Model Development of Smart Transportation using the Performance Measurement of Smart City Result with It Balance Scorecard and IPA Matrix: Jakarta Case

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Abstract: The purpose of this research is to carry out evaluations and measurements related to the application of smart cities Jakarta which will continue propose a smart transportation model. The methodology used in the evaluation is using the IT Governance approach with the IT Balance Scorecard and IPA Matrix with 200 respondents from Jakarta residents. The results of this paper show there are three major problems that need to be addressed immediately: Deliver Value; Manage operational service performance; Deliver successful IT projects, and the solution purposed is creating smart transportation model, as a form of improvement.

1 INTRODUCTION

The population growth has increased to 29.43% from 2017 to 2050, reaching 9.772 billion people (of Economic and Affairs, 2017). The result of this condition is increasing complex in one of big cities problems, but transportation also being one problem in large cities. Good transportation facilities just avoid congestion are always the main points, but beside that the needs to be considered is provoding safe and comfortable transportation being a real thing faced in the city today. Based on land transportation statistics from Indonesian Central Bureau of Statistics, it is known that the level of accidents is still high even the death is quite high.

The high mobility of people and goods in Jakarta still not in accordance with safety and comfortable public transportation. The current trend is designing smart transportation related to smart alternatives to control private vehicles and reduce congestion (Pindarwati and Wijayanto, 2015) Previously, the similar development had been carried out, not only using transportation system management but also using RFID as part of its development (Wen, 2010).

In Indonesia especially Jakarta City, many implementation proposals have been made, but for some people, application of the technology is the main point, but conversely transportation is not only about avoiding congestion but also how to create safe transportation. The level of accidents related to transportation still not good and become a story, we can say, it happend without stopping.

In this paper will conduct an assessment in advance related to the implementation of smart city that has been applied before and propose the design of transportation system framework specifically in Jakarta to provide smart and safe transportation solutions. This study is based on literature and the data used are land transportation statistics from the National Statistics Agency.

2 RELATED RESEARCH

Previously, the research started with reference search related to smart transportation previous research which would be used as references:

Table 1: Previous Research Comparison of Smart Transportation Model

Author	Literatur	Result
(Pindarwati and Wijayanto, 2015)	Measuring performance level of smart transportation system in big cities of Indonesia	Presented a comprehensive framework for benchmarking smart transport cities, which was illustrated using the data of 5 large city in Indonesia
(Dirgahayani, 2013)	Environmental co-benefits of public transportation improvement initiative: the case of Trans-Jogja bus system in Yogyakarta, Indonesia	This paper examined the environmental co-benefit of public transport improvement programme by taking the introducting of Trans-jogja bus system in Greater Yogyakarta, Indonesia as the case study.
(Wibowo and Suryanegara, 2016)	On developing the model of Smart Logistic Transport in Indonesia	Proposed the business model of smart logistic transport in Indonesia
(Effendi et al., 2016)	Smart city Nusantara development through the application of Penta Helix model	This paper presented the framework for smartcity nusantara with penta helix model collaboration.
(Purnomo et al., 2016)	Smart city indicators: A systematic literature review	This paper conducted research of generating the developer trend in the Smart City, especially on indicators which are generally regarded as the main factors in deciding the development of the city

Previous studies focused more on building models without conducting an assessment process and also prior evaluation. This research will start with evaluation and also continue with assessment process related to the application of smart city will be carried out using the BSC IT approach which the approach is used not only ttake measurements but also as an assessment of IT management systems and in detail conducting assessments related to 4 perspectives namely: (1) Corporate Contribution; (2) Stakeholders; (3) Operational Excellence; (4) Future Orientation (Grembergen, 2005)

3 THEORETICAL BACKGROUND

3.1 Smart Transportation Definition

Smart Transportation can be defined as transportation model that utilizes wireless technology automatically so as to facilitate and increase comfort for passengers and drivers in their mobilization activities. Increased safety and efficiency factors are concern in an intelligent transportation system (Pindarwati and Wijayanto, 2015).

Previous research has proposed a framework for intelligent transportation needs. There are 3 layers needed for intelligent transportation, namely (1)input layer, (2)storage layer, (3)analysis layer and communication layer (Shukla et al., 2016).

This is to answer transportation problems that are common in big cities, such as: congestion, difficulties in parking locations, length of travel due to congestion, inadequate public transportation and disruption of distribution (Pedersen, 2016).

Previous challenges emerged in the development of smart transportation such as the availability of good

communication / data lines, the provision of accurate information and adequate electronic devices began to be overcome with the development of IoT and Cloud Computing (Yang et al., 2016)

3.2 Smart Transportation Measurement

Smart Transportation Measurement The model of smart transportation calculation uses an analysis of the availability of transportation services to provide solutions to transportation problems. There are 6 categories with each of the 3 domains analyzed (Pindarwati and Wijayanto, 2015) (Debnath et al., 2014) :

a Categories: Process and control, heal, prevent, Sense, Predict, Communicate

b Domain: Public, Private, Commercial and Emergency

Another concept mentions, the need for the following factors as important things that need to be measured in assessing smart transportation systems in a city, namely: (1)mobile services, (2)the creation of operational efficiency of transportation services, (3)availability of information for users, and diversity payment model. Other supporting factors that also need to be addressed are (1)the availability of parking systems, (2)lighting systems, (3)car services and (4)electricity-based refueling and (5)management of transportation assets (Pedersen, 2016).

3.3 Jakarta Transportation Systems

Jakarta has an area of 740.28 square kilometers with a population of around 10.27 million people in early of 2018, on these working days this number has increased due to the arrival of workers from other cities such as Bekasi, Tangerang, Bogor and Depok. This growth has resulted changes in land use often not in accordance with urban planning and lack of public services for urban infrastructure needs (Katadata, 2018) Along with the improvement of road infrastructure, economic growth and people's income, the number of vehicles has increased (of Economic and Affairs, 2017). Based on data from the Jakarta Transportation Agency, the ratio number of private vehicles and public ransport vehicles is 98% and 2%. Various efforts have been made by the provincial government of DKI Jakarta to deal with the problems of the capital city of Indonesia such as: the provision of public transportation (TransJakarta Bus, LRT, MRT), traffic engineering (regulation of odd-even vehicle numbers, restrictions on vehicle types).

3.4 Smart City Definition

Many definitions of smart city have emerged, previous research defines Smart city as a city with the ability to monitor, integrate the conditions of infrastructure including roads, land transportation, sea transportation, communications, electricity, water and buildings including buildings so that resources become more optimal includes monitoring security aspects as part of the maximum service to citizens (Madakam, 2016). As part of implementation and realization of Smart city, there are 6 characteristics need to be available in the city, namely: Smart Economy, Smart Environment, Smart Governance, Smart Living, Smart Mobility and Smart People (Purnomo et al., 2016).

3.5 IT Balance Scorecard Definition

The IT Balance Scorecard governance was developed to assess how well the organization carries out IT governance. IT Balance Scorecard governance is not only done as a measurement system for IT governance processes, but also can show a cause and effect relationship between perspectives (Jairak and Praneetpolgrang, 2013).

The framework from IT Balance Scorecard can describe in figure 1 while, first the corporate contribution perspective measures the performance of IT governance processes for ensuring that business can achieve maximum profit from IT while reducing risk at a reasonable point. Second, the stakeholder perspective are to measure stakeholder satisfaction, management of stakeholder needs, and legal/ethical compliance. Third, the operation excellence perspective identifies the maturity of IT governance structures and processes. Lastly, the future orientation perspective is designed to measure the foundations of skills, knowledge, and IT/business partnership for IT governance delivery (Van Grembergen and De Haes, 2005).
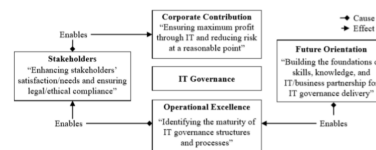

Figure 1: IT Balance Scorecard (Van Grembergen and De Haes, 2005)

4 METHODOLOGY

The method used in this paper is a literature review, as well as making measurements using the IT Bal-

ance Scorecard and intensive literature comparison conducted in Indonesia which is specifically carried out in other big cities to see the characteristics of the region, transportation infrastructure and types of vehicles to suit the conditions of the city of Jakarta . The initial stage done by providing data and information about the area, transportation, accident rates etc. Then transportation intelligence is valued from all cities and then compared. Intelligence indicators were adapted from a journal published by (Debnath et al., 2014) which is the basis for research preparation as well as a benchmarking framework and better development related to a smart and safe transportation system. Data, transportation and infrastructure areas were obtained from the Indonesian Central Bureau of Statistics.

Data collection given to 200 respondents to Jakarta community which assessment using a Likert scale and also self-measurement using matrix important approaches and performance analysis by (Martilla and James, 1977) which measurements focus on how important and the level of achievement related to implementation.

In figure 2, Quadrant I is "concentrate here", the valuation of this attribute is an important part but low performance is identified, the improvement effort must be focused on this quadrant. Quadrant II is "Keep up the Good Work", valuation which means very important and indicates that achievement has been very good, which has been well implemented and the organization is able to maintain its performance. Quadrant III is labeled "low priority", where the assessment in this quadrant is considered as a low or not important enough interest. Quadrant IV is labeled "possible overkill", in this quadrant it is not too interested but has a relatively high performance.
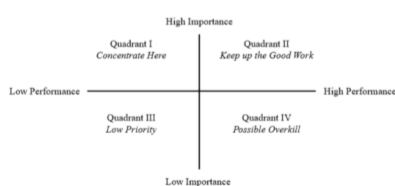

Figure 2: Important and Performance Analysis (Martilla and James, 1977)

Likert scale to measure the importance of starting from a scale of 1 to 3, namely: 1 = not important; 2 = important; 3 = very important, while measuring performance starts from a scale of 1 to 3, namely: 1 = not monitoring; 2 = monitoring; 3 = always monitoring.

In this study, the authors used an instrument adopted in (Abu-Musa, 2007) study where out of the 23 instruments in this study only used 15 instruments which were divided into 4 BSC IT perspectives where the authors considered according to the conditions of
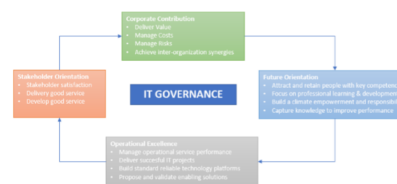
smart city implementation in Jakarta as present in fig. 3.

Figure 3: The Instruments of Measurement of IT BSC (Abu-Musa, 2007)

5 DATA ANALYSIS & RESULTS

The next study continued with evaluating using the IT BSC on the implementation of smart cities where the evaluation results are as follows:

Table 2: Cronbrach Reliability Scale

Construct	Item	Cronbach's a (Important aspect)	Cronbach's a (Performance aspect)
Corporate Contribution	CC1;CC2;CC3;CC4	0.811	0.902
Future Orientation	FO1;FO2;FO3;FO4	0.765	0.873
Stakeholder Orientation	SO1;SO2;SO3	0.881	0.852
Operational Excellence	OE1;OE2;OE3;OE4	0.745	0.872

The T test done by check the reliability of each item of each construct. In table 2 the results of the test show that Cronbach test results show a value above 0.70 where it can be concluded that the items tested have a reliable value.

The next test result is to identify significantly between importance and performance. In figure 3, the test results show that the respondent's results show the distribution in each quadrant. The Importance and

Performance Matrix shows that: quadrant I shows attributes that need to be improved; quadrant II informs the point that the organization has worked well and needs to maintain its quality; quadrant III shows low priority priorities and organizations usually limit resources in quadrant III; quadrant IV focuses on optimal use of resources including the re-establishment of policies in an organization.

The next test result is identify significantly between importance and performance. In figure 4, the test results show that the respondent's results show the distribution in each quadrant. The Importance and Performance Matrix shows that: quadrant I shows attributes that need to be improved; quadrant II informs the point that the organization has worked well and needs to maintain its quality; quadrant III shows low priority priorities and organizations usually limit resources in quadrant III; quadrant IV focuses on optimal use of resources including the reestablishment of policies in an organization.
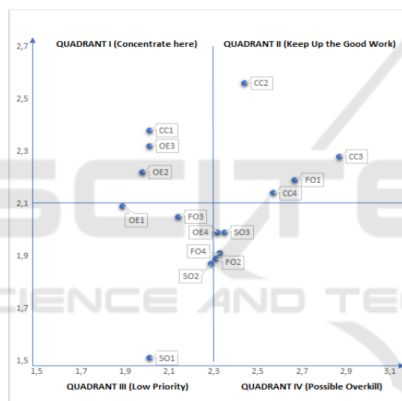

Figure 4: Result of IT BSC based on Important and Performance Analysis Matrix

In **Quadrant I**, there are 3 instruments namely Deliver Value; Manage operational service performance; Deliver successful IT projects. This indicates that performance measurement has not yet been carried out properly, especially in the 3 instruments. In **Quadrant II** there are 4 instruments, namely Manage Costs; Manage Risks; Attract and retain people with key competencies; Achieve interorganization synergies are in good performance but quality must be maintained to be even better. In **Quadrant III** there are 6 instruments, namely Manage operational service performance; Build a climate empowerment and responsibility; Propose and validate enabling solutions; Capture knowledge to improve performance; Delivery good service; Stakeholder satisfaction which is included in the "low priority" category where the organization will usually limit resources to maintain the quadrant, further a brief interview with respon-

dents is informed that if this is possible if the instruments in quadrant I are carried out in good condition then all quadrant III instruments will be automatically has good results even with minimal supervision. In **Quadrant IV** there are 2 instruments, namely develop good service and focus on professional learning & development where in this quadrant it is indicated that there is a need for further policies or improvement of policies, as well as more optimal use of human resources.

6 PROPOSED MODEL OF SMART TRANSPORTATION

Based on analytical data from the Central Statistics Agency, it is known that in Jakarta specifically there is a transport fleet with a total of around 45,902 whose growth decreased 2.08% over the previous year. And based on the results of the Balance Scorecard IT test related to the implementation of smart city where the main focus on the instrument in quadrant I is: Deliver Value; Manage operational service performance; Deliver successful IT projects proposed the smart transportation model as follows:
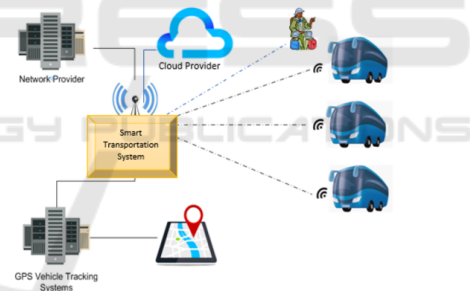

Figure 5: Smart Transportation Purposed Model

Sukhla's (2016) research has proposed a Smart Transportation system architecture, which consists of four layers, namely the input layer, storage layer, analysis layer and the last communication layer. The model, we propose is a further development of the architecture. As illustrated in Figure 5, the process starts from the first layer which is the basic part that collects all the information entered through several input devices such as: CCTV, RFID, and GPS Vehicle Tracking System. All of the following input data will be collected into storage media and processed through database. The results obtained from this analysis process is information according to the needs of the passengers and the bus managers including the drivers inside. Intensive communication in the form of information requests from buses that operate into data storage, makes this model continue to grow in informa-

tion and data processing. And in the end the system can be smart to answer each question or request information with accurate data in real time. The communication media used utilize the network provided by the network providers in the area, so as to reduce the investment costs of the implementation of this model. The use of cloud computing technology and big analytic data is needed especially in the data storage and processing.

In detail, to clarify the model proposed, figure 6 illustrates the use case of the main functions that exist in the proposed smart transportation model. The first activity is carried out by the system admin who fills out the initial data in the form of: Daily route transportation, route tracking, position tracking, status checking. Notifications will be sent automatically when data changes occur. Passenger and driver can request information such as transportation tracking, status trip updates, daily route and vehicle condition information especially for drivers. Every incoming data is processed by the system, so that if a dangerous condition occurs, it can be avoided, because the system has given a warning / notification first.
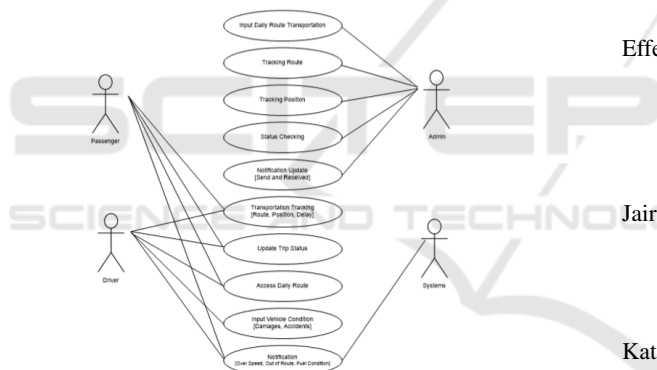

Figure 6: Use Case of Smart Transportation Function

7 CONCLUSIONS

According to the development of the Smart City concept that is increasing, transportation problems are also become a special concern. Based on the results of data analysis from 200 respondents, using the IT Balance Scored Card and Importance and Performance Analysis matrix approaches it is known that there are three major problems that need to be addressed immediately, namely: Deliver Value; Manage operational service performance; Deliver successful IT projects. If this problem can be handled properly, then the problems in other quadrants can also increase. The purposed smart transportation model, as a form of improvement in quadrant one, has been

adjusted to the availability of infrastructure and availability of facilities in the city of Jakarta. With limited coverage in this study specializing in public transportation facilities in the city of Jakarta, further research can be done by adding data from private transportation modes and other types of vehicles, as well as adding data from other cities. Application development from this model can also be used as further research, so that it can be directly useful to reduce the number of accidents.

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