Application of Smart Mobility in the DKI Jakarta Transportation System with KRL Commuter Line Transportation Mode

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| KEYWORDS	ABSTRACT
smart mobility; KRL commuter line; accessibility; sustainable; information technology system	Congestion is one of the main problems of DKI Jakarta as the National Capital. Complex population mobility due to high population density and territory. Urban transportation problems can be solved by building strong, extensive, and effective transportation systems and networks to ensure a high level of accessibility. Electric Rail Train (KRL) Commuter Line is one of the alternative public transportation that is expected to anticipate and reduce congestion levels. This research was conducted to find out how the development and contribution of KRL Commuter Line transportation modes in supporting the implementation of the Smart Mobility concept in DKI Jakarta. This research is a qualitative approach carried out using the comparative description method, which compares indicators of research variables with conditions that occur in the field. The results of this study state that all aspects of Smart Mobility have been achieved in the KRL Commuter Line transportation mode. In the aspect of accessibility, it can be seen from the number of stations, the number of train series, and the number of trips also increased from year to year. On the sustainable side, KRL Commuter Line can be considered environmentally friendly because it uses an emission-free and efficient source of electrical energy in the use of space, each KRL Commuter Line trip can accommodate up to 3,000 passengers. Aspects of information technology systems, which in terms of electronic payment systems PT KCI is open and adaptive to technological developments.

Introduction

DKI Jakarta Province as the State Capital has urban problems, such as congestion caused by increasing population, high population density, and high urbanization (Hasoloan, 2018). Based on TomTom Traffic Index Ranking 2017, DKI Jakarta ranks 4th as the most congested city in the world with congestion levels reaching 61 percent of 404

cities measured from 58 countries on six continents. Congestion is also caused by an increase in the number of private motor vehicles that is not proportional to the increase in road length and infrastructure. As a result, Jakarta is also ranked 4th as the capital of the most polluted country (Sunitiyoso et al., 2022).
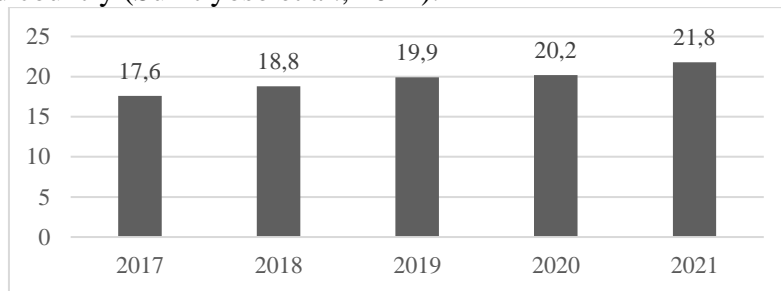
Graph 1
Growth Trend in Number of Vehicles in Jakarta (in millions)
Source: Central Bureau of Statistics, 2021

Several policies taken by the Government to overcome Jakarta's congestion, such as the construction of flyovers, underpasses, and toll roads (Nugroho, 2013). The collaboration carried out between the DKI Jakarta Provincial Government and the Central Government, as well as other stakeholders encourages the development of public transportation, such as the arrangement of KRL stations integrated with TransJakarta, Jakarta MRT, Jakarta LRT, and trans micro transportation through the Jaklingko program, improving the quality and coverage of public transportation in Jakarta, revitalizing sidewalks, providing bicycle lanes, to implementing traffic restrictions through an odd-even system (Oktorini & Barus, 2022). This relentless effort gave positive results, namely the reduction in DKI Jakarta's congestion level to rank 46th with a congestion index of 34 percent. All the progress that occurs in DKI Jakarta is inseparable from the concept of development as a Smart City that is able to encourage changes in it (Sriratnasari et al., 2019).

DKI Jakarta applies the concept of Smart City or Smart City in the application of city development and its citizens. Smart City is also seen as an accessible, sustainable, cohesive and inclusive city, blending technocentric vision with aspects related to social capital, environmental sustainability, urban services, etc. (Battarra et al., 2017). In addition to being encouraged to improve urban services, Smart City is also expected to improve the quality of life and accessibility of infrastructure facilities. All of these aspects are included in the Smart City model, with six dimensions, namely smart economy, smart people, smart governance, smart environment, smart living, and smart mobility (Giffinger et al., 2007).

As a city full of mobility problems, DKI Jakarta cannot be separated from applying the concept of Smart Mobility. Smart Mobility can be defined as a network system that is mainly characterized by both digital and physical connections to meet people's needs, the use of appropriate technology to improve the performance and attractiveness of mobility systems, sustainability to reduce the need for travel and hence reduce energy consumption and carbon emissions (Lam & Head, 2012). Smart Mobility is considered a top choice looking for a more sustainable transportation system. Three main characteristics that must be possessed, namely accessibility, sustainability, and information system technology make the mobility system suitable to support the development of urban activities by paying attention to user needs (Medeiros et al., 2018).

KRL Commuter Line itself has become an inseparable part of the lives of most Jabodetabek residents, especially in the field of transportation. In carrying out their daily activities ranging from work (83%), school (16.8%), and courses (0.2%) residents rely on KRL Commuter Line as the main mode of transportation (Arif et al., 2023). Before the COVID-19 pandemic, daily users of KRL Commuter Line from 2017-1029 reached an average of above 300 million users per year, but after the COVID-19 pandemic that hit the world and also Indonesia, it resulted in a significant decrease in KRL Commuter Line users in 2020, dropping to 150 million users per year, even continuing to fall in 2021 to 124.8 million users in Jabodetabek due to the Implementation of Community Activity Restrictions (PPKM) level 4. (Dihni, 2022)

In its journey, KRL Commuter Line through its operating company PT Kereta Commuter Indonesa (KCI) focuses on the use of information technology to support the acceleration of integrated business processes with the aim of adjusting operational patterns to be more efficient, synergizing with the direction of the times, and increasing competitiveness, in an effort to improve time efficiency and productivity of existing human resources (Commuter, 2021). The development of KRL Commuter Line is carried out by adding new infrastructure, both physical and technological, to develop a range of services for wider accessibility to the user community. Strengthening supporting infrastructure such as station infrastructure also continues. On innovation in finance, namely the use of electronic payment methods, making applications for route information, schedules, and departure times as well as booking and purchasing train tickets (Solihati & Indriyani, 2021).

Therefore, in this research, it will see how the development and contribution of KRL Commuter Line in supporting the application of the Smart Mobilty concept in the transportation system in DKI Jakarta.

Research Methods

This research was conducted to find out how the development of KRL Commuter Line transportation modes in supporting the implementation of the Smart Mobility concept in DKI Jakarta. Researchers use a descriptive qualitative approach with a comparative method, which compares indicators from research variants with real conditions in the field (Creswell, 2014). This research uses secondary data and is collected by means of a literature review that is in accordance with the topic of this writing. Literature review is a method of collecting data and analyzing relevant data and/or information from previous research (Snyder, 2019). Literature review can combine findings and findings from previous research results whose results will be relevant and useful for researchers to conduct analytical studies.

Results and Discussions

KRL Commuter Line is one of the modes of transportation that serves the mobility of the people of DKI Jakarta. To see the development and contribution of KRL Commuter Line in the application of the Smart Mobilty concept in the transportation system in DKI Jakarta, To get an overview of the implementation of the Smart Mobility project, there are three categories that support, namely accessibility, sustainability, and information technology systems (Battarra et al., 2017). Accessibility, namely the provision of safe and affordable modes of transportation for the community. Sustainable, that is, the transportation provided is environmentally friendly transportation and / or uses renewable

energy. Meanwhile, Information Technology Systems is the use of technology that can increase efficiency and have an impact on user behavior. The measurement of Smart Mobility Jakarta is carried out using the parameters contained in the theory.

Table 1 Smart Mobility Categories, Indicators and Parameters

Category	Indicator	Parameter
Accessibility	1. Creation of a new mobility infrastructure 2. Improvement of public transport 3. System reinforcement	• Procurement of public transportation (number of fleets) • Public transport lines (freight routes) and Frequency of arrivals • Public transport demand (number of passengers) • Freight density • Access to the station
Sustainable	• Mobility promotion	• Ecological public transport
Information Technology System	• Mobility platform • Mobile apps and other technology products	• Electronic payment systems • Information about routes, schedules, times

Source: (Battarra et al., 2017)

The following are the results of a comparative analysis between the parameters of the Smart Mobility theory and the existing conditions in KRL Commuter Line transportation:

Accessibility

There are five accessibility parameters of KRL Commuter Line, as mentioned in the table above. Judging from the number of passengers, based on data from the KCI Annual Report from 2017 to 2021, it is known that the number of passengers has increased and decreased. In 2017, the number of passengers in one year was 315,853,991 passengers. Then it rose to 336,798,524 passengers in a year or 922,736 passengers / day in 2018. In 2019, the number of passengers was 336,274,343 passengers or 921,300 passengers / day.

The number of passengers for the first time dropped dramatically in 2020 by 155,378,627 passengers or 424,532 passengers / day, this decrease was related to the Covid-19 pandemic which made a series of social distancing policies issued starting in March 2020, this condition was a force majeur event for KCI. In 2021, the number of passengers also decreased, as many as 131,148,587 passengers per year or 359,311 passengers / day, this condition was also caused by the spread of the COVID-19 pandemic which was high at that time. On September 8, 2021, the implementation of vaccine certificates was also implemented as a requirement to ride the KRL Commuter Line, this also contributed to the number of passengers, where the number of vaccination coverage is currently still not much, and efforts to make this requirement are part of encouraging an increase in the number of vaccination coverage.

Judging from the number of passengers who tended to increase before the Covid-19 pandemic, it can be admitted that the KRL Commuter Line is considered promising for passengers. The absence of other feasible public transportation options, especially for people living outside the Jakarta area such as Bogor, Depok, Tangerang, and Bekasi, makes KRL Commuter Line passengers experience an increase. KRL Commuter Line also provides certainty of departure time even though in a year there are things that interfere with the certainty of the time such as train derailment or signaling problems.

KCI is also trying to increase the number of stations, in 2017 there were 79 stations, rose to 80 stations in 2019, and again rose in 2020 to reach 105 stations until 2021. The increase in the number of stations is an effort to bring the presence of commuter trains

closer to passenger domicile and break the density at certain stations. Transit stations such as Manggarai are also being repaired by adding new buildings, so that transit between routes becomes easier.

In terms of routes, based on KCI's annual report from 2017 to 2021 tends to stagnate, with a total route coverage of 418.5 KM, considering that until now there has been no construction of new routes by the government. With existing routes, it continues to be optimized to manage passenger density through the addition of trains to 10 and 12, from the usual 8 trains in a series. The number of networks operating also continues to rise, in 2017 there were only 83 total networks with 936 trips per day. In 2021, despite the decline in passenger numbers, there were 1,005 trips per day on 94 trains.

The increase in the number of trains in a series aims to carry more passengers, while the addition of the series is quite significant. The increase in the number of circuits will affect the time of arrival, but it becomes a problem for congestion on the highway as there is still a plot crossing between trains and other vehicles. To solve the problem of crossing this plot, it needs to be done across sectors, not only KCI, but also the support of the local government, for example by building underpasses and flyovers, this is certainly not cheap and easy for the Regional Government. So the solution of adding trains in a series and widening the platform is the right step by looking at the existing obstacles.

In terms of parking, the fulcrum stations that are the main access for passengers such as Bogor, Bekasi, Serpong, and Depok Stations are quite good, judging from the availability of parking and parking management. Parking management is carried out professionally by PT Reska Multi Usaha which is one of the subsidiaries of PT Kereta Api Indonesia (Persero) (KAI). This guarantees the certainty of vehicle safety for passengers to leave their vehicles. Not only at the fulcrum station, the station in the middle of the city also has quite good parking such as at Tebet, Kalibata, and Manggarai Stations. This condition is supported by the availability of land owned by KCI.

Passengers who do not use private transportation to get to the station are also helped by the integration of the station with other public transportation, along with the revitalization of the station and cooperation between KCI and local governments such as with the DKI Jakarta Provincial Government, for example at Sudirman Station which is now integrated with the MRT and TransJakarta. Even at some stations, other supporting public transportation is specifically provided such as at Tebet Station where TransJakarta provides new routes to Kampung Melayu and Kuningan.

Judging from stakeholders who work together in supporting KCI accessibility, the DKI Jakarta Provincial Government has collaborated well, by providing various supporting infrastructures such as connectivity with the MRT and TransJakarta, widening sidewalks, arranging access in and out of stations, and structuring MSMEs. For other Regional Governments, it seems that there has been no maximum effort in improving passenger accessibility to ride commuter trains, be it in Bekasi, Tangerang City, South Tangerang City, Depok City, and Bogor City.

The parties who contribute to improving the accessibility of commuter trains in the buffer city are private, such as in South Tangerang City is a housing developer around the Cisauk area that connects the station with the market and provides connecting buses to the surrounding area. Of course this is to encourage high occupancy rates in the residential area

Sustainable

KRL Commuter Line is one of the mass transportation that has advantages, including efficiency in the use of space and energy. KRL Commuter Line is based on

emission-free electrical energy sources, so the application of electrification of railway lines is useful to reduce fuel use. In one KRL Commuter Line trip, a series consists of eight to 12 with a maximum capacity of 3,000 passengers (KAI, 2022). The number of 1 series of KRL is able to replace the use of 428 private cars and 1,500 motorcycles. The presence of KRL in addition to increasing the ease of transportation will also reduce air pollution levels.

Another effort made by KCI in making KRL Commuter Line into sustainable transportation, namely the provision of environmentally friendly stations, starting at Sudirman Station, Jurangmangu Station, and Klender Station. Eco-friendly stations are equipped with technology and service facilities, including cell phone recharge stations with electricity sources coming from solar cell panels, waste management with separation of waste types and equipped with garbage houses, and station parks to make the station cooler and more beautiful KAI Commuter, 2019. In addition, the facilities provided are more environmentally friendly, including providing hand dryers as a substitute for wipes in hand washing stations, choosing more water-efficient faucet types, making biopores, replacing a number of wall fans with one HVLS (High Volume Low Speed) fan unit, to automatic timers regulating the on/off lights at the station.

Information Technology System

The aspect of information technology systems can be seen from two parameters, namely electronic payment systems and information about routes, schedules, and times in real time.

First, it is viewed on the basis of electronic payment systems. As one of the efforts to improve services, KCI implemented an e-ticketing system on July 1, 2013. An e-ticketing system is a computer chip electronic card-based system that contains information such as balances, fares, and itineraries, grown to replace paper-based ticketing. This is also a form of KCI's support for government and Bank Indonesia programs to encourage the creation of a cash-less society or people who transact without cash.

Now, there are several options for KRL Commuter Line ticket payment systems, namely through Multi Trip Cards (KTM), Bank Electronic Money such as e-money, Flazz, Brizzi, TapCash, or payment via QR-Code, such as Gojek and LinkAja (KAI Commuter, 2022). Payment via KTM and electronic money with a balance system, while QR-Code is a virtual payment system with a cooperating partner application that will be used at gate in and gate out at the station. The number of KRL ticket payment transactions by users using KMT is 63.60% of all transactions. Meanwhile, 31.88% of users use Bank Electronic Money-based transactions and transactions using QR Codes as much as 1.54%.

Second, the availability of real time information, be it routes, schedules, and times of KRL Commuter Line. Since 2014, KCI has released the Access Electric Rail Train (KRL Access) application, as an application for information, tariffs, and schedules for KRL Commuter Line. Some of the features contained in KRL Access, namely being able to find out the position of the train and departure schedule in real time. Now, KRL Access can also check the balance of the Multi Trip Card using a smartphone that has NFC and during the Covid-19 pandemic, there is a station density information feature that is updated every five minutes. In addition, there are news and information on KRL disturbances, and columns to accommodate passenger complaints. Until 2021, the latest version of the KRL Access application has been downloaded by 200 thousand users (Kumparan, 2021).

Another effort issued by the DKI Jakarta Provincial Government, namely through

PT Jaklingko integrates payment systems, tariffs, and routes in MRT, TransJakarta, LRT, KCI, and Railink. Passengers can plan, book, and pay for various types of mobility services in one JakLingko application including through the KRL Commuter Line (Jakarta Smart City, 2021). Jaklingko issued smart cards and applications with QR Code-based payment systems. The application provides services for users to choose the fastest and cheapest route with the preferred mode of transportation along with details of travel time and total costs traveled. The integrated distance-based fare starts from Rp2,500 as boarding fee and Rp500 per kilometer, with a maximum fare of Rp10,000 for a combination of urban transportation and a maximum of Rp15,000 for sub-urban transportation.

The available information technology system can make it easier for passengers to arrange their trips so as to increase efficiency in population mobility. Information system-based services provided in the DKI Jakarta transportation system are considered good, as many as 66.70% of respondents stated that public transportation modes (one of which is the KRL Commuter Line) provide information about departure and arrival routes and schedules through applications (Agni et al., 2021). Meanwhile, 85.20% of respondents said ticket purchases or payment card top-ups were practical and easy to do.

Conclusion

Based on the characteristics that have been analyzed in each aspect of Smart Mobility in the KRL Commuter Line transportation mode in Jakarta, it can be concluded that the existing categories have been met. In the accessibility category, it can be seen that the number of passengers tends to increase from year to year. In addition, the number of stations, the number of train series, and the number of trips have also increased from year to year, even though in 2020 the Covid-19 outbreak had an impact on the operation of the KRL Commuter Line. Then in the sustainable category, KRL Commuter Line can be considered environmentally friendly because it uses an emission-free and efficient source of electrical energy in the use of space, each KRL trip can accommodate up to 3,000 passengers. Furthermore, the category of information technology systems, which in terms of electronic payment systems KCI is open and adaptive to technological developments. Payment for KRL Commuter Line tickets can be made using a Card or QR Code on the user's mobile phone. Information on route availability, schedules, and times can also be accessed on the KRL Access application which can be downloaded on devices on both Android and IoS platforms, so that it can be accessed by users from various circles.

Although all categories have been met, KCI also needs continuous support from stakeholders, such as KAI, the Ministry of SOEs, the Ministry of Transportation, and local governments in this case, especially the DKI Jakarta Provincial Government. In terms of accessibility, sustainability, and information technology systems will be maximized by KCI as long as it gets support from these stakeholders, for example related to integration with other public transportation, closure of plot crossings, completion of double tracks on lines that coincide with long-distance trains, and traffic management in the station area

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