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Evaluation of Smart Mobility Indicators in Responding COVID-19 Pandemic in Indonesia

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ABSTRACT

The COVID-19 outbreak cuts the number of trips and people's movement during the day. Not only because of the community's awareness of the disease transmission but also because of the enforcement from the government to apply the mobility policy. This changing trip behavior is predicted to happen throughout the time of pandemic and post-pandemic. On the contrary, when mobility is decreasing, the role of ICT in community activities is increasing. This condition leads to an interesting question for the smart city, especially the smart mobility concept, whether the smart mobility concept has been properly addressed and responded to the pandemic and post-pandemic era or not. This paper aims to explore how far smart mobility planning has been applied by local governments in Indonesia, especially in response to community activity during the pandemic era. Our approach in this paper is a qualitative study in evaluating online local government planning documents as our main data. We choose the study cases in three cities that got high-tier ranks in the smart city awards in 2019 (based on Rating Kota Cerdas Indonesia/Indonesia's Smart Cities Rating), which are Semarang, Samarinda, and Magelang. We review the literature on smart mobility indicators and those smart mobility indicators used in planning documents. Then, we evaluate the relevance of those indicators to the condition of the pandemic and post-pandemic era. We found that smart mobility indicators have not received much concern as the main aspect of a smart city in Indonesia.

Keywords: Indonesia's smart city, smart mobility, COVID-19 pandemic, indicators.

INTRODUCTION

One of the influences of the COVID-19 pandemic is it has changed people's travel patterns. Almost in all countries, the government limits mobility in public places to reduce severely contagious virus transmission. Public transportation must limit its passenger number. Meanwhile, people tend to choose private vehicles because of safety considerations to have less contact with other people. However, the activity of people, such as going to school, market, or office, could not stop, even when mobility is limited. Insistently, routine activity should get helped with online practice and technology usage. People adapt to do their activities with online telecommunication, such as telework, teleconferencing, online learning, and even telehealth (Mouratidis dan Papagiannakis, 2021).

A few years back, technology has been held an important role to support and help human activities. In the city planning area, technology measure has been introduced to be integrated with the planning documents to establish the concept of a smart city. In the early concept, the elements of a smart city are separated into 6 (six), including smart economy, smart people, smart governance, smart mobility, smart environment, dan smart living (Giffinger (2007). Of those six elements, the one closely related to transportation is the smart

mobility element. In particular, several studies have formulated the definition of smart mobility. Although the definition may differ according to the context (So et al, 2020), something that is generally similar to the definition of smart mobility is the use of technology to create mobility becoming more accessible, efficient, safe, and sustainable (Dia, 2016; Benevolo et al, 2016; Lyons, 2017, Giffinger 2007). According to Deloitte (2018), with the development of transportation technology, in addition to traditional public transportation, there are 4 (four) other alternative modes included in the definition of smart mobility such as ridesharing, bicycle commuting, car-sharing, and on-demand ride service.

However, the COVID-19 pandemic has led to new challenges and opportunities or more to the need for a new perspective on smart mobility elements that focus on preventing COVID-19 transmission during travel, including in Indonesia. The early concept of information and technology usage is for supporting efficiency and safety mobility, such as the integrated payment of public transportation, real-time traffic information, automated vehicle detection, and other technology practice before the pandemic era. While, in the pandemic era, health protocol, such as physical distancing and the percentage of public transportation becomes the main factor to be considered in the implementation of smart mobility in the future (So et al., 2020).

Then, this paper aims to identify to what extent the implementation of the smart mobility concept in Indonesia is based on the government perspective and its relevance to the changing of people's mobility during the COVID-19 pandemic. Cases that are chosen in this study are cities that were ranked as top smart cities in Indonesia, e.g. Semarang, Samarinda dan Magelang, by an evaluated institution, RKCI (rating Kota Cerdas Indonesia, 2019). This study also emphasizes the government's part for its role as an authority in smart city development.

This article has 6 (six) parts. First, this section is the introduction. Then, the second part is a literature review about people's mobility patterns in the pandemic era and smart mobility benchmarking abroad and in Indonesia. The third part is the methods, data, and analysis procedures. The fourth part is about the result. Last, the conclusion and discussion are in the fifth and sixth parts.

SMART MOBILITY REVIEW

Mobility has been considered one of the indicators of transportation system performance. The common definition of mobility is the capability to get to various activity places, such as stores, schools, or workplaces (Giuliano and Hanson, 2017). Meanwhile, smart mobility is one of the main elements of a smart city, a concept that was initiated as an effort to create a sustainable city through ICT support (Ahvenniemi et al, 2017). The development of the smart city concept began in the early 2000s through research related to smart cities in cities in Europe (see Giffinger, 2007). In his research, Giffinger (2007) defines 6 (six) main elements in the smart city concept, namely smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

Several studies have been conducted in developing relevant smart mobility components and indicators (see Debnath et al, 2014; Garau, 2015; Battara, 2018; and Chen and Silva, 2021). The most cited study related to smart mobility was conducted by Debnath et al (2014). This study assessed 26 (twenty-six) cities in the world using 63 (sixty-three) smart mobility indicators that were divided into six main components (sensing, processing and control, communicating, predicting, healing, and preventing) and in 3 transportation groups, or subsystems (private transport, public transport, and commercial and emergency transport). In another study, Battara (2018) also developed a set of smart mobility indicators to assess several cities in Italy by combining 2 sets of smart mobility indicators, 18 indicators developed by Garau (2015) and 22 indicators developed by Gillis et al (2015). This

combination produces 29 indicators which are divided into 3 categories of mobility actions, namely, accessibility, sustainability, and ICT (Information and Communication Technologies). In a recent study, Chen and Silva (2021) also developed a set of smart mobility indicators by considering several sets of indicators that have been developed in previous studies to assess the performance of cities in the UK. The consideration of many previous studies is also reflected by the adaptation of 3 (three) transportation groups in Debnath et al (2014) and 3 (three) mobility action categories in Battarra (2018).

Among others, the most cited study is Debnath et al (2014) which focuses on the integration between smartness and infrastructure availability. The study argued that smart mobility indicators should not only look at the existence of transportation infrastructure but also have to emphasize the integration of transportation infrastructure and communication and information technology. On the other hand, some studies such as Battara (2018) and Chen and Silva (2021) emphasize the integration of smart mobility indicators with the sustainability aspect. Therefore, in their study, bicycles, pedestrians, and other high-tech environmentally-friendly vehicles are still being considered as indicators.

During the pandemic COVID-19 era (since around March 2019), mobility has dropped in number significantly around the World (Abu-Rayash & Dincer, 2020; Beria & Lunkar, 2021; Bucsky, 2020; De Vos, 2020; Shakibaei, de Jong, Alpkokin, & Rashidi, 2021). The concern about the spread of the virus from person to person has also reduced the use of public transportation and shifted to the use of private transportation, including the use of bicycles and pedestrians. (Buehler & Pucher, 2021; International Transport Forum, 2020). According to Mouratidis dan Papagiannakis (2021), this condition does not necessarily continue after the pandemic is over. However, should the trend of private vehicle usage continue to increase, there are negative consequences that need to be anticipated, such as congestion, increased pollution, and inequality in accessibility. The International Transport Forum (2020) also explains that the reduction in traffic flow that caused emptier roads leads to an increase in cars' average speed. This needs to be considered because it can increase the potential for accidents for cyclists and pedestrians. This needs to be considered because it can increase the potential for accidents for cyclists and pedestrians.

In Indonesia, the smart city planning concept is officially adopted by the Indonesian government through the ministry of communication and information. Since 2017, the Ministry of Communication and Information has initiated the smart city movement in Indonesia and developed a guideline to support the development of the smart city in Indonesia (Directorate General of Informatics Applications, 2017). It consists of a smart city assessment component based on the readiness element and the smart city pillars element. The readiness element is divided into the structure, the infrastructure, and the superstructure. The smart city pillars consist of six main elements adopted from Cohen's smart city wheel which are (1) Smart Governance including Public Service, Bureaucracy, and Public Policy, (2) Smart Branding including Tourism Branding, Business Branding, and City Appearance Branding, (3) Smart Economy including Competitive Industry, Welfare, and Transaction, (4) Smart Living including Harmonization of Regional Layout, Health Facilities, Mobility Access, (5) Smart Society including Community Interaction, Learning Ecosystem, and Safety & Security, (6) Smart Environment including Environmental Protection, Waste Management, and Energy

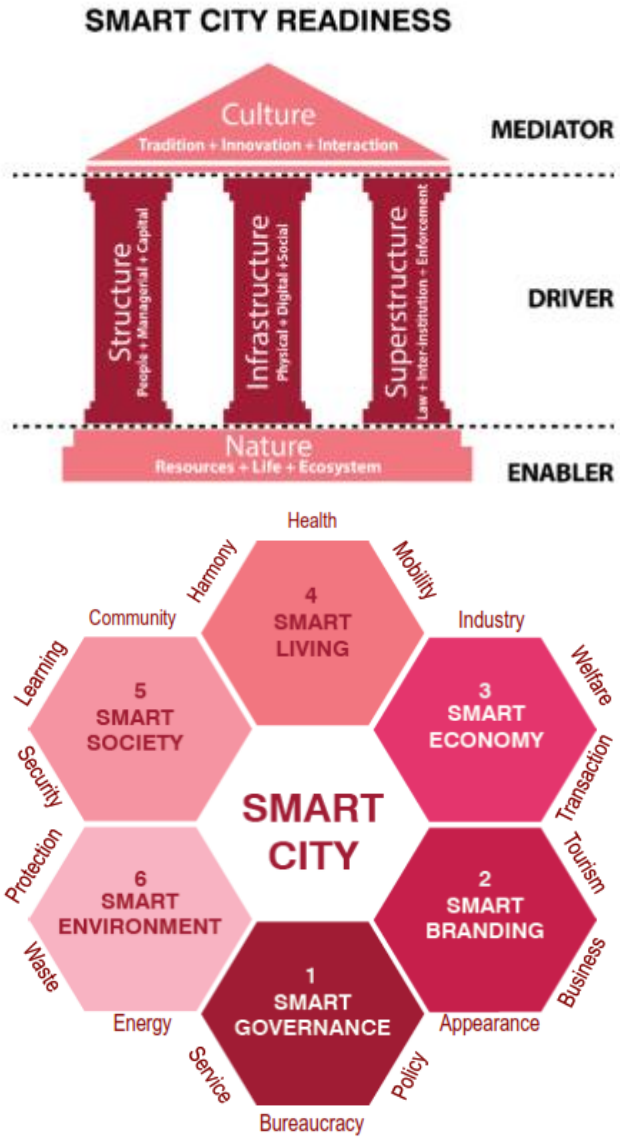

Figure 1. Smart City Readiness (above) and Smart City Dimension (below)
Source: Citiasia Center for Smart Nation (CCSN)

Slightly different from the smart city wheel concept and the earlier concept introduced by Giffinger (2007), the smart city guideline in Indonesia does not consider smart mobility as the main element but as a subset of smart living elements together with smart harmony and smart health. As the name implies, smart health is related to health-related programs while smart harmony is related to programs in the housing sector. Smart mobility itself is defined based on the role of local governments in creating environmentally-friendly transportation ecosystems that connect public needs (Mahesa et al, 2019).

METHODS

This study used a qualitative approach by using secondary data, several previous studies, and government planning documents as the main data sources. Previous studies to be reviewed related to two things. The first is related to the changing of mobility patterns during the COVID-19 pandemic and the second is related to several smart mobility indicators in several countries.

In identifying the changes in people's mobility patterns, this study also uses mobility data from COVID-19 - Google Global Mobility Report from March 3, 2020, to June 6, 2021. However, available data is at the provincial level, while the unit of analysis in this study is at the city level. Therefore, Google Mobility Data is only used as a general description and not an accurate condition.

This study took 3 Indonesian cities as cases that are in the top smart city rank based on the 2019 Indonesian Smart City Rating (RKCI) 2019, namely Semarang, Samarinda, and Magelang which are classified as large, medium, and small cities in Indonesia respectively. For mobility data, Central Java Province mobility data is used to describe the general people's mobility trend in Semarang City and Magelang City. Meanwhile, mobility data of East Kalimantan Province is used to describe the general people's mobility trend in Samarinda City.

Related to smart city planning in Indonesia, some documents to be studied were the smart city development master plan, the city's Medium-Term Development Plan, and the strategic/action plan of the related department such as the Department of Transportation and the Department of Communication and Information.

The indicators used in this study were several sets of indicators that have been developed previously. By using compare and contrast analysis, this study selected relevant indicators from two previous studies. The first study was conducted by Debnath et al (2014) who focuses on the integration of transportation infrastructure and information technology. The second study was conducted by Chen and Silva (2021) who comprehensively considered previous smart mobility studies. However, because this research focuses on the perspective of the local government (authority), then these indicators will only be selected which are related to the authority of the local government (table 1)

Table 1. Selected smart mobility indicator

	Private	Public	Emergency
Accessibility	En-route detection	Responsive supply	En-route detection
	Detect at parking facilities	**Demand prediction**	**Demand prediction**
	Driver – Infrastructure	Passenger detection	Dynamic route guidance
		Track/service recovery	In-vehicle safety management
		En-route detection	Authority – Operator
Sustainability		Early service failure warning	
	Detect for enforcement	Infrastructure safety & security	
	Infrastructure safety & security	Incident recovery	Responsive supply
	Vehicle – Driver		
	Incident recovery		
Innovation	Passenger detection	Signal priority; driverless transit vehicle	Vehicle – Vehicle
	Detect at intersections	In-vehicle safety management	Signal priority
	Control signal; speed limit; expressway entry ramps speed limit; % metered ramps	Authority – Vehicle	
		Operator – User	Early disaster warning
	Toll/parking charge payment	Detect at terminal/depot/station/stop	Asset recovery

Table 1. Continued…

	Private	Public	Emergency
	Automated parking systems		Incident recovery
	Traffic flow prediction	detection of unauthorized vehicles:	Special event planning
		Intermodal and e-fare payment	Commercial transport planning
	Infrastructure – Vehicle	Electronic travel tickets by mobile devices	
	Integrated land-use planning	Public transport planning	

RESULT

Post COVID-19 mobility and Smart mobility indicator

One of the significant changes during the COVID-19 pandemic is the reduction in people's mobility and a shift in the use of public transportation to private transportation driven by concerns about the risk of virus transmission. Based on google mobility data, the overall people mobility in non-residential areas in Central Java and East Kalimantan is still less than the normal condition which was before March 15, 2020.

The residential percent change shows that mobility in both provinces had a positive trend towards normal. However, residential mobility in Central Java was still almost 100 percent higher than normal conditions which means that people were still more active in residential areas. Meanwhile, in South Kalimantan, people's mobility in residential areas was already in normal condition. The trend towards normal conditions was also seen in transit areas for both Central Java and East Kalimantan. Although it was in a declining trend, mobility in the transit area had been in normal condition at the end of May 2021. This condition occurred because there was a major religious activity, Ied Fitr. The similarity between the two provinces can also be seen in the people's mobility in the workplace area which is still not normal and even still showing a trend away from normal conditions.

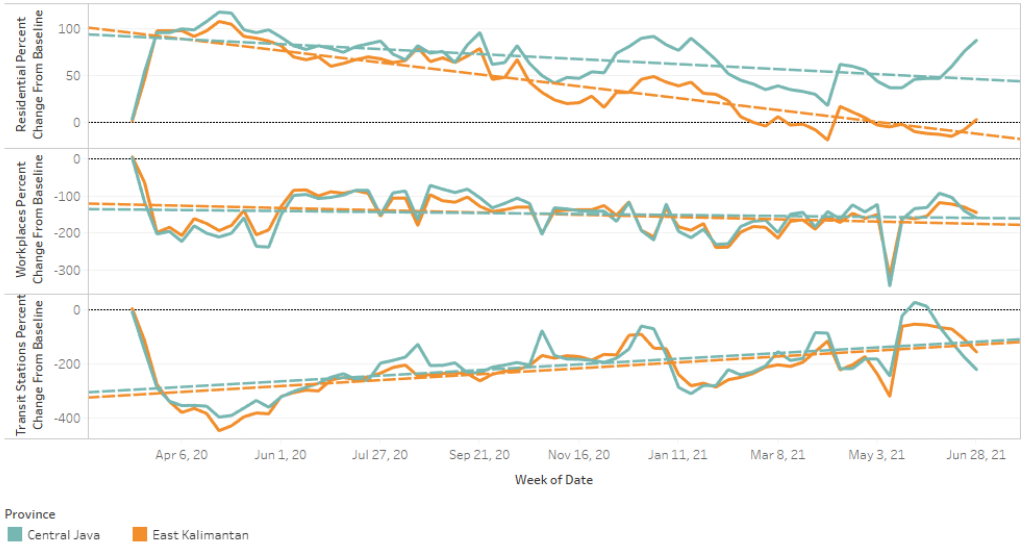

Figure 1. Mobility Percent Change From Baseline in Central Java and East Kalimantan based on Google Mobility data

Even though there has been a trend towards normal conditions in residential and transit areas, the nature of people's mobility has changed significantly. The face mask is mandatory when using public transportation. Furthermore, in inter-city transportation such as trains and planes, vaccination is also a mandatory requirement for passengers. The change in mobility nature is also seen in the increase in private car usage. This phenomenon could be seen from the steep decline of the mobility trend towards normality in residential areas that was not followed by the mobility trend in transit areas.

Compared to the set of indicators compiled in this study, private vehicles have become a concern in smart mobility indicators such as the use of GPS and automated private vehicle detection infrastructure. In terms of infrastructure, several things such as cameras for monitoring and their automatic signal regulators in various types of locations have been considered. However, what is still lacking are indicators related to bicycles and pedestrians. The increasing level of vulnerability for pedestrians and cyclists, both from virus transmission and cars, does need attention. So far, the existing smart mobility indicators related to pedestrians and bicycle lanes are still limited in their availability and not on the role of technology. (see Battara et al, 2018)

Smart mobility program in Semarang, Samarinda, dan Magelang

According to the 4 government planning documents being studied, the Medium Term Development Plan, Strategic Plan, Action plan, and Smart City Masterplan, each region has a smart city planning concept in various terms. The description of the smart city concept in each city is as follows.

Semarang

Semarang, a big city that is ranked as the top smart city according to RKCI does not have many special programs related to smart mobility. In the Medium Term Development Plan, the concept of smart city development is more emphasized in the elements of smart governance, namely the development of systems for planning, budgeting, controlling, reporting, and managing regional finances and assets. Meanwhile, programs related to smart mobility are listed in the strategic plan and action plan of the transportation department and the communication and information department, namely the procurement and installation of the Area Traffic Controller System (ATCS). ATCS is an information technology-based traffic control system that includes several main systems such as servers and workstations, video surveillance, and vehicle detectors. Other programs related to smart mobility are listed in the Semarang Smart City Master Plan where the Government plans 1 program related to smart mobility among 31 programs in the smart living element titled smart bus application development program.

Samarinda

The smart city program listed in the Medium Term Development Plan of Samarinda City focuses on developing information and communication technology infrastructure in the city. More specifically, The Department of Transportation and The Department of Communication and Information plan two smart mobility-related programs in their strategic and action plan. First, procurement and installation of traffic lights and area traffic control systems (ATCS). The second is the information technology application development program. Other programs related to smart mobility in Samarinda City can be found in the smart city master plan. There are 5 out of 21 programs in smart living elements such as roads and other transportation infrastructure construction and maintenance. Although there are quite many, the 5 smart mobility programs are still not specific and do not clearly show the use of information technology in their implementation.

Magelang

Similar to Semarang, Magelang's smart city program listed in its Medium Term Development Plan focuses more on the use of information and communication technology to support the smart city concept through the smart government's public services that will be implemented through Communication and Information Department. In addition to the governance-related program, the Communications and Information Department and the Transportation Department were also planning several programs related to smart mobility in their strategic and action plan document. Similar to Semarang and Samarinda the smart mobility-related program is the development of ATCS. Apart from it, there are no other programs related to smart mobility even in its smart city master plan. Magelang Government has only programs related to smart health and smart harmony subelements in its smart city master plan. It has a sort of smart mobility strategy which is using the internet of things in transportation matters. However, it has not been elaborated into the smart mobility program.

DISCUSSION

In general, the three regions studied have programs related to smart cities which are in improving public services which are included in the elements of e-governance. In the smart mobility element, the three cities also have a similar program, namely the development of ATCS from the transportation department. Based on the smart city master plan document, each city has differences in responding to smart mobility indicators. The basic difference lies in the level of detail of the planned program. Semarang is a city that has a fairly detailed planning program. In addition, its status as a large city with a large population creates the need to increase efficiency in public transportation through the trans bus application program. This is not the case in the other two cities which are smaller in size and do not yet have an urgent need for public transport. Although it is quite detailed, the smart mobility program in Semarang City is still very few compared to the smart health and smart harmony subelements-related programs. This also happened in 2 other cities. Magelang has not even had a program related to smart mobility in its smart city master plan. Samarinda, even though it has many smart mobility-related programs, substantially it does not necessarily be directly classified as 'smart'.

Contrary to smart mobility-related programs, the other two smart subelements in smart living element namely smart health and smart harmony are quite many. The emphasis on smart health and smart harmony-related programs in those three cities can illustrate that health issues are and are still the main issues in urban development. Although the problem of congestion still exists, the solution in transportation is still focused on the procurement of non-digital transportation infrastructures such as the construction of roads and transportation nodes.

When confronted with the pandemic conditions that have changed the pattern of people's mobility, it can be said that the three cities do not yet have a relevant and significant smart mobility-related program. Existing smart mobility programs, both in sectoral strategic/action plans and in master plan documents are still limited to traffic flow regulation. Meanwhile, the need for mobility during and after the pandemic requires more advanced technology that can ensure that health protocols when driving are still followed. From the indicators compiled, technology such as ANPR, detection of the number of passengers, and direct notifications to drivers will increase the health protocols compliance.

CONCLUSION

The COVID-19 pandemic situation has a direct impact on people's mobility, including in Indonesia. Travel and travel policies will increase the spread of public transportation, and

reduce traffic and the number of public transportation users, accompanied by an increase in private transportation, cyclists, and pedestrians.

Then, what about the role of smart mobility in this changing mobility pattern? Several indicators are still relevant and need to be adjusted, especially in the public transportation system. The role of technology in the number of passengers with certain criteria can increase public confidence in using public transportation. Parallel to that, the negative impact of using private vehicles can be mitigated with technologies that directly connect authorities with drivers such as ANPR and cellular notifications.

Unlike in developed countries that have more advanced technology in transportation sectors, in Indonesia, the utilization of the smart mobility concept to accommodate people's mobility during and after the pandemic is still lagging. Currently, the development of Indonesia's smart cities is still more focused on government services, health dan housing sectors while smart mobility still has not become a major concern. City governments are still expected to put considerable effort to support efficient and safe mobility during and after COVID-19.

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