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Asserting the Female Mobility Pattern as Smart Mobility Indicator: Lesson Learned From Bus Rapid Transit (BRT) Passengers in Indonesia

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Abstract

Female passengers dominate the mobility by employing Bus Rapid Transit (BRT) in Indonesia and they possess a unique travel pattern compared to men. Women require more genuine investment efforts in comfortable and safer infrastructure for accessing and utilizing public transportation. The implementation of a smart city is one of the infrastructure investments. Smart mobility is one of the service cluster divisions, and smart mobility indicators are taken into account in the implementation. The objective of this study is to convert female mobility patterns and attitudes toward BRT service into smart mobility indicators. The method used is quantitative, and the questionnaire is designed to poll 209 people. Chi-Square and Likert scale are employed to analyze those criteria. The results demonstrate that the BRT has provided the female passenger services that they require at the current service level. The passenger pattern demonstrates that women depend on the BRT service to meet their transportation needs. Furthermore, the ICT criteria as a core for smart mobility has been challenging for both parties (female passengers and BRT operator). The limitation of this study is that it cannot demonstrate empirically that smart mobility is free gender biased and gaps until public transportation is fully inclusive.

Keywords

Bus Rapid Transit (BRT), female passenger, mobility pattern, smart mobility

1 Introduction

Transportation is an essential means in supporting the success of a country's development, particularly in supporting community economic activities (Sinaga et al., 2019) and Bus Rapid Transit (BRT) operations have proliferated throughout Indonesia's major cities. One of BRT in Indonesia is Trans Jateng. Trans Jateng is a BRT that runs from Bulupitu Bus Station (Purwokerto) to Bukateja Bus Station (Purbalingga) in Central Java Province, Indonesia. The BRT's operation is a strategic step toward reviving multimodal connections in this region. This multimodal connects the Purwokerto and Purbalingga Type A Bus Stations, the Purwokerto Train Station, and the General Sudirman Airport in Purbalingga (Hardiyanto, 2018).

Female passengers dominate the mobility by employing BRT in Purwokerto and Purbalingga. More than 70% of BRT users are women (Saintika and Romadlon, 2019). It is a traditionally accepted norm that women are limited by household responsibilities, even in modern times. On the other hand, as women's education levels rise and the cost of living rises, they are no longer confined to the home; they move and travel for work and other purposes, encompassing social activities (Harumain et al., 2021). Women encounters more significant restrictions on mass urban mobility in developing countries. Although case studies of the BRT system resulted several benefits such as reduced travel time, air pollution, and unintentional impacts on the attributes and challenges of female's specific mobility, further research is required (Malik et al., 2020). Women's mobility is facilitated by access to safe, dependable, and affordable public transportation, which is increasingly recognized as a crucial determinant of female's economic participation (Tayal and Mehta, 2021).

Gender equality promotes women's participation in decision-making by increasing accessibility, security, and

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comfort, particularly in transportation. Gender equity differs from gender equality by definition. Gender equity is the condition in which men and women have the same conditions and equal opportunities to obtain rights in the social, economic, political, and cultural fields. Meanwhile, gender equality only provides equal opportunities but excludes those who are unable to access them (Allen, 2018).

Female passengers possess unique travel pattern compared to men. One of which is women's tendency to travel as they prefer to own short trips by public transportation and rarely employ private vehicles compared to men on a daily basis (Queirós and Costa, 2012). Furthermore, the frequency of women traveling on trips is characterised by the fact that they travel less, but the travel time is longer due to limited transportation access (Lecompte and Juan Pablo, 2017). Hence, women require genuine investment efforts in comfortable and safer infrastructure in accessing and administering public transportation (Martinez et al., 2018).

One of the infrastructure investments is a smart city initiation. Numerous predictions assert that 68% of the world's population will live in cities by 2050 (United Nations, 2018). A smart city aims to create a comfortable, safe city and strengthen competitiveness in the economy (Iqbal, 2021). Moreover, a smart mobility is one of the service cluster divisions in a smart city (Bokings et al., 2020). The scope incorporates transportation, infrastructure, and technology in system integration (Hsb et al., 2017). Implementing smart mobility shall consider smart mobility indicators. Therefore, this study concerns asserting female mobility patterns and their perspective with BRT service as smart mobility indicators. Smart mobility indicator determines the strengths and weaknesses of the city during initiating smart mobility, which is directing to the future development (Kusumawardani et al., 2021). The smart mobility indicator begins from public transport availability (BRT) and their pattern (Orlowski and Romanowska, 2019). Moreover, service perception and pattern will be affirmed as smart mobility indicators. Provided that both cities are launching smart cities, it is necessary to include smart mobility as a consideration for women's mobility. As a result, the objective of this study is to investigate BRT service perception from female passenger insights. This study adds a new way on how to place female mobility patterns into smart mobility indicator. Furthermore, by asserting the female mobility patterns, it can be a guidance to achieve latest standard service for safety, comfort, and affordable in public transportation.

2 Methods

2.1 The covered respondents

The study was conducted in Purbalingga and Purwokerto City, both in Central Java Province, Indonesia. The method employed was both quantitative and qualitative. There were total of 209 interviewees. The questionnaire was designed to collect data on female passenger habits in order to support smart city implementation in both cities via smart mobility indicators. The direct interview was administered to gather information. The results were then submitted and collected employing a Google Form. The information gathered incorporated passenger demographics (address, age, job, and the purpose of using BRT). The questionnaire was graded on a Likert scale of one to five, with one (1) means entirely disagree and five (5) is entirely agree. The total questions were 20, and those were distributed into five major needs for implementing an Intelligent Transportation System as a part of smart mobility (Frayer and Kroot, 1996) and four smart mobility indicators (Muliarto, 2009). The matrix can be identified in Table 1.

Table 1 The indicator matrix primary require of passenger and smart mobility indicator

Indicator	Safety	Comfort	Quick	Easy to use	Under control
Less mobility	Security staff at each the bus stop (A1)	The bus stop accommodates the starting point (A6) The bus stop accommodates destination point (A7)	The bus stop at strategic places (A17)		
Move freely	Safety at the bus stop (A2)	Pedestrian and access road to the bus stop (A8)	The bus stop design (A11)	Suitable bus capacity (A18)	
	Safety on the bus (A3)	Good air conditioner on the bus (A9)	The bus stop facilities (A12)		Good services (A19)
Less travel time	The driver is not speeding (A4)	Available all the time (A10)	Reliable Travel time (A13) Reliable waiting time (A14)		
ICT	Camera in the bus and the bus stop (A5)		E-money (A15) Factual time information by a mobile app (A16)	Factual time information at the bus stop (A20)	

The passenger's top priorities, according to Table 1, are safety, comfort, speed, ease of use, and control. The smart mobility indicators are less mobility, free movement, shorter travel times, and the utilization of ICT as the core of the smart city system. Because there are fewer mobility variables, the BRT can plan their travel to be as short as possible for the distance. Move freely implies that the movement of female passenger is as simple as they are, and that the movement of female passenger is as quick as they require.

The partial implementation is indicated by the green cell. It implies that some bus stops have good pedestrian access roads, while others do not (A8) and that camera is being installed on the bus, but the bus stop has not yet been installed (A5). The yellow cell represents the planned implementation or that it has not yet been installed. The plan is to have security personnel at each bus stop (A1), E-money (A15), real-time information via a mobile app (A16), and real-time information at each bus stop (A20). The rest has been completed to enhance their service to the passengers.

2.2 Data analysis

The data analysis of this study utilized Chi-Square test and Likert scale analysis. The Chi-Square test employed for determining the mobility pattern and the Likert scale scrutinized the female passenger perspectives with the BRT services.

2.2.1 Chi-Square test

The demographics' significant correlation and mobility attributes were approached by implementing the Chi-Square test with Minitab 19 software (alfa is 5%). The test was in accordance with the actual data and tabulated those variables into a matrix. There was significant relation if the Chi-Square test was higher than the Chi-Square table, and the hypothesis was generated below.

H_1: The demographics possess a significant correlation with female mobility attribute.

2.2.2 Likert scale analysis

The Likert scale analysis implements interval analysis to gain the interval ratio. Equation (1) could be perceived below:

$$K = (A - B)/C, \tag{1}$$

in which
K = interval scale
A = highest value
B = lowest value
C = number of criteria.

According to Eq. (1), the interval scale was 0.8, and the calculated scale category could be perceived in Table 2.

3 Result and discussion

3.1 Demographic of respondents

The bus route connects Bukateja Bus Station and Bulupitu Bus Station, passing through Purbalingga. The bus service begins at 5.00 a.m. and ends at 7.30 p.m. Fig. 1 depicts the map and route. Purwokerto begins at Bulupitu bus station and travels to Bukateja bus station via Jompo and Purbalingga Bus Stations (yellow line). The Bukateja Bus Station connects to the General Soedirman Airport in Purbalingga. The estimated distance from the bus station is three kilometers. After arriving at the bus station, the bus returns to Bulupitu Bus Station via Pasar Manis (blue line). Pasar Manis is a bus stop that closes to Purwokerto Railway Station with estimated distance is one kilometer (Fig. 1). Therefore, the BRT line links among the Airport, bus station, and railway station to enhance the mobility of both residences.

The demographics of the respondents were dominated by the female passengers from Purbalingga (51.2%), followed by Purwokerto (36.8%) and other cities (12.0%) (Fig. 2). The other towns were around both cities (Banjarnegara, Cilacap, and Brebes), and some travelers were from Jakarta. The options of employment status encompassed student, housewife, and labor. Those proportions were almost similar of all being over 20%. The age was dominated by the category of 35 years old (39.2%), followed by the categories between 15 and 25 years old (35.4%) and between 26 and 35 years old (23.4%). The rest of traveler were under 15 years old. Furthermore, the objective of utilizing BRT was dominated by visiting relatives (34.4%) and working (20.6%).

According to the employment status, most of the respondents were personal company employees and students. The private sector employees had a proportion of 45.32%, and the student had 35.25%. The majority of the employees are Yogyakarta natives, as are the majority of the students. It was caused that Yogyakarta was a center for industrial trade and education. The following

Table 2 Likert scale category

Scale	Category
1.00–1.80	Entirely disagree
1.81–2.60	Disagree
2.61–3.40	Moderately agree
3.41–4.20	Agree
4.21–5.00	Entirely agree

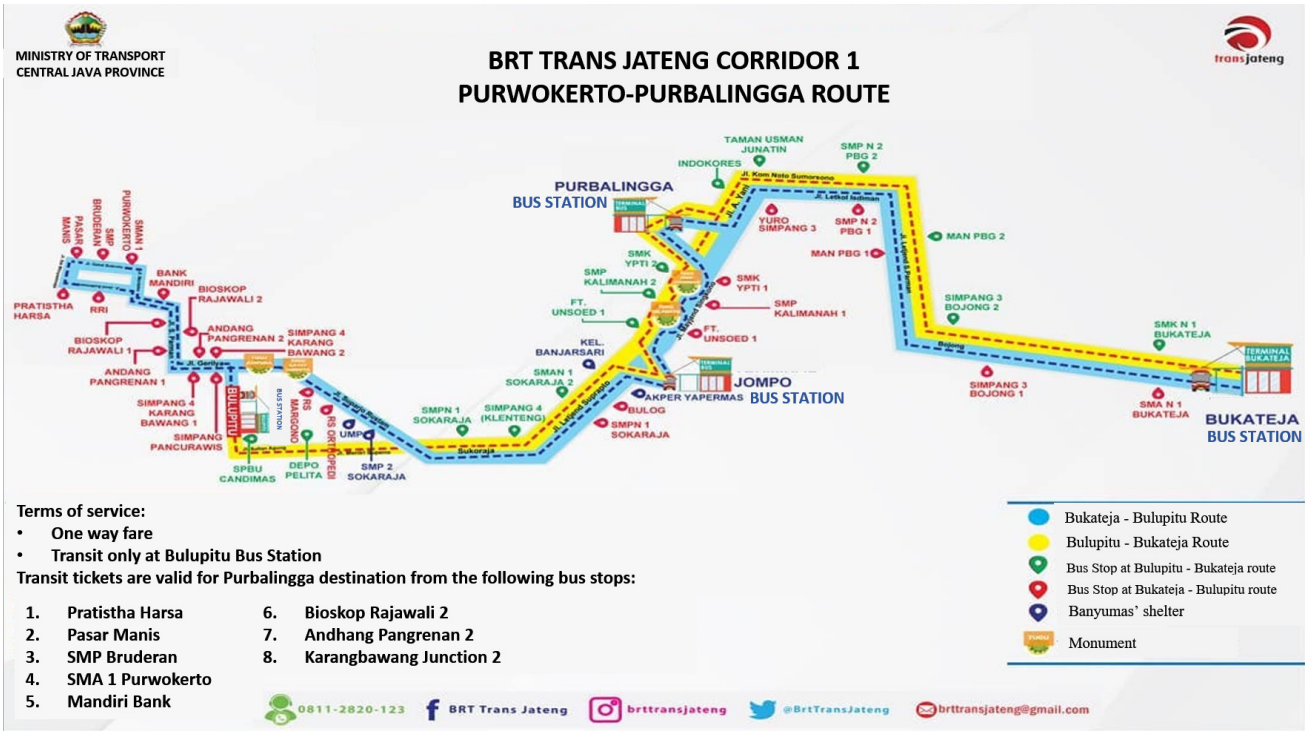

Fig. 1 BRT Trans Jateng Purwokerto-Purbalingga route

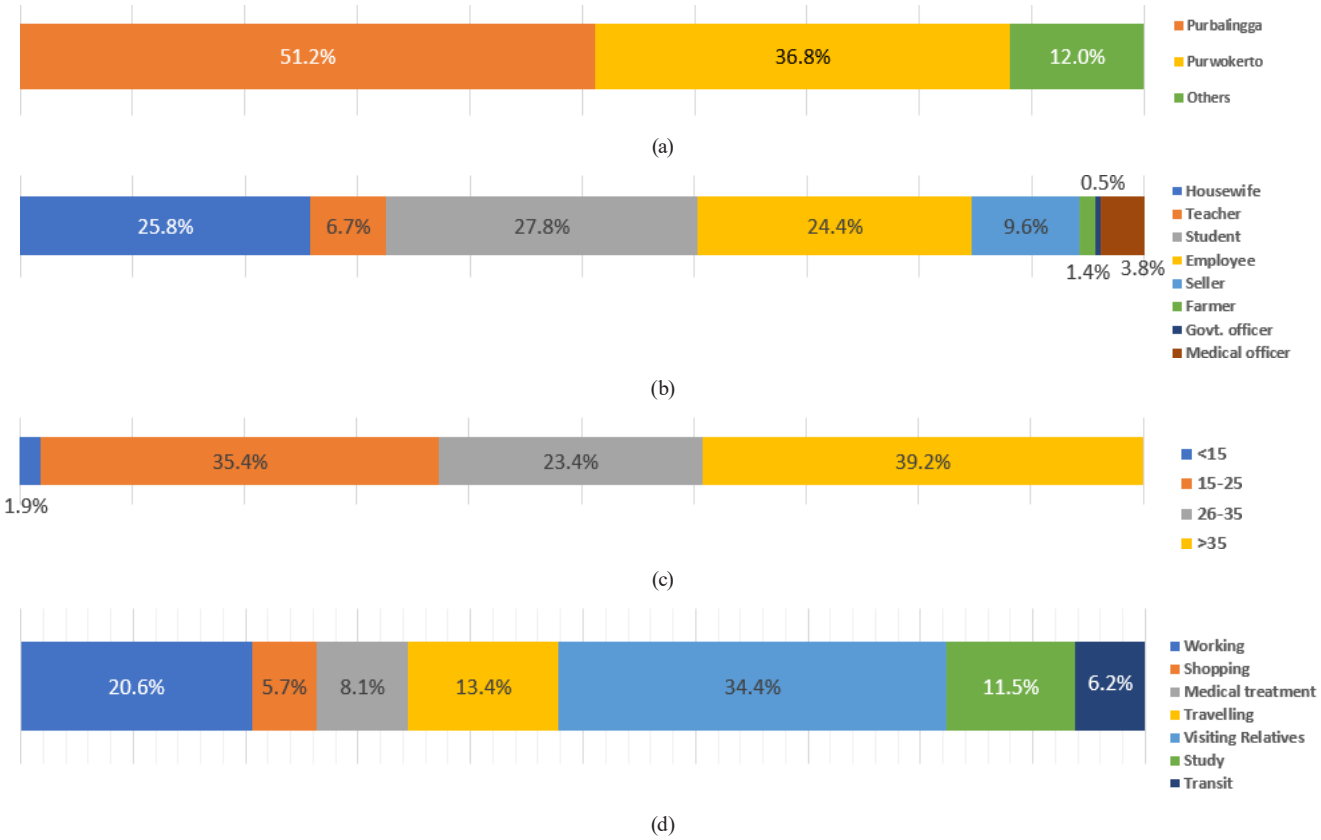

Fig. 2 Respondent demographics encompass place (a), job (b), age (c), and travel objectives (d)

categories of civil servant/police/military and businessman had similar proportion 7.43%. The remainder were housewives (3.12%) and professionals (1.44%).

3.2 Female passenger mobility pattern

The female mobility pattern is determined by their transportation preference, estimated travel time to destination, departure, and destination point percentage. Motorcycles

dominated the personal vehicle, which is reliant on BRT. The proportion of passengers who owned a bike is 47.4%, while 41.6% depend on public transportation. The remaining modes of transportation were bicycle, conventional bus, car, and walking. It indicated that the majority of female passengers were low until they reach a middle-income level. Furthermore, female passengers relied on alternative modes of transportation to achieve the bus stop origin and destination. Motorcycle (40.2%) was the most common mode of transportation from their home to the bus stop origin, followed by walking, conventional bus, car, and bike (Fig. 3).

According to Fig. 4, female passengers spend the most time at the bus stop, averaging six to ten minutes. They are followed by between 11 to 15 minutes, less than five minutes, and more than 15 minutes. It signifies that the

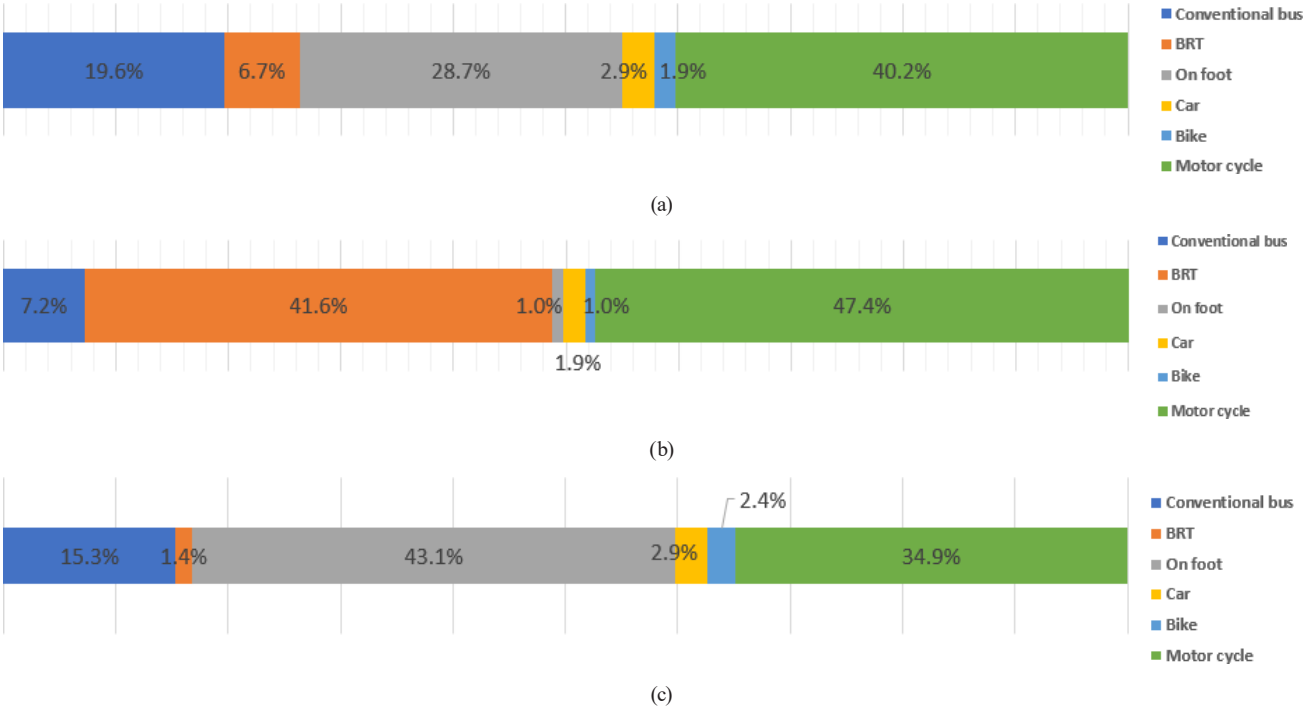

Fig. 3 Transportation modes used by female passengers to bus stop (a), main vehicle (b), and from bus stop (c)

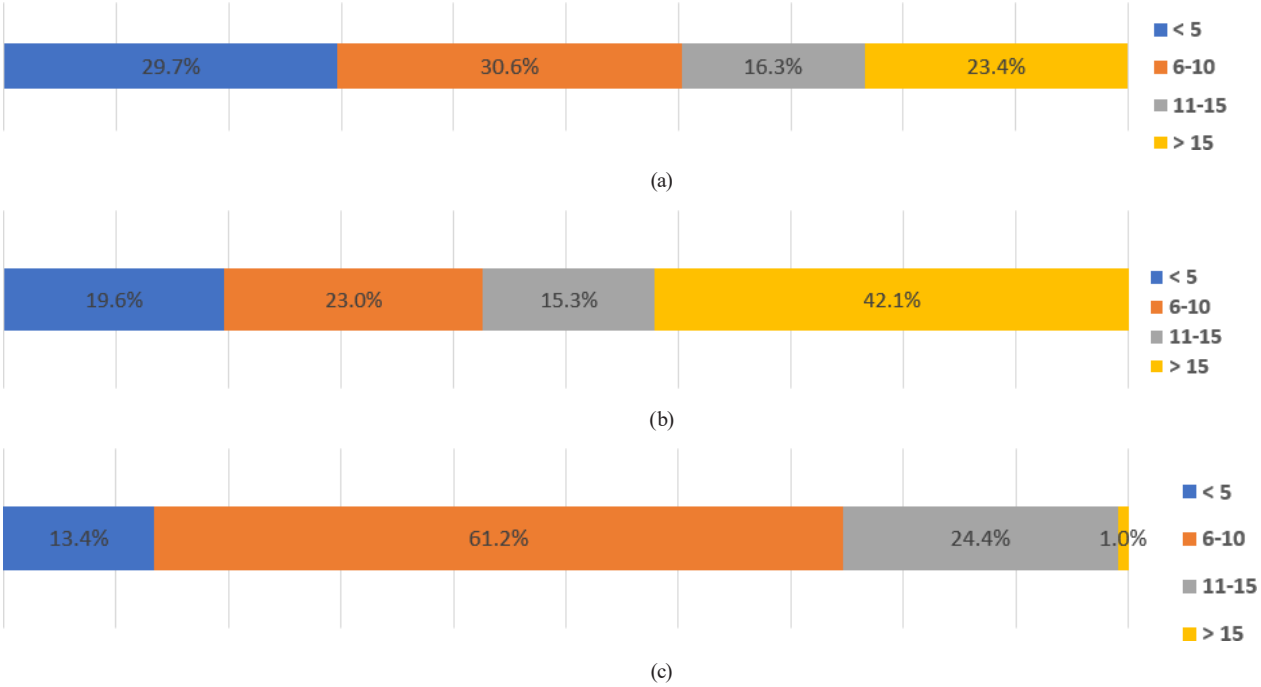

Fig. 4 Estimated female passengers travel time to bus stop (a), to destination (b), and waiting time at bus stop (c) in minutes

time between a BRT and the next BRT is approximately 6–10 minutes, depending on road conditions. The most common estimated travel time from home or work is six to ten minutes (30.6%) and less than five minutes (29.7%). They were separated by more than 15 minutes and 11 to 15 minutes. It denotes that the closest bus stop for female passengers have reached their starting point.

Furthermore, the majority female passengers travel more than 15 minutes from the bus stop to their final destination. It is followed by six to ten minutes, less than five minutes, and 11 to 15 minutes. It implies that the destination is still some distance from a bus stop. Therefore, the BRT provider shall consider providing additional transportation modes to suit the particular situation.

BRT stops have 54 bus stops, 19 bus stops from Bukateja Bus Station and 35 bus stops from Bulupitu Bus Station. The most frequented bus stops of female passengers are Purbalingga, Bulupitu, and Bukateja Bus Stations. The total proportions exceeds 65% (Fig. 5 (a)). It indicates that the bus stop provides a good starting point, such as a motorcycle parking lot, a large waiting room, and easy access to public transportation. Furthermore, the most popular destination is Bukateja Bus Station (Fig. 5 (b)). This bus station is the trip's final stop. This bus station is also located near the border between Purbalingga and Banjarnegara City, where many laborers and housewives reside. The following destination points are Purbalingga Bus Station, Bulupitu Bus Station, and Klenteng Junction.

3.3 Chi-Square test result

The Chi-Square test measures the relationship between the demographics and their mobility attributes (Table 3). Based on Table 3, the passengers living place owns a significant relationship with primary transportation, estimated time of arrival to the bus stop, and pre-bus stop transportation. The distance between their residence and the closest bus stop possesses correlation with the living place and those mobility attributes. The main mode of transportation varies depending on the passengers' economic status or level of access to the bus stop. It also has an impact on the relationship between living location and estimated time of arrival at the bus stop. Age has also been discovered to have a significant relationship with estimated time arrival at the bus stop and pre-bus stop transportation.

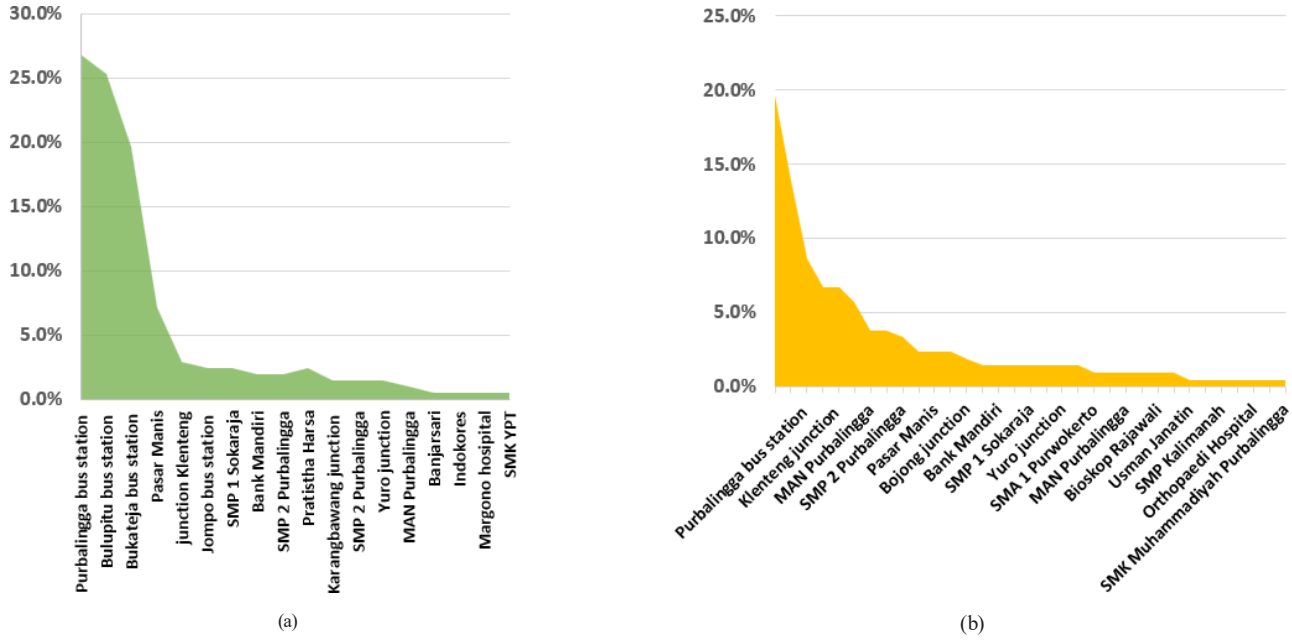

Fig. 5 Female passengers departure point (a) and destination point (b) in percentage

Table 3 Chi-Square test result

Demographics	Main transportation		ETA to bus stop		Estimated waiting time		ETA to destination		Pre-bus stop transportation		Post-bus stop transportation	
	Chi-Square	DF	Chi-Square	DF	Chi-Square	DF	Chi-Square	DF	Chi-Square	DF	Chi-Square	DF
Place	23.912*	10	15.586*	6	13.422*	6	5.918	6	31.743*	10	15.526	10
Age	8.965	15	18.070*	9	5.808	9	5.868	9	25.791*	15	13.777	15
Job	38.912	35	13.878	21	32.755*	21	21.999	21	34.613	35	46.963	35
Objective	38.219	30	15.571	18	30.513*	18	9.408	18	35.916	30	56.886*	30

Only the estimated waiting time has a significant relationship with the job. It is influenced by the various purposes for which the BRT is used. If they work as laborers or students, they will rush to their destination. Their journey is also during peak hours, and they must board the bus at a specific time to avoid crowding. If the intention of the trip is to visit family, the passengers will be more relaxed while waiting for the bus, and if the bus is already full, they will be able to stay for the next BRT. It is impressed by the significant relationship between the goal of using BRT and the estimated waiting time.

Furthermore, the primary objective utilizing BRT is directly connected to post-bus stop transportation. It is associated with the mode of transportation availability following the installation of the BRT. The majority of passengers travel by motorcycle (including online motor taxis) and walking. Female passengers on motorcycles still take trip to their destination. The maximum estimated distance is approximately ten kilometers. The BRT provider can implement a feeder to access the passenger residences by enhancing the safety standard. Walking, it is demonstrated that the bus top of the BRT has arrived at the female passenger destination point.

3.4 Smart mobility indicator preferences

The three main concepts underlying smart mobility indicators are primary ITS needs, good mobility indicators, and an ICT support system. The primary conditions for implementing ITS are necessary requirements for developing and implementing an advanced smart mobility system to improve the travel experience of passengers. The excellent mobility indicator denotes public transportation's ability to provide excellent service and the standard for urban movement. Then, an ICT support system is an essential tool for maintaining smart city implementation.

Referring to Table 4, all of the female passenger preference results demonstrate "agree" toward utilizing the BRT services except safety on the bus and good services that the passenger mentions "entirely agree". It implies that the passengers satisfied with the existing services and expected BRT operators to escalate some safety facilities. The female passengers that the service has been up to standard. Except for putting security personnel at the bus stop, the BRT provider has accomplished the fewer mobility indicators. It is difficult to implement due to the high investment. A bus stop's purpose is to allow passengers to board and disembark.

The passengers agreed on the move freely indicators, but they expect to enhance pedestrian access to the bus stop. Some BRT stops are well-installed in the inner city, but they have not yet been implemented in the outer city. As a result, by increasing the willingness of existing and new passengers, the pedestrian will be included in the next development agenda. The passengers expect that the bus's safety will be enhanced, and this is reflected in the overwhelming response. Recently, the implementation has been excellent, but the BRT provider must maintain safety during busy peak times.

The less travel time indicator illustrates that the passenger agrees or approves of the service. The passengers agree that the service is excellent. The BRT has been operational (working hours), with consistent travel and waiting times, and the driver is performing admirably.

The last is implementing ICT. The passengers anticipate that technology will be employed to improve safety and comfort, but there is no evidence that they agree with the outcome of ICT adoption. The concern about technology will result in higher service costs. The bus has cameras, but it has not yet been installed at the bus stop. There is no e-money (traditional payment), no mobile app for real-time bus information (position, arrival time, and capacity), and no real-time information at bus stops. Because the BRT operator can determine and evaluate the services, all of the indicators can be fulfilled while keeping the investment cost in mind. The operator must assess whether the technology meets their needs and whether there are any issues with technological adoption.

Table 4 Smart mobility indicator preferences result

Indicator	Safety	Comfort	Quick	Easy to use	Under control
Less mobility	4.19 (A1)		4.05 (A6) 3.94 (A7)		3.84 (A17)
Move freely	4.05 (A2) 4.22 (A3)	4.16 (A8) 4.15 (A9)	4.00 (A12)	3.88 (A11)	4.14 (A18)
Less travel time	3.84 (A4)	3.92 (A10)	4.14 (A13) 4.11 (A14)		4.24 (A19)
ICT	3.99 (A5)			3.47 (A15) 4.08 (A16)	4.16 (A20)

3.5 Practical implications and recommendations

The study's objective is to determine the main criteria for smart mobility indicators based on female passengers. The specifications will result in new smart mobility indicator perspectives for achieving sustainable transportation. The requirements will guide women's participation in decision-making and involve them in the enhancement of service provision (Bamwesigye and Hlavackova, 2019; Hamilton et al., 2005). It is able to acquire the expected nature of travel needs (Porru et al., 2020), escalate the multimodal access for female passengers, and minimize the gender biased in transportation. Furthermore, the marking incorporates the women in terms of smart city initiatives in accordance with the needs of transportation and information access (Sangiuliano, 2017).

The first criterion is transportation requirements. Female passengers are dominated by housewives, students, and laborers, with an age ratio ranging from 15 to more than 35 years old. The majority of people who implement BRT perform are to visit relatives or to work. Furthermore, the mobility characteristics of female passengers are owning and depending on motorcycles and BRT as primary modes of transportation. Some of them employ a hybrid of motorcycles and BRT. The motorcycle as the primary mode of transportation demonstrates that female passengers are car-less and frequently passengers (Basarić et al., 2016). They ride a motorcycle from and to a bus stop to gain faster time. Moreover, according to this case, the BRT has been primary transportation to fulfil their needs. The service of BRT has been accommodated and assisted their mobility.

The female passengers spend more than 15 minutes waiting for the bus. They spend approximately one hour traveling from their starting point to their final destination, despite the fact that women prefer transfer or waiting time of ten minutes or less (Chowdhury, 2019). Associated with this situation, the BRT operator shall respond with bus availability, particularly at peak hours.

The relationship between the demographics and mobility attributes reveals that residence influences the main mode of transportation, arrival time at the bus stop, and pre-bus stop transportation. It is associated with the distance from their residence to the bus stop. It also occurs in the age ratio of female passengers. It demonstrates that female passengers prefer to make a shorter trip to the BRT stop by motorcycling or walking (Lecompte and Juan Pablo, 2017; Queirós and Costa, 2012). Furthermore, the employment status and objective of utilizing BRT significantly are associated with the estimated waiting time at the bus stop. It is in accordance with the flexibility and affordability of the BRT (Ajayi, 2017). In general, the female passengers feel satisfying with the existing service and expects more safety on the bus by implementing better service. Therefore, the fundamental needs of their mobility have been facilitated by the BRT operator.

ICT is the second criterion. In the smart mobility initiative, ICT is the central system. The only ICT implementation is camera on the bus. Due to technology's utility for female passengers, the bus operator has not been yet invested. The preferences demonstrate that they agree, but there is no evidence that the passengers will respond negatively. They do not anticipate avoiding higher service costs or responding to new technology adoption (Romadlon, 2021). The female passengers have lower resources (many of them are students and housewives), lower access to a smartphone, and lower lever on digital literacy (Singh, 2020). Implementing smart mobility for female passengers will be more challenging and more investing. In Germany, there is a mobile application for personal safety when using public transportation, but the female passengers are less likely to download the application (McCarthy et al., 2016).

4 Conclusions

Female passengers mobility is an essential issue since the high percentage of public transport with concern to safety and security. The female passenger mobility patterns differ from male passengers, and it can be be employed as a measurement to mark as part of smart mobility indicators. According to the findings, it offers insightful results. First, at the current service, the BRT has complied with the requirements of female passengers. The passenger patterns demonstrate that they rely on BRT service to meet their travel needs, which encompass working, studying, and visiting relatives. The BRT has accommodated travel, despite the fact that passengers must wait for more than ten minutes for the bus, making their travel time longer than utilizing a private vehicle. The second is the ICT criteria as a core for smart mobility has been a challenge for both parties. The operator shall invest more, and the passengers have to adopt the latest technology.

Therefore, implementing smart mobility is more challenging in accordance with the female passenger mobility patterns. Another concern is whether the female passengers benefit due to this service. Hence, future research is recommended to be conducted by measuring a developing country's implementation and service benefit to obtain the gap and analysis. Furthermore, empirical reserach is

required to demonstrate that smart mobility can eliminate gender biased and gaps in public transportations.

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