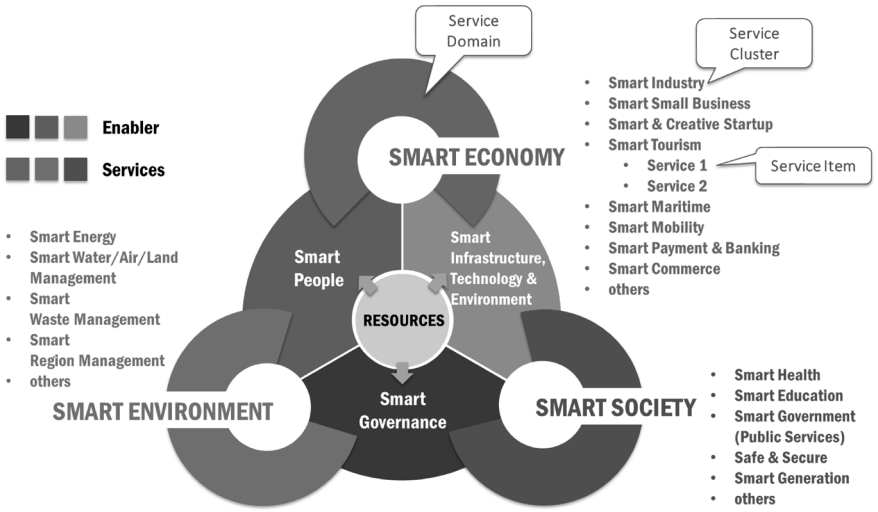

Fig. 2. Smart City Model in GSCF 2[10]

abler for upper layer (service layer). There are three enablers: (1) people, (2) governance, (3) infrastructure, technology, and environment. People as resources are differ with people as enablers. People as resources are people as is, without enhancement. People as enabler is people with strong and dedicated competencies and ready to become enabler for upper layer.

As seen in Fig. 1, GSCF have Smart City Measurement Model. This model combines two view or dimension of a city or smart city as seen in Fig. 3. The first dimension is the status or achievement of the city. This view represents the achievement of "Quality of Life". The second dimension represents the way that conducted by the city to move to the better condition. This view represent the smartness dimension. This second dimension consist of 5 (five) levels such as (1) ad hoc, (2) initiative, (3) scattered, (4) integrative and (5) smart[9, 10]. Fig. 4 show these five levels, and differences between levels.

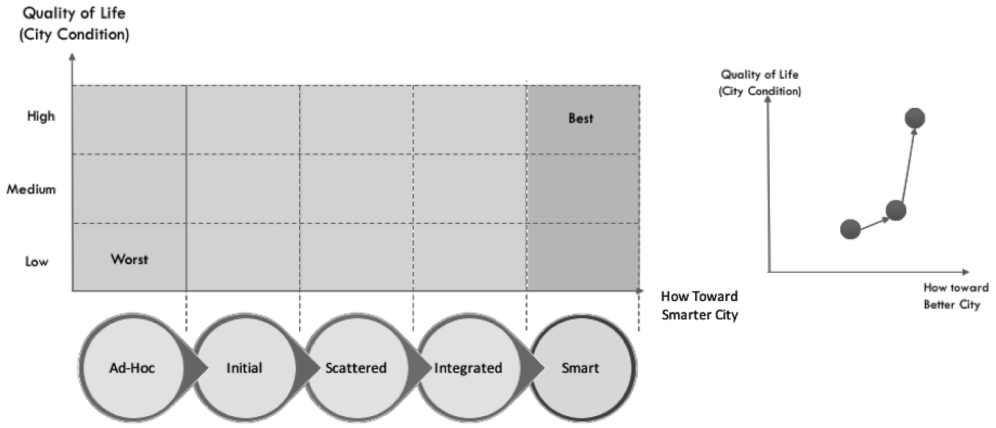

Fig. 3. Quality of Life and Maturity Level View[9), (10)]

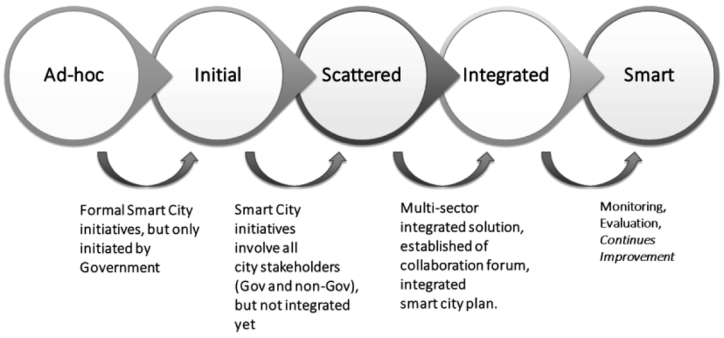

Fig. 4. Maturity Level[9), (10)]

3. Measurement Process

This research is done through several stages as follows:

a. The Self Evaluation Survey was conducted to all cities in Indonesia excluding the administrative city of DKI Jakarta Province (total of 93 from 98 cities). The self-evaluation survey technique is conducted where each city fills the city questionnaire sheets independently and online through the web.

b. Evaluation of self-evaluation results from cities based on the GSCF method, the result of this stage is the determination of 31 cities of finalists by division of city classification:
   a. Large Cities (population＞ 1 million people)
   b. Medium Cities (population between 200 thousand–1 million people)
   c. Small Cities (population ＜200 thousand inhabitants)

c. Survey or verification for the data received based on the city self-evaluation to 31 selected cities was done by going to those cities. In-depth assessment was conducted by conducting interviews and surveys to the municipal authorities as well as to the community (sampling)

d. Mapping is done by conducting evaluation of the results of verification and In-depth assessment to

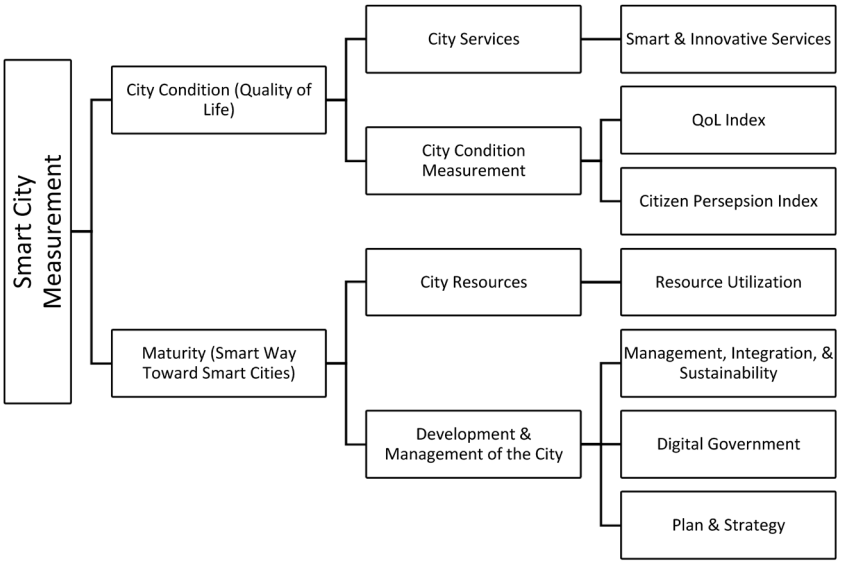

Fig. 5. Smart City Maturity Measurement Component

the finalist city. Based on the assessment result we will get the city position in its readiness to apply smart city.

The key success of moving towards Smart City is the implementation of all components of the model in a holistic manner. If the city cannot meet its need based on its available resources, then the city should focus consequently at: (1) enabler and (2) process or initiative. Enabler is a key component to ensure the achievement of the various processes of Smart City (Smart-Health, Smart-Education, and so on). Today many cities are focusing only on processes or initiatives, but ignoring its enabler. As a result, the goal of the process is not effectively achieved. For example, a city that has an MRT fails to solve congestion issue due to no attempt to improve human behaviour for other modes of transport.

The evaluation and mapping process of GSCF 2 is done by assessing two categories:

- Current situation via assessing each dimension/sub field has a list of indicators with assessment metrics and evaluation values.
- Process, which is assessed through questionnaire data to know the process / smart way of the city in overcoming the problems of the city and innovate and the city management in the framework of smart city.

Calculations for the maturity rating were performed using the formula:

$$Maturity\ Rating = \sum_{Dimension\ a}^{Dimension\ n} \left(\frac{Total\ Indicators\ Value}{Total\ Maximum\ Value} \times Weight \right)$$

To be different from other city measurement held by the government of Indonesia, in GSCF 2 the aspect of Smart Way toward Smart Cities has more impact to maturity level than the City Condition. The values needed to reach each Maturity rating are:

Table 1. Example of GSCF 2 Assessment metrics and Evaluation

List Indikator dan Metrik Penilaian							Assessment		Penilaian
Sub Bidang	List Indikator	Lv 1	Lv 2	Lv 3	Lv 4	Lv 5	Kondisi Kota		Nilai
Pusat Kegiatan Ekonomi	Jumlah pasar tradisional (rasio per jumlah penduduk)	1	4	8	17	1018	k1		10
	Persentase jumlah penduduk miskin	0,0125	0,0489	0,0667	0,1047	2,7229	k2		30
	Presentase jumlah pengangguran	0,0006	0,052725	0,07425	0,099	0,5372	k3		70
	Rata-rata pengeluaran per kapita								
	⇒ Pada tahun 2015	1859	880333	3685091,5	14012250	1,04463E+14	k4		70
	⇒ Pada tahun 2016	2028	740234,5	1307892	14620000	10000000000	k5		50
	Rata-rata pendapatan perkapita								
	⇒ Pada tahun 2015	1158	2748642,75	33952301	67288375	1,02626E+14	k6		30
	⇒ Pada tahun 2016	2316	587500	37136340	101285000	3,24377E+11	k7		30
	Persentase peningkatan PDRB	0	0,054475	0,06275	0,093125	1,5739	k8		30
	Persentase peningkatan investasi dan usaha	-0,0151	0,0634	0,241	0,5326	596,71	k9		10
	Persentase tingkat inflansi yang terjadi dalam 1 tahun	-1,0703	0,020275	0,03355	0,0503	38,82	k10		70
	Persentase pertumbuhan nilai ekspor	-7,0761	-0,00815	0,0808	0,2538	231,59	k11		50
	Persentase pertumbuhan nilai impor	-2,42	-0,0026	0,0689	0,3361	1016,98	k12		70
	Sebutkan jumlah Bank Perkreditan Rakyat yang terdapat di kota	0	4	8	17	134	k13		70
	Berapa jumlah koperasi yang ada	0	130	277	721,5	2565	k14		50

–Ad hoc has a maturity value of 0–20%

–Initiative has a maturity value of ＞20–40%

–Scattered has a maturity value of ＞40–60%

–Integrative has a maturity value of ＞60–80%

–Smart has a maturity value of ＞80–100%

4. Evaluation and Mapping Result

Based on the evaluation and calculation conducted on several cities in Indonesia, the result is described as follows:

- On average the cities in Indonesia still Scattered or Initiative level of Smart City Maturity. From 31 cities, only 3 cities can reach the Integrated (level 4 of 5). The results of current research also show that there is no city in Indonesia who managed to reach the level of maturity of Smart based on GSCF 2 Criteria.
- Based on all value on city condition (quality of life) and smart way toward smart cities we create a mapping condition of these cities to get an idea of how the position of a city compared to other cities in the context of smart city. From we can see that despite of having the same maturity level, there are cities that have advantages in the implementation of smart initiatives, there are also cities that have advantages in impact on the quality of life of the city. Some cities have better initiatives to be a smarter city than other even though their city condition not as good as other city, but still managed to reach the same maturity level.
- From Table 2 below we found some interesting fact that:
  - Small cities have below average maturity values when compared to other city categories, this also include the smart way (initiatives) toward smart cities and their city condition & quality of life. Handicap for small cities category also found in management & development process, innovation ecosystem, digital government readiness and also the Integration readiness compared to the bigger cities category.
  - Below average value also found in large cities on the Smart Economy rating, Smart Environment

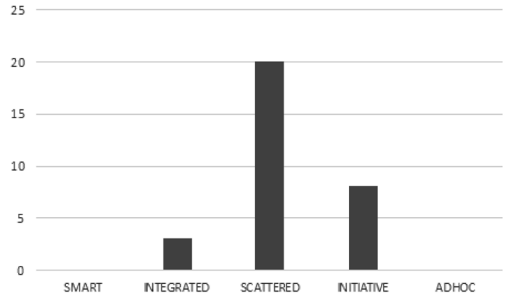

Fig. 6. Indonesian Smart City Rating & Mapping Result (1)

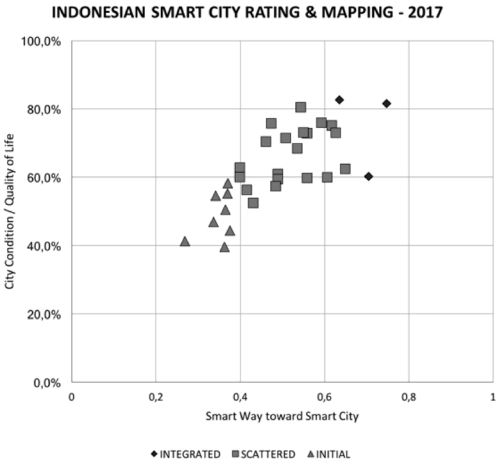

Fig. 7. Indonesian Smart City Rating & Mapping Result (2)

Table 2. Average Value for Smart City Rating Criteria (case study: 31 Cities in Indonesia)

Rating Criteria	Average Value			
	All Cities (31)	Large Cities (10)	Medium Cities (11)	Small Cities (10)
Smart City Maturity (Overall)	**48.3%**	52.1%	50.7%	**42.0%**
Smart Way Toward Smart Cities	**49.3%**	54.5%	51.5%	**41.5%**
City Condition and Quality of Life	**62.6%**	64.7%	65.9%	**56.9%**
Smart Economy	**66.0%**	**64.2%**	67.8%	**65.9%**
Smart Environment	**62.7%**	**61.6%**	63.3%	63.2%
Smart Social	**68.1%**	**64.4%**	70.8%	68.7%
Smart Health	**76.8%**	**74.0%**	82.5%	**73.3%**
Smart Mobility	**69.5%**	**68.1%**	70.7%	69.7%
Safety and Security	**59.7%**	**53.1%**	61.0%	64.8%
Development and Management of the City	**48.5%**	55.4%	51.2%	**38.7%**
Digital Government	**58.2%**	65.7%	59.6%	**49.2%**
Integration Readiness	**40.5%**	44.8%	42.8%	**33.7%**
Infrastructure Readiness	**68.0%**	**65.6%**	69.5%	68.7%
Innovation Ecosystem	**64.1%**	**63.3%**	65.0%	64.0%
Competitive Ecosystem	**70.3%**	**67.9%**	71.5%	71.5%

rating, Smart Social rating, Smart Health rating and also the Safety and Security rating especially when compared to the category of medium cities. This is because of the urbanization problem and challenges in large cities that need to be solved are more complex.

- The lowest value from all criteria found in aspect of Management & Development process amd Integration Readiness. This aspect needs more attention for cities in their efforts to be smarter city.

5. Conclusion

The measurement of smart cities in this study uses GSCF 2 that was adapted to fit on Indonesian condition. Based on case study, our measurement results had shown that the maturity level of some selected cities in Indonesia has reach the integrated level (level 4 out of 5) but the others still in scattered level or even in initial level. Management & development process and also integration readiness are the aspect that needs more attention for cities in their efforts to be smarter city. From the results of these measurements, for further research we can develop some recommendations and roadmap details to support the cities toward smart cities.

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