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Smart City Readiness based on Smart City Council's Readiness Framework

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ABSTRACT

The level of urbanization which may impact on urban problems could be resolved through city development enabled and supported by the advanced ICT to build the city smart. To develop the city smart, the readiness of smart cities enablers should be assessed. The study was conducted based on pilot study through a survey on the smart city readiness. The analysis of smart city readiness in Yogyakarta showed that the evaluation of smart city projects implemented partially; only operational and asset optimization, and access to comprehensive device management implemented over 50%. Smart city readiness not only be measured by technological aspect but also need to be measured as non-technological aspects. Thus, measurement of readiness smart city can be more comprehensive.

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1. INTRODUCTION

The growth of population and level of urbanization has changed the demographic cities in the world and in Indonesia. The world's population in 2010 will increase 26.42% in 2035, and increase 38.10% in 2050 [1]. Universally, urban areas will be the choice of people living than rural areas. The world population is 30% lived in urban areas in 1950, increased 54% in 2014, and projected 66% by 2050 [2]. Meanwhile, the projections for the next 25 years of Indonesia's population in 2010 to 2035 continue to increase 26.68%. The level of urbanization is estimated to reach 66.7% in 2035, which is Jakarta, West Java, Yogyakarta, and Banten Province already above 70% in 2035 [3].

The increasing level of urbanization is a momentum of smart cities movement characterized by increasing economic competitiveness, environmental issues; insufficient infrastructure; quickly upgrading Information and Communication Technology (ICT) capableness and reducing ICT prices [4-7]. The smart cities trend is worth for head of the region to make city initiatives smart [5]. Globally, cities are already implementing smart initiatives in providing better services for citizens, businesses, employees, and governments [4], [8]. The initiatives use the capabilities of advanced ICT as an enabler to make cities more liveable, more workable and more sustainable [5], [9], [10]. However, the way to smart cities have obstacles, such as siloed, redundancy implementations; lack of funding, ICT expertise, merged services, citizen participation, and smart city planning [11], [12].

To plan a better future, cities should know how ICT transform the cities [4], [11]. To understand how smart cities deploy and use ICT to transform the liveability, workability, and sustainability of cities, the readiness of smart cities enablers should be assessed. Smart cities enablers are ICT capabilities consist of

brainware, hardware, and software. Brainware covers vision, strategies, planning, initiatives, programmes and projects, financing and budgeting, and transparency [4], [8], [11], [13-16]; leadership, organization, structure, and governance [9], [4], [14], [15]; citizen, stakeholder, and business partnership, collaboration, and engagement [4], [13], [14], [17]; innovation, service delivery, and productivity [4], [10], [15], [18]; analytics, decision-making, and privacy [11], [13], [14], [18]; and assessment, measurement, controls, and improvements [4], [6], [11], [14]. Hardware involves architecture and infrastructure platform [4], [6], [10]; network and broadband connectivity, availability, interoperability, security, quality, and affordability [11], [13], [17], [18]; computing resources, instrumentation and control, technology components and use [9], [11], [13], [15], [17]; development, adoption, and implementation Internet of Things [11], [4]. Software includes application and service platforms [13], [18]; geographic information systems [13]; interoperability, security, and privacy [11], [13], [18]; (big) data architecture, management, generation, collection, discovery, analysis, use, sharing, protection, and open data [4], [11], [13-15], [19], [20]; development and implementation [11]. The readiness capture the correlation among a city's services and its enablers. The description of smart city resources captured from related work as follow.

Framework/Model	Indicators	References
Critical Urban Mobility Factors Assessment	General and specific infrastructure measurement, organizational experience, additional measurement, change management	[9] 2016
Turkey Smart City Assessment	Universal: sustainability and scalability applications ICT: technology modules, business companions, geographic information systems, open data, security, and privacy Organizational: partnership and economic structures	[13] 2016
Evaluation and Reporting in UK Smart Cities	Activities and initiatives: direction, shareholder partnership and commitment, approach, key achievement indicators, and data grouping, gathering, studying and using Approaches effectiveness: purpose, city awareness, prospective assessment improvement, and approaches contribution Evaluation reports: impacts reporting, decision-making contribution, and outcomes improvements	[14] 2016
Evaluation of Key Performance Indicators of Smart Cities by Delphi Analysis	Technology: network and service architecture, data safety and confidentiality Environmentally friendly: air and internal contamination water quality, energy Production: investment, occupation, exportation/importation, revenue Value of life: learning, healthiness, protection, comfortable Fairness and societal enclosure: revenue, gender, open community Physical infrastructure: peeped water, electrical energy, constructions, managing waste	[18] 2016
Smart City Transformation based on SWOT Analysis	Vision, valuation, initiatives, build and deployment	[11] 2015
IDC MaturityScape IDC MaturityScape: Smart City	Vision: plan, direction, business model, costing Culture: creativity, public involvement, openness Process: cooperation, governance, and management, assessment, institution ICT: platform and data architecture, Internet of Things, business and technology incubation Data: data security, collection, analysis, sharing, and open data	[4] 2015
Smart Cities Maturity Model and Self-Assessment Tool	Strategic, data, technology, governance and management, service delivery, and public involvement	[15] 2014
Networked Society City Index 2014	ICT Maturity: infrastructure quality and availability; affordability prices; ICT, personal, and public usage	[17] 2014
Smart City Readiness Framework	Connectivity, compatibility, security and privacy, managing data, ICT resources, and analytics	[5] 2014

2. RESEARCH METHOD

In order to measure the readiness of smart city, the ICT readiness of the city should be assessed. This research uses Smart City Readiness Framework provided by Smart City Council [5] as shown Figure 1. This framework describes the relationship between city services to accomplish for citizens and technology enablers that can make city services easier. The vertical city services represent essential responsibilities that city need. The horizontal enablers are technology abilities that increase city services.

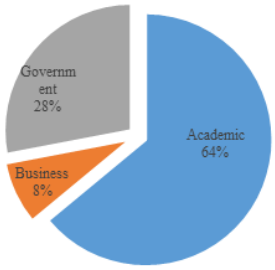
The sampling using non-random sampling method (non-probability) with a convenience sampling survey technique of computer-delivered survey via instant messaging related to the relevant research group. A pilot study conducted with a sample size of 25 respondents with the questions [5] (see Appendix).

		City responsibilities								
		Universal aspects	Built environment	Energy	Telecommunications	Transportation	Health and human services	Water and wastewater	Public safety	Payments
Technology enablers	Instrumentation and control									
	Connectivity									
	Interoperability									
	Security and privacy									
	Data management									
	Computing resources									
	Analytics									

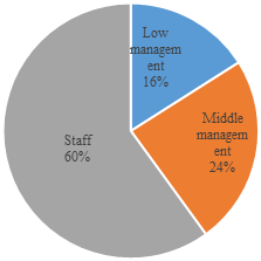
Figure 1. The Smart City Framework [5]

3. RESULTS AND ANALYSIS

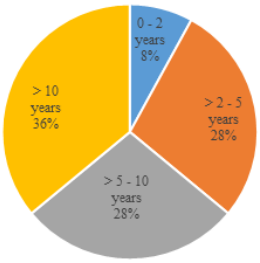
The city measurement related ICT readiness uses Smart Cities Framework proposed by Smart Cities Council [5]. Key terms used are smart city services, enablers, and implementation progress. Smart city services provide cities essential responsibilities that must be available such as built environment, energy, telecommunications, transportation, health and human services, water and wastewater, public safety, and payments. Smart city services add the responsibilities, namely tourism and education.



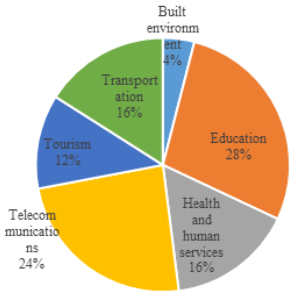
(a) Respondents' Institution



(b) Respondents' Position



(c) Working period



(d) City Services

Figure 3. Respondents' Profile

The survey was conducted in August to September 2016. The survey distribution was done via Instant Messaging (Doctoral Student WhatsApp Group) and Facebook Group (E-Government Research Group). There were 25 people participated. The selection criteria were for those who studied and lived or are studying and living in Yogyakarta, Indonesia. The results showed that the institutions respondents were

mainly from academic institutions (67%) followed by government (28%) and business (8%). The respondents were dominated by staff (60%) followed by middle management (24%) and low management (16%). The working period of the respondents who worked more than 10 years was 36%. In terms of city services availability in Yogyakarta, the respondents mentioned several aspects such as education, telecommunications, transportation, health and human services, tourism, and environment. The profile of respondent is illustrated in Figure 3.

Smart city enablers use the role of ICT to improve city services. According to [5], there are seven technology enablers to support city services. These include instrumentation and control, connectivity, interoperability, security and privacy, data management, computing resources, and analytics [5]. Implementation progress is the evaluation of smart city projects (technology as an enabler). The findings are presented in a separate section as follow.

3.1. Instrumentation & Control, Connectivity, and Data Management

Instrumentation and control are technology components and technology use which the capabilities of the control system to manage, monitor, and control city conditions [9], [11], [13], [15], [17], [5]. The instrumentation consists of sensors, closed circuit TV and video monitors; and control associated with remote management [5]. Gathering information using instrumentation and taking action using control devices are the purpose of this capability [5]. However, instrumentation issues should be mentioned, such as privacy and security, legacy devices, and connectivity [21]. Connectivity is a network and broadband connectivity, availability, interoperability, security, quality, and affordability [11], [13], [17], [18], [5]. Connectivity is also the connection of devices and control system in order to collect, analyse, and use data [5]. Networks linked to Wi-Fi, and cellular [18], [5]. Technology has changed the way to communicate, especially the robust technology enabler such as Internet of Things (IoT), machine-to-machine communications [11], [4], [5]. Data management is the accuracy, accessibility, reliability and timeliness of data in order to store, protect and process the data [4], [5], [11], [13-15], [19]. Data is managed properly by maintaining data integrity and value, making transparency and sharing policy related to access, authentication and authorization [5], [6], [18]. The result of Instrumentation & Control, Connectivity, and Data Management as shown Figure .

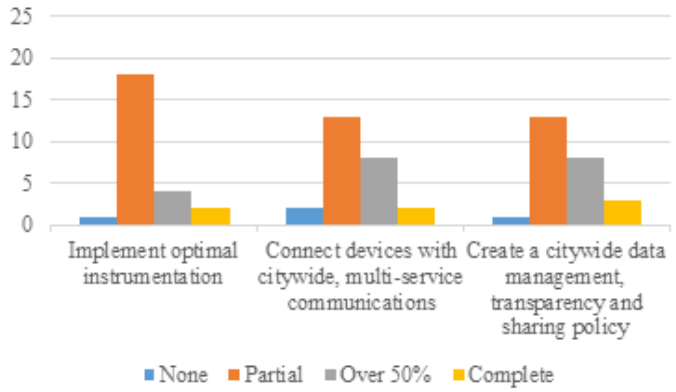


Figure 4. Instrumentation & Control, Connectivity, and Data Management

Generally, smart city project is related to instrumentation & control, connectivity, and data management is deployed partially in Yogyakarta, as presented Figure 4. This implementation progress implied that 72% of the respondents measured the optimal instrumentation implemented incompletely, 52% respondents evaluated the connection of devices with citywide, multi-service communications; and the implementation of creating a citywide data management, transparency and sharing policy applied partly. Data management related to sharing data problem was caused by siloed institutions approach, and institutions rarely share data and collaborate on initiatives [5]. Thus, integrated institutions approach, shared data between institutions, correlated with other data services will improve the results and reduce the cost.

3.2. Interoperability

Interoperability is the capability of data and information exchange from different products and services providers [11], [13], [18], [5]. Mostly technology enabler project was related interoperability

deployed partially in Yogyakarta. This execution progress inferred that 52% of the respondents judged the commitment to open standards realized moderately, and 44% respondents assessed the practice of open integration architectures and loosely coupled interfaces deployed incompletely. Nevertheless, 40% respondents appraised the prioritizing use of legacy investments implemented moderately as presented Figure 5.

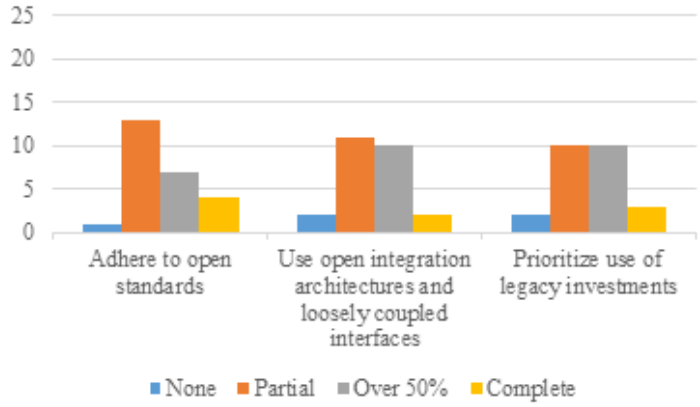


Figure 5. Interoperability

3.3. Security & Privacy

Security and privacy are data safety, privacy, physical property related to technology, policy, and practice [11], [13], [18], [5]. This includes privacy rule publication, cyber security system implementation in order to build trust [5]. In general, the implementation progress of smart city project is related to security & privacy deployed partly in Yogyakarta, such as 40% of the respondents measured the privacy rules publishing used relatively and 52% respondents considered the security framework and cyber security organized incompletely as accessible Figure 6.

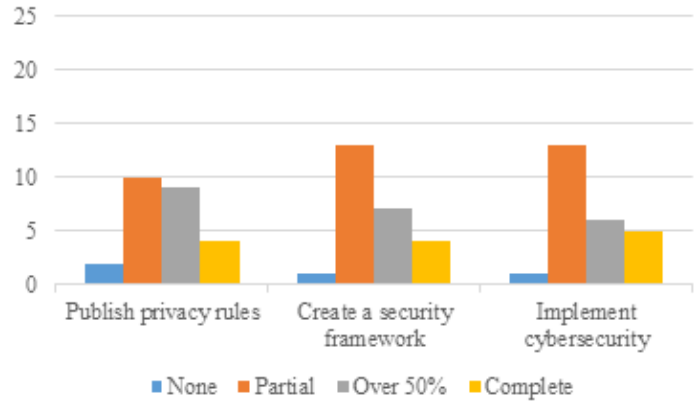


Figure 6. Security & Privacy

3.4. Computing Resources

Computing resources include sophisticated hardware, software, and data storage needed for the smart city [4], [5]. A geographic information system (GIS) and cloud computing (public, private and hybrid models) [22] are the most capable resources to compute the city services [13], [5]. Commonly, the implementation progress of technology enabler is related to computing resources used moderately in Yogyakarta. This completing progress concluded that 52% respondents assessed the consideration of cloud computing framework implemented partially; 48% respondents evaluated the use of an open innovation platform deployed reasonably; 44% respondents judged the access of central GIS equitably; 48% respondents valued the access to comprehensive device management implemented more than 50% as displayed Figure 7.

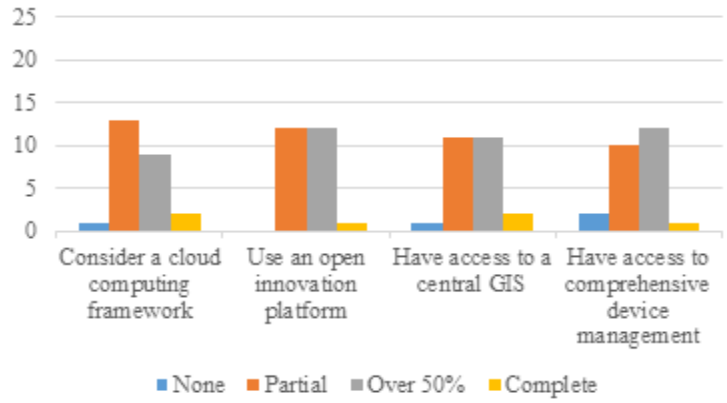


Figure 7. Computing Resources

3.5. Analytics

Analytics is the creation of new insight from the data provided by instrumentation [11], [13], [14], [18], [5]. Analytics utilize data from across departments to identify new knowledge, solutions and improve outcome [4], [5], [20]. City analytics provides analysing, forecasting, predicting, automatically plotting, and personalized city needs and services [15], [5]. Generally, the smart city project of technology enabler is related to analytics used moderately in Yogyakarta. This implementation progress depicted that 48% respondents judged the accomplishment of full situational awareness applied partly and so did the adoption of predictive analytics (36%); whereas 40% respondents assessed the achievement of operational and asset optimization executed more than 50%, as shown Figure 8.

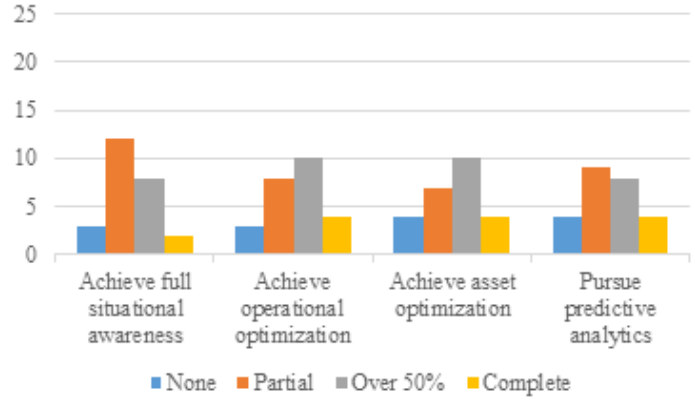


Figure 8. Analytics

Based on the assessment of respondents related to progress implementation of all technology enabler to support smart city showed that the evaluation of smart city projects realized partly in Yogyakarta. Meanwhile, only operational and asset optimization and comprehensive device management implemented more than 50%. However, smart city project that needs to be improved consist of the optimization use of instrumentation; connection devices with citywide, multi-service communications; open standards; open integration architectures and loosely coupled interfaces; the use of legacy investments; privacy rules publishing; security framework; cyber security implementation; citywide data management, transparency and sharing policy; cloud computing framework; open innovation platform; the access to a central GIS; situational awareness; and predictive analytics.

Smart city readiness does not only be measured by the implementation progress of smart city project related to technological aspects, such as infrastructure and infostructure but also needs to be seen the readiness of non-technological aspects, namely suprastructure. Suprastructure covers vision and mission, policies and strategies, planning and budgeting, initiatives, programmes and projects [4], [10], [11], [13-16], [8]; leadership, institution, structure, and governance [4], [9], [14], [15]; citizen, stakeholder, and business

partnership, collaboration, and engagement [4], [13], [14], [17]; innovation, service delivery, and productivity [4], [15], [18]; analytics, decision-making, and privacy [11], [13], [14], 18]; and assessment, measurement, controls, and improvements smart city projects [4], [11], 14]. Thus, measurement of readiness smart city can be more comprehensive, covering aspects of the suprastructure (brainware), infrastructure (hardware), and infostructure (software). It can be used as inputs in the preparation of the conceptual framework of the smart city for development.

4. CONCLUSION

Based on the results and discussion, it can be concluded that the evaluation of smart city projects in Yogyakarta was implemented partially, such as instrumentation implementation, city device connections and service communications, open standards, open integration architectures, legacy investments usage, privacy and security, cyber security, data management, cloud computing framework, open innovation platform, GIS, situational awareness, and predictive analytics; only operational and asset optimization and access to comprehensive device management implemented over 50%. Smart city readiness not only be measured by implementation progress of smart city project, especially technological aspect, such as infrastructure (hardware) and infostructure (software). Smart city readiness may also need to be measured as non-technological aspects, namely suprastructure (brainware). Thus, measurement of readiness smart city can be more comprehensive, covering aspects of the suprastructure, infrastructure and infostructure.

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APPENDIX

Survey Questions [5]

Technology enablers	How smart cities deploy and use ICT to enhance city services?	Implementation progress: none	partial	over 50%	complete
Instrumentation and control	Implement optimal instrumentation				
Connectivity	Connect devices with citywide, multi-service communications				
Interoperability	a. Adhere to open standards b. Use open integration architectures and loosely coupled interfaces c. Prioritize use of legacy investments				
Security and privacy	a. Publish privacy rules b. Create a security framework c. Implement cybersecurity				
Data management	Create a citywide data management, transparency and sharing policy				
Computing resources	a. Consider a cloud computing framework b. Use an open innovation platform c. Have access to a central GIS d. Have access to comprehensive device management				
Analytics	a. Achieve full situational awareness b. Achieve operational optimization c. Achieve asset optimization d. Pursue predictive analytics				

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