(e)ISSN 2656-8896 (p)ISSN 2656-890X
Journal of Infrastructure and Facility Asset Management – Vol. 3, Issue 3, December 2021

The Physical Integration of Smart Transportation Characteristics of Suroboyo Bus and the Feeder

Cindy Nur Aziza Rahman[1,a)], **Eko Budi Santoso**[2,b)] **& Siti Nurlaela**[3,c)]

[1)]*Department of Architecture, Faculty of Civil Engineering, Planning and Geo-Engineering, Institute Teknologi Sepuluh Nopember*

Correspondent : [a)]cindyrahman.cr5@gmail.com, [b)]santosoeb@gmail.com & [c)]sitnurlael0@gmail.com

ABSTRACT

Surabaya City is one of the cities in Indonesia that applies smart mobility. In implementing smart transportation, Surabaya city has already had a mode of transportation that supports the implementation of the ITS-ATCS infrastructure, namely Surabaya Bus. Not only to rely on advanced transportation modes and infrastructure facilities, one of the principles of smart transportation is the integration of modes. This study aims to examine the characteristics of physical integration that can be developed and maximized for the application of the Suroboyo bus multimodal smart transportation integration. The research method uses for the analysis is descriptive analysis while the method used for the data collection is primary data collection. The physical integration of smart transportation characteristics of Suroboyo Bus and the feeder such as the use of terminals, the use of bus stops, and transfers, need to maximize their function in the application of the physical integration of smart transportation for Suroboyo bus and feeder transportation.

Keywords : infrastructure management, integration, smart transportation

PRELIMINARY

Surabaya City is one of the cities in Indonesia which applies smart mobility. Surabaya City utilizes ITS-ATCS implementation as a smart system to support its transportation management with the use of technology which able to control traffic lights in real-time based on current traffic conditions. Surabaya City government provides E-dishub for mass transportation information and public transport management.

In implementing smart transportation, Surabaya city has already had a transportation mode that supports the implementation of the ITS-ATCS infrastructure, namely the Surabaya bus. Suroboyo buses have advanced technology and are equipped with real-time application services on an Android-based smartphone. Suroboyo bus is integrated with a road traffic control system. The traffic light will automatically turn green when this bus passes (Efendi, 2018).

Suroboyo bus as public transportation has advantages over other public transportation in Surabaya City and it also has several problems. One of these problems is that public transportation networks often overlap, resulting in duplication of services and conflicts among operators of the existing public transportation modes. Especially on the Purabaya-Rajawali route, Surabaya bus passes 45 stops on the main roads of Surabaya City starting from Jalan Jendral A. Yani to Jalan Rajawali and passing through various activity centers such as malls, universities, tourist attractions, and shops is overlapping between with the other transportation mode.

It is not enough to rely on advanced transportation modes and infrastructure. One of the principles of smart transportation is the integration between one mode and another (Nurmandi, 2014). It is in line with what Kadarisman (2014) explains suppressing the use of private transportation and improving more adequate public transportation facilities and infrastructure can only be achieved through a multimodal transportation system and an integrated public transportation system. Network integration is the key to the success of a public transportation service system in a region or city (Neumann & Nagel, 2011).

In previous research, people's preference for the integration of public transportation in the Surabaya City leans toward the need for conformity of scheduling and mode frequency settings, integration of manual and digital service information, network integration according to community travel patterns, tariff integration using a progressive tariff system and payment system. cash, as well as integration with social and environmental aspects, particularly those related to comfort, safety, and friendliness by changing modes and periodic maintenance (Yulianti, 2013). The transportation information system arises because of the need for people to move from their original location to their destination (Yulianti, 2013).

Besides, there is no conformity of schedules and information on public transportation services so travel time and costs cannot be calculated accurately (Tahir, 2005). Likewise, the Suroboyo bus already has a real-time information application but no feeder transportation is integrated with the Suroboyo bus. From the description above, this study would like to examine the characteristics of physical integration that can be developed and maximized for the application of the integrated multi-mode smart transportation of Suroboyo bus and the feeder.

LITERATURE REVIEW

Smart Transportation

Smart mobility in the concept of a smart city illustrates an ever-changing environmental development, such as traffic jams which are increasingly becoming a problem for big cities in Indonesia. To respond to the dynamic environmental changes in the traffic sector, innovation steps are needed, to address traffic problems with innovations following the needs of the smart mobility concept (Boyne, 2010). The concept of smart transportation is a paradigm shift for a more flexible and multimodal transportation system, from unimodal to a multimodal transportation system that is comfortable and highly flexible (Hasel, 2015). Smart transportation consists of three parts, namely smart parking, smart transportation management, and integrated multi-modal transport (Pedersen, 2016).

Smart mobility means innovative traffic and transportation infrastructure that saves resources and is built on new technologies for maximum efficiency, accessibility, affordability, and safety of the transportation system, and compact urban development is an important factor in this context (Eremia, Mircea, et al, 2017). The new, easy-to-use facility will make it easier for people to switch to an integrated transportation system that is focused on environmentally friendly modes of transportation. Smart transportation is a more environmentally friendly alternative to conventional public transportation systems in terms of service frequency, stop location and range, and more flexible routing (Yigitcanlar, 2008).

Elements of Smart Transportation

The elements of smart transportation in a smart city according to Perdeden (2016) are as follows :

1. Mobility as a Service (MASS)

   It is a change in technology, socio-demographics, and behavior that facilitates the step toward multimodal transportation that combines walking, car, bus, bicycle, train,

and other forms of transportation (Lennert (2011). Provision of transportation through a real-time personal service model. integrating all types of mobility options and presenting them to customers in a fully integrated way to make it from a to b as easy as possible There is interactive information as an initial step in providing mobility as a service (Carpenter, 2018).

2. The existence of an Information System

   Smart City relies heavily on smart computing. Smart computing refers to the new generation of hardware, software, and technology networks that provide real-time IT systems (Shah, 2017). Good and in-depth analysis can help residents make smarter decisions that are accompanied by actions that optimize business processes.

3. Multimodal Payment System

   Smart Mobility Aggregators are new mobility operators building digital platforms (including payment systems and ticketing systems), and physical mobility networks (parking zones for bicycles or car-sharing) (Kaim, 2016). Ease of Transaction as users can access mobility using various payment channels such as phones, watches, smart cards, or bank cards regardless of the mode of transportation they use. Payment terms are flexible such as users can pay for their choice of mobility via pre-paid, post-paid, or pay as you go.

Multimodal Integration Concept

An integrated transportation system is the transportation of goods or passengers from origin to destination using more than one transportation without interruption. The purpose of those statements are costs, administrative management, documentation, and the existence of one party who is responsible (Salim, 2016). In general, integration means integration or integration into a complete or unified whole. Multimodal transportation is a system that connects different modes of transportation such as land transportation, air transportation, sea transportation, and railways so that it can facilitate passengers to complete their entire journey using more than one mode (Zhang and Hansen, 2016). Network integration is the key to the success of a public transportation service system in a region or city (Neumann and Nagel, 2011). Integration of transportation modes can be interpreted as a complete integration of the types or forms (transportation) used to move people and goods from one place (origin) to another (destination). Integration of public transportation modes is a form of public transportation system management that combines two or more modes of public transportation to realize optimal public transportation services. Not only that, multimodal transportation integration not only facilitates passengers to connect to the broad transportation network but also with shifting movements. safe, comfortable, and efficient between various modes of transportation (Vespermann & Wald, 2011).

The concept of multimodal public transportation consists of modes complementing the above statements, namely connecting, main mode, multimodal network, and facilities (Alamsyah, 2014). The explanation is as follows:

1. The liaison mode serves as a liaison before and after the main mode being used.
2. The main mode is usually used in the longest and longest journey of the other modes.
3. Multimodal network, namely the availability of an integrated network between the modes
4. The facility is a mode shift facility to attract private transport passengers that can integrate with public transportation

Forms of Multimodal Integration

The forms of integration are physical integration, integration, tariff integration, information integration, and institutional integration (Litman, 2017). Here's an example of each form of integration:

1. Physical integration such as from broad mode networks and facility integration
2. Tariff integration such as using a smart card for tariff integration
3. Integration of information such as transit link guides and extensive information boards provides comprehensive information on all aspects of travel
4. Institutional integrations such as a multi-modal Translink agency were established in 1989. Provide strategic planning and integrated services.

The integration components in the integration guidelines are as follows:

Table 1. Physical Integration Components

Component	Information
Direct connection	The direct connection will cut the distance and travel time by up to 74%
Direct crossing	Level direct crossing as more universal access and passengers can access the bus stops faster
Area Accessibility	The basic principle is to improve pedestrian accessibility within a 500-meter radius, not only on main roads. Additional pedestrian comfort in the form of corridors that are protected from the weather, greening, activation of sidewalks, and building facades.

Source: ITDP, 2019

RESEARCH METHOD

This research used the descriptive analysis method. The purpose of the descriptive method is to change a set of raw data into an easier-to-understand form in the form of more concise information (Istijanto, 2009).

DATA COLLECTION

Primary survey data were obtained from direct observation in the field. This primary survey was conducted to determine the actual conditions so that there were no errors in the data processing. The primary survey technique in this study used field observation techniques, namely direct observation of the research variables and questionnaires.

Secondary survey data were obtained from reports, documents, and maps that were available in several agencies and related literature. Secondary data collection was carried out through institutional survey techniques and literature surveys. The data obtained namely the map of the Surabaya public transport route International survey Surabaya City Transportation Agency and the smart transportation componentliterature survey journal/book.

RESEARCH ANALYSIS

Use of the Surabaya bus' bus terminal on the Purabaya-Rajawali route which departs from Purabaya terminal consists of 5 buses, while 2 other buses depart from Rajawali stop. In a day the Suroboyo bus goes around 6 times a day. Departure time starts at 06.00 A.M (GMT+7), with a waiting time of 30 minutes from 05.30 A.M (GMT+7). Especially on Sundays, Surabaya bus departs from Purabaya bus station at 10.00 A.M (GMT+7), with a

waiting time of 30 minutes starting at 09.30 A.M (GMT+7). The following are the results of observations of the average duration of Suroboyo bus trips for 7 days starting April 4th, 2019 to April 10th, 2019 to find out the frequency of terminal use by Suroboyo buses. The following are the results of the observation of the Suroboyo bus waiting time:

Table 2. The observation result of waiting time and departure time of Suroboyo buses at the terminal

Date	Bus	Time to go	Headway	Information
Thursday, April 4, 2019	1	06.00	30 minutes	On-time
	2	06.21	20 minutes	Early
	3	06.45	15 minutes	Early
	4	07.20	35 minutes	Late
	5	07.41	20 minutes	Early
Friday, April 05 2019	1	05.55	25 minutes	Early
	2	06.30	35 minutes	Late
	3	06.40	10 minutes	Early
	4	07.20	20 minutes	Early
	5	08.00	40 minutes	Late
Saturday, April 6, 2019	1	06.10	10 minutes	Early
	2	06.45	25 minutes	Early
	3	07.20	35 minutes	Late
	4	08.00	40 minutes	Late
	5	08.20	20 minutes	Early
Sunday, April 7, 2019	1	09.30	30 minutes	On-time
	2	10.00	30 minutes	On-time
	3	10.30	30 minutes	On-time
	4	11.00	30 minutes	On-time
	5	11.30	30 minutes	On-time
Monday, April 8, 2019	1	06.10	40 minutes	Late
	2	06.20	10 minutes	Early
	3	06.40	20 minutes	Early
	4	07.00	20 minutes	Early
	5	07.20	20 minutes	Early
Tuesday, April 9, 2019	1	06.08	38 minutes	Late
	2	06.30	22 minutes	Early
	3	06.50	20 minutes	Early
	4	07.10	20 minutes	Early
	5	07.30	20 minutes	Early

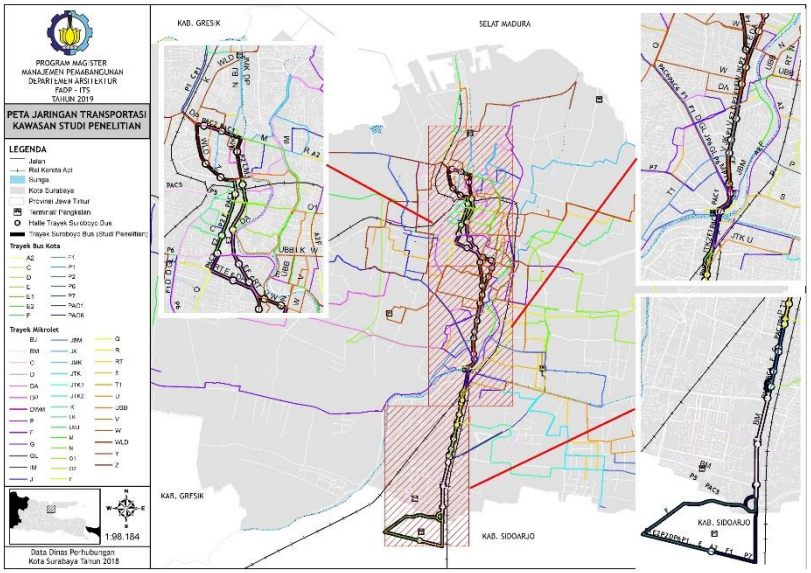
Source: Survey results, 2019

From the table above it can be concluded that the waiting time at the Suraboyo bus' bus station exactly matches the waiting time limit of 20% of the buses, before the waiting time limit of 56%, exceeds the 23% waiting time limit. This may imply that the departure time of the Suroboyo bus does not have a patent departure time. So that the feeder transportation has the potential to be uncertain or not be able to be on time in serving the mode shift from the Surabaya bus. So the characteristics of terminal use in the integration of the Suroboyo Bus and feeder transport 56% of the Suroboyo Mus departures from the terminal before the waiting time limit where it does not have a fixed departure schedule.

Use of the Surabaya Bus bus stop for the Purabaya-Rajawali (back and forth) route Suroboyo Bus is the only public transportation that stops at the designated stop (bus stop), other vehicles will stop everywhere if a passenger stops them. The use of bus stops is also still limited. The average stop time for Surabaya bus is 15 seconds. So the characteristics of the

use of bus stops, namely the uncertain schedule and the relatively fast stop times, can potentially be uncertain or not be able to be on time in serving the mode shift from the Surabaya bus.

The level of ease of switching between modes is obtained from the level of ease of getting the feeder mode at the designated stop. From the results of the interview regarding the mode shift, it is quite easy because Suroboyo bus users can take a lyn or a motorbike taxi. Although the mode shift is easy based on the questionnaire, it does not include the mode shift that is meant in smart mobility because the feeder mode that is ridden is limited. The results of the mode questionnaire used in the mode shift in the concept of smart mobility. When compared with the habit of integrating modal shifts, 60% of respondents who use public transportation respond are using the bus mode followed by lyn. The rest, 16% use a bus followed by an ojek, 6% use an ojek followed by a train followed by an ojek and 3% other modes. So the feeder with the most potential in the integration of the Suroboyo bus is lyn. The following map is the route of some transportation modes that overlap with Suroboyo Bus:



Picture 1. Map of lyn as a feeder that passes through the Suroboyo bus route

On the Surabaya-Rajawali (back and forth) route, there are 1 terminal and 42 bus stops along the Surabaya bus route. The location of all bus stops is close to pedestrian paths and the location of the bus stops is close to the center of activity, which along Suroboyo bus route are the centers of offices, commerce, schools, and near settlements. Also, the bus stops are equipped with directional signs, namely "bus stop" signs and some route markers. The stop does not interfere with the smooth running of traffic. The number of stops in the form of bus stops was 50% and 50% for bus stops.

The stop is a level crossing, a pedestrian overcrossing (JPO). The stops that have an on-level pedestrian bridge are 53% and 46% have pedestrian overcrossing (JPO). So the modal shift characteristics at the Suroboyo bus stop mostly have facilities that support integration, namely the pedestrian crossing. Either in the form of on-level crossing or an overcrossing. Shelters that have level crossing will have a high score because the travel time for pedestrians in changing the level crossing mode will be faster than with a pedestrian overcrossing.

18 bus stops provide alternative mode switching information boards. So, the characteristics of the Surabaya bus stop is that 42% of them have provided information facilities for mode shifting.

From the description above, the characteristics of the modal transfer facility are as follows:

1. The feeder transportation that is mostly used by users after the integration of the Suroboyo bus is lyn
2. The number of stops in the form of bus stops is 50% and 50% is equipped with pedestrian access.
3. Has facilities that support integration, namely a crossing bridge of 53%
4. The Suroboyo bus stop has provided information facilities for a mode shift of 42%.

CONCLUSION

In the application of the physical integration of the smart transportation of Suroboyo bus and the feeder and reviewed from the analysis of the characteristics of the physical integration, it concludes that the use of terminals, use of bus stops, and transfer facilities need to be maximized. There is supposed to be a fixed schedule so that the terminals and bus stops can be put into good use by passengers for mode shifting and transportation mode can be easily integrated into its fixated time so that the service can meet the expectation of the user. For the modal transfer characteristics, the average facility is above 50%.

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