READINESS OF INCORPORATING BIG DATA TO SUPPORT SMART GOVERNANCE OF YOGYAKARTA CITY

Sushardjanti Felasari
Department of Architecture
Faculty of Engineering, Universitas Atma Jaya Yogyakarta
Jl. Babarsari 44, Yogyakarta 55281, Indonesia
Email: sfelasari@staff.uajy.ac.id

M. Sani Roychansyah
Department of Architecture and Planning
Faculty of Engineering, Universitas Gadjah Mada
Jl. Grafika 2, Bulaksumur, Yogyakarta 55281, Indonesia
Email: saniroy@ugm.ac.id

ABSTRACT

The increasing number of problems arising in the city because of the limited resources requires local governments to solve it in a smart way using innovative technologies and available abundant data creatively. Big data should be an integral part of smart city strategy as it is used as an input for decision-making policy formation for supporting smart governance. This paper discusses readiness and challenges of the city of Yogyakarta towards the realisation of smart city means, especially related to availability and management of the data. It identifies the possibilities of how urban data is generated, selected and used to govern and manage the city. It analyses systematically three different available data sources that are used by the city in three stages of application, namely sensing, understanding, and acting. The big data consists of government-generated data, private-generated data including universities and NGO, and citizen-generated data. E-government that is already implemented in the city governance supported by innovations developed by each local government-working unit (SKPD) is substantial and initial data sources in this context. Private sectors also follow and play an important role in contributing urban data through their business applications. Meanwhile the development of the Internet and the increasing public accessibility to the online information such as the use of social media is a potential data generator to capture the aspirations and participation from the citizens.This paper shows that to encourage level of readiness toward smart governance of Yogyakarta City, a comprehensive sensing and understanding the data as fundamental stage in incorporating big data is needed as well as an integrated top-down and bottom up data management approaches.

Keywords: level of readiness, big data, smart governance, smart city, Yogyakarta City

1. INTRODUCTION: TOO MUCH DATA WHAT NEXT?

In the last ten years the city of Yogyakarta has experienced rapid growth as a result of modernization. A wide range of urban challenges in the modern era has been faced by the city such as limited land, urbanization, congestion, crowded, slum, poverty etc. The increasing number of problems arising in the city because of the limited resources requires local governments including Yogyakarta city government to solve it in a smart way such as implementing information and communication technology in the municipal governance which is commonly known as a smart city strategy.

In preparing to accomplish the smart city initiatives, the city of Yogyakarta has implemented e-government that is an information system of the city governance (City Mayor Rule number 15 year 2015 on e-Government). By this rules local government-working units (SKPD) have developed many ICT based innovations to support effective, efficient, transparent, accountable and participative public services. Meanwhile Yogyakarta has other potential resources to support the smart city initiative i.e the availability of Internet that is accessible for the public. According to APJII (Indonesian Internet Service Provider Association) Yogyakarta has about 63% Internet penetration from its total population [1]. It means that a large number of people living in Yogyakarta city already have access to the Internet to find such information through social media and news pages, accessing education information and public services as well as for online transaction.

The extensive use of ICT in various activities related to city consciously or not have generated various types of data that inform the condition of the city itself from various aspects. All those ICT based activity as well as online activities presents how urban data can be generated. Data is central to smart cities, in particular the use of big data and open data, as it provides real time information. Nevertheless, to which extent this data is available and how to be utilized to support smart governance seems to have not been widely discussed. This paper describes readiness and challenges of the city of Yogyakarta towards the realization of smart city means, especially related to availability and management of the data. By analysing systematically three different available data sources that are used by the city in three stages of application, namely sensing, understanding, and acting, the position of the city of Yogyakarta can be mapped to encourage level of readiness toward smart cities initiatives.

2. BIG DATA AS AN INTEGRAL PART OF SMART CITY

Smart city is a term used to describe the use of innovative technologies and data creatively as the means to solve cities' sustainability challenges in economic, social and environmental issues such as rapid urbanisations, climate change like energy use and air quality, city services like transportation and healthcare to drive economic growth. The point of becoming a smart city is that it will increase resilience and improve the lives of citizens.

There are two main approaches in smart city initiatives i.e. 'top-down' and 'bottom-up' [2]. Top-down approaches focus on technology, efficiency and master planning, integrating data from different systems into a central operations centre. Meanwhile bottom-up approaches focus on citizens and how they can use innovative technologies, such as mobile applications, social media, DIY sensors and open data to create solutions to issues that matter to them and enable behaviour change.

Data are an integral part of the smart city and are used as input for decision-making, policy formation, and to inform citizens and businesses. With the developments in technology recently many sources such as sensors, humans and applications start generating data, which due to inexpensive storage and processing capabilities create what we called big data (Zaslavsky, Perera, & Georgakopoulos, 2012). Big data has three characteristic i.e. volume (related to the size of the data), variety (related to type of the data including the sources such as sensors, webs, devices, social networks, mobile phone apps, etc), and velocity (related to the frequency the data generated and processed). Open data are often provided with no guarantee about their veracity, continuity or lineage (in terms of documentation that establishes provenance)(Mcardle & Kitchin, 2016). There is great potential to apply smart technologies to the city challenges but there is also potential issues facing the development of smart cities such as abuse, privacy, sustainability and ethics.

However, as big data is not usually collected with any quest for 'understanding' the system that is being automated in mind, it represents the 'exhaust' from the systems used to manage and control various aspects of the city (Williams, 2013). Thus it usually lacks the kind of structure that conventional data collection systems always have such as population censuses. In this sense, it requires a very different set of techniques and methods – referred to as urban analytics. Very often such data is not coincident with the purpose for which analysis is required, hence considerable manipulation, cross-classification and integration with other data sets is needed to make it fit-for-purpose (Batty, 2016).

Kitchin and McArdle (2016) present a convincing argument that bigness of big data depends on context. Therefore the more important is not about its bigness but much more about how the data is organized in context, control, store and process it and what it tells us about the city. In general although big data potentially provides us with massive amounts of information pertaining to how individuals and urban objects change and interact in space and time, much of this is unstructured in that no order on its collection is usually imposed and the analyst must either discover this order or impose it form prior conceptions as reflected in other data and/or theory.

There is some concern in terms of accessing, extracting, storing, and certainly understanding big data that the automated systems for accessing and archiving such data may not be stable and much of it might be lost if the systems or the people who are building them change (Batty, 2016).

Big Data is certainly enriching our experiences of how cities function and it is offering many new opportunities for social interaction and more informed decision-making with respect to our knowledge of how best to interact in cities (Batty, 2013).

3. SENSING BIG DATA IN THE CITY OF YOGYAKARTA

In general data traffic in the city of Yogyakarta consists of government-generated data, private-generated data such as businesses, universities and NGO, and citizen-generated data. E-government that is already implemented in the city governance supported by innovations developed by each local government-working unit (SKPD) is substantial and initial data sources in this context. Private sectors also follow and play an important role in contributing urban data through their business applications. Meanwhile the development of the Internet and the increasing public accessibility to the online information such as the use of social media is potential data generators, which capture the aspirations and participation from the citizens.

Government-generated Data

In 2014, Regional Development Planning Agency of Yogyakarta city (Bappeda) has developed a roadmap 2015-2019 for developing e-government towards a smart city initiative. According to the roadmap, there are five stages of the development of e-government namely (1) strengthening of the network infrastructure and data centres, (2) strengthening information systems infrastructure, (3) integration of data and the development of integrated applications, (4) data warehouse, and (5) implementation of the policy to the smart city.

So far at least there are about 88 local government-working units (SKPD) in Yogyakarta city [3], which generate initial and substantial data from public services including from energy providers and health services through their innovations as data centres (Figure 1). Some of the local-government working units also use sensors, webs, devices, social networks, and mobile phone apps to collect real-time data of the city.

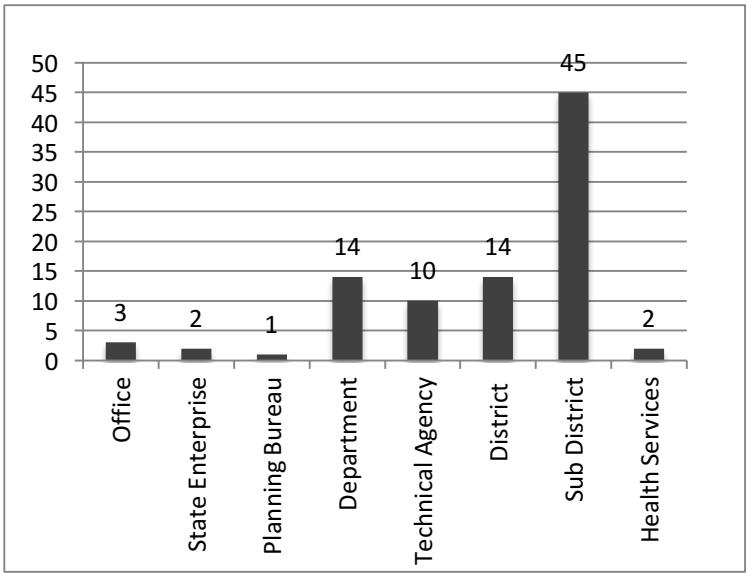


Figure 1. The number of local government-working units (SKPD).
Source: http://www.jogjakota.go.id

In higher level for example, data also generated by Provincial Government of Yogyakarta through developing mobile apps called 'Jogja Istimewa' (Special Jogja) which shows 97% information about the city [4]. The main features of the apps consist of information related to travel, culture, public services, businesses, transportation, education, and health services in the city of Yogyakarta (Figure 2). Through the apps, citizens can access the information and give feedback and comment about the city to the government.

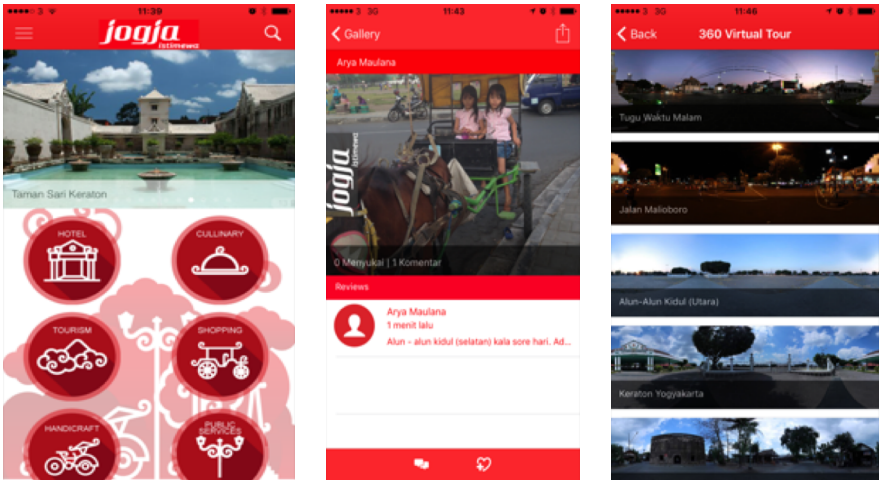


Figure 2. 'Jogja Istimewa' (Special Jogja), developed by Provincial Government of Yogyakarta.
Source: http://diskominfo.jogjaprov.go.id/

The mobile application also presents the traffic condition in the city of Yogyakarta through their CCTV and TV live streaming placed in many points in the corner of the city. In addition to transportation problems for example, many sensors have been mounted on 'Trans Jogja'- a public transportation service owned by the government. Data generated from the sensors not only shows the driving behaviour but also informs the road and traffic condition of the city. The local government-working units also use social network such as Tweeter, Facebook, YouTube, Whatsapp and Google+ to disseminate information and government policy to the community. Nevertheless the types of social media used by the local government-working units seem different from each department and there is no explanation how data will be used afterwards.

Private-generated Data: Businesses, Universities and NGO

Businesses, Universities and NGO located in the city of Yogyakarta have generated data in their activities and transactions that can be used by the government for policy and decision-making. About 3 state universities and more than 26 private universities are established in the city of Yogyakarta. These universities for examples have contributed academic data transaction to the city government especially under the department of education. Education information and online services has been presented through the webs such as school information, school location, school registration, etc.

In addition 162 NGOs located in Yogyakarta also provide data such as data related to environment (33), public policy (15), women and gender (7), housing (1), small enterprises (5), disaster management (2), energy (1), etc [5]. Meanwhile the development of Internet access and qualified human resources in Yogyakarta in the last 5 years have supported rapidly the growth of businesses and services industry in the city. Based on research conducted by Jogja Digital Valley (JDV), Yogyakarta had become the birthplace of 190 national start-ups and as many as 32.33% of start-ups claim to choose the city because of its cheap operational costs [6].

Jogja Digital Valley (JDV) is an ICT business incubator secondly developed by Telkom, a state-owned telecommunications company, to complete the digital creative ecosystem, which aims to increase the number of developers acceleration for games, edutainment, music, animation and software services, especially in the city of Yogyakarta and surrounding areas. JDV has developed as a place that is very strategic for potential individual developers and start-up companies which supplies creative content for IT products and services to be offered actively to the IT market that is booming at this time. Figure 3 shows some mobile applications developed by individual developers and the start-up companies related to transportation system, vehicle tax, culinary businesses, travel and tourism, public services, etc.

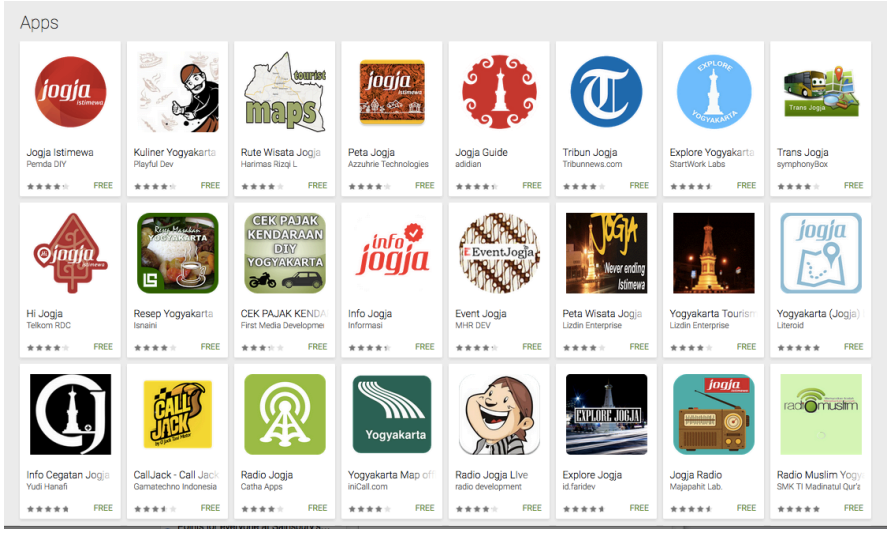


Figure 3. Some mobile applications (24 of 244 apps) related to the city of Yogyakarta

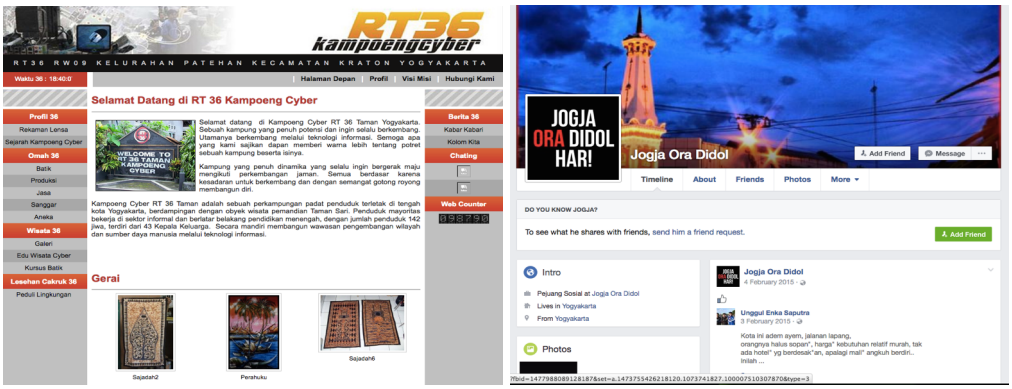
Citizen-Generated Data

The development of access to the Internet at the city of Yogyakarta makes some of the daily activity increasingly move to the online world. Social media seems to be the most favourite virtual world used by the community to communicate each other online and to participate in the development of their neighbourhood.

One example is showed by neighbourhood 'number 36' at cyber village in Tamansari district in Yogyakarta (Figure 4 a). At the beginning it was only a webblog made by its community leader as a medium to inform all the activities in this area. This development then continues by giving a number of training to the community to increase their digital literacy such as making an email account, using social media as a communication tools, etc. After several years of persistent efforts not only the community can improve their participation using digital tools but also increase their economy condition by utilizing information technology for promoting their local 'batik' production online.

Citizen-generated data is also produced by the use of social network and locative media such as Facebook, Twitter and Instagram as a media for communication and discussion including giving critiques to the city government. A Facebook page called 'Jogja Ora Didol' (Jogja is not for sale) is an example of how the citizens criticized the city government using ICT for issuing many permits related to the hotels construction and development in the city which causes problems such as traffic jam, environmental and social issues (Figure 4 b). In response to the critic and problems, the city government has issued a temporary moratorium on this hotels construction and development subsequently.

Figure 4. Cyber Village in Tamansari District (a) and Facebook page for criticising the development of hotels in Yogyakarta city (b)
Source: ***http://www.rt36kampoengcyber.com (a) and https://www.facebook.com/profile.php?id=100007510307870&fref=ts (b)***



UNDERSTANDING BIG DATA TO SUPPORT SMART GOVERNANCE OF YOGYAKARTA CITY

There are a number of challenges related to big data such as how to capture, storage, search analysis and virtualization of the data. It is necessary for the city municipality to concern the way and what to sense, how to understand the data and what action should follow after data collection.

The roadmap for Yogyakarta smart city set the indicators into seven aspects i.e. the smart environment, smart mobility, smart government, smart economy, smart people, smart living, and smart disaster management. Based on Boyd Cohen's smart city wheel, the city of Yogyakarta has the following condition in terms of smart governance dimension:

Table 1. Data compilation related to smart governance of Yogyakarta city based on indicators from Boyd Cohen's smart city wheel.
Source : (Anonim, 2016)

Indicator	Description	Yogyakarta's Data	Additional Info
Online procedures	Percentage of government services that can be accessed by citizens via web or mobile phone	0.339285714	
Electronic benefits payment	Existence of electronic benefit payments (e.g.social security) to citizens (Y/N)	Yes	Health Services
WiFi coverage	Number of WiFi hotspots per km2	10/km2	
Broadband coverage	Percentage of commercial and residential users with internet download speeds of at least 2Mbps	27%	Telephone subscribers 2014
	Percentage of commercial and residential users with internet download speed of at least 1 Gbps	N/A	Indiehome Max 100Mbps
Sensor coverage	Number of infrastructure components with installed sensors 1 point for each: traffic, public transit demand, parking, air quality, waste, H2O, public lighting	2	Traffic, public lighting
Integrated health and safety operation	Number of services integrated in a singular operations centre leveraging real-time data. 1 point for each: ambulance, emergency/disaster response, fire, police, weather, transit, air	2	Yes 118
Open Data	Open data use	N/A	
Open Apps	Number of mobile apps available (iPhone) based on open data	N/A	
Privacy	Existence of official citywide privacy policy to protect confidential citizen data	Yes	On process ISO 27001/ 2013

Table 1 shows the indicators related to smart governance and the fact from Yogyakarta city. Some data are not available (N/A); some are only at the low quantity and quality if compared to the benchmark of smart city dimension. Therefore in order to understand the flow of data and how to connect it, it is necessary to establish a working group consists of several related local government-working units and private stakeholders for each smart city dimension as shown in Table 2. By knowing which working groups involved to achieve the smart dimension, the type of data, the flow, and how to analyse the data can be more understood, discussed and well planned.

Table 2. Working Group Members for Smart City Dimension.
Source: (Anonim, 2016)

Local Government Working Unit	Working Group based on Smart City Dimension						
	Smart environ-ment	Smart mobil-ity	Smart gover n-ment	Smart econo-my	Smart people	Smart living	Smart disaste r manag e-ment
Department of Housing and Regional Infrastructure (Dinas Permukiman dan Prasarana Wilayah)	V	v				v	v
Environment Agency (Badan Lingkungan Hidup)	V					v	
Regional Development Planning Agency (Badan Perencanaan dan Pembangunan Daerah)	V	v	v	v	v	v	v
Department of Health (Dinas Kesehatan)	v				v	v	
Department of Transportation (Dinas Perhubungan)		v					
PT. Gamatechno		v					
PT. Jogja Tugu Trans - state-owned bus company		v					
PT. Telkom - state-owned telecommunications company		v		v			v
Seluler provider (Telkomsel, Indosat, XL)		•		v		v	v
Kepolisian Resor Kota			v			v	
Civil Registry Service Office (Dinas Kependudukan dan Catatan Sipil)			v				
Department of Tax and Regional Finance Management (Dinas Pajak dan Pengelolaan Keuangan Daerah)			v	v			
One-stop Permit Services Center (Dinas Perizinan)			v				
General Election Commission (Kantor Pemilihan Umum)			v				
Central Bureau of Statistics (Badan Pusat Statistik)			v				
Department of Industry, Trade, and Agriculture (Dinas Perindustrian Perdagangan Koperasi dan Pertanian)				v	v		
Department of Culture and Tourism (Dinas Kebudayaan dan Pariwisata)				v	v		
PT. PLN – state-electricity enterprise				v		v	v
Jogja Digital Valley				v			
PT. AINO Indonesia				v			
Department of Manpower and Transmigration (Dinas Sosial Tenaga Kerja dan Transmigrasi)					v		
Community and Women Empowerment Agency (Kantor Pemberdayaan Masyarakat dan Perempuan)					v		
Department of Education (Dinas Pendidikan)					v		v
Regional Library (Perpustakaan Kota)					v		
Regional Disaster Relief Agency (Badan Penanggulangan Bencana Daerah)							v

Currently level of understanding of the data collected from different sources is apparently not optimal. Besides the lack of capability of Yogyakarta government working units in managing the data, this is partly because there is no overarching policy on how this data will be treated.

5. INTEGRATED TOP-DOWN AND BOTTOM UP DATA MANAGEMENT

Based on the availability of data generated from 3 different sources and level of understanding presented above, we tried to map the level of readiness of Yogyakarta City towards the realisation of smart city means. Figure 5 shows the findings. The phase of data handling from basic to advanced stage (i.e. sensing, understanding, and action) and the utilization of diverse data sources (government's data, non-government's data, and community's data) will drive and affect the level of governance transformation. The transformation from normative to smart governance takes place in several stages i.e. normative, collaborative, interactive, and smart. Normative governance for example is dominated by the utilization of data from single source only such as Government's data though at the implementation stage it could be processed through an advanced action. Meanwhile collaborative governance starts to use and take the benefits from the availability of non-government's data and crowd-source data. Furthermore interactive governance will accommodate more diverse data and varied implementation innovatively according to the capacity of their governance. Lastly in the smart governance a full automation will handle different type of data.

From the data presented previously Yogyakarta city seems to be in between the normative and collaborative governance. Sensing, understanding and put into action are phase already done by the councils in managing the availability of government's owned data. On the other hand the city councils are sensing only a few data from crowd-sources (private or citizen generated data). In order to improve the level of city governance, a comprehensive data treatment as fundamental stage in incorporating big data seems needed as well as an integrated top-down and bottom up data management approach. The increasing complexity of the problems that faced by an increasingly open data and big data in the city governance should trigger the municipality to support the acceleration in the city's development goals.

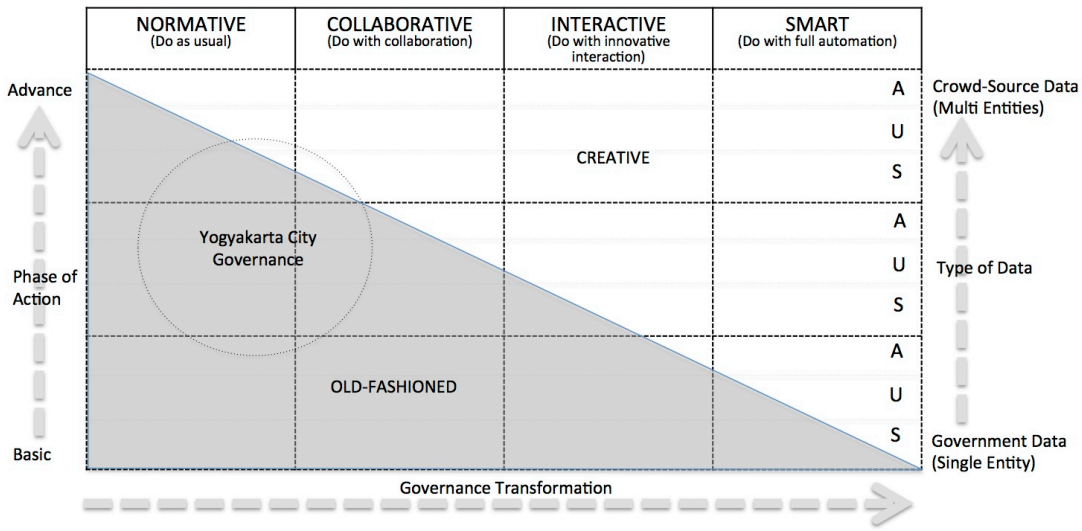


Figure 5. Level of governance and the use of data in the city of Yogyakarta

6. CONCLUSION

In preparing to accomplish the smart city initiatives, the city of Yogyakarta needs to improve their level of governance from normative to the more advanced level by managing data not only from the government but also data from non-government organizations and the communities. This is important as data can be used to support decision-making and policy formation for public services. Establishing a working group from different stakeholders can coordinate an integration of data from single to multiple entries.

Nevertheless the utilization of large amount of data and automated governance not always guarantees the achievement of Government's development goals in terms of vision and mission. There are many challenges follows. Big data that is generated from single entity to crowd source data such as social media data will provides the Yogyakarta city government with massive unstructured data, which is no order on its collection. Therefore designing the type of data input for the system should be well planned in advanced as well as how to connect the data. In addition it is also important to overlay/superimpose the data with the planning process as well as implementing contextual data analysis.

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