

Spatial Equity in Trans Jogja Performance in the Yogyakarta Urbanized Area (YUA)

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Abstract. The availability of facilities and supporting infrastructure in a region is an absolutely necessity. Public transportation is important in accommodating the movement of low-income groups or captive users who have limited mobility options. However, most of the low-income people in the Yogyakarta Urbanized Area (YUA) currently prefer to use motorcycles rather than Trans Jogja. This is expected to be caused by the poor quality of public transport and the lack of equity in Trans Jogja services. This research focuses on transport equity by overlaying the effectiveness of Trans Jogja as the public transportation and the distribution of low-income communities per sub-district in the YUA. This study found that the performance of Trans Jogja based on the indicators of affordability, availability, accessibility, and acceptability is already effective. However, in the agglomeration of Sleman and Bantul Regency, the affordability aspect is still less effective. Meanwhile, the appraisal of the public transport equity found that there are some areas that are fair, with a large low-income population and effective performance of Trans Jogja. Some other areas are considered unfair because the low-income population is high but the performance of Trans Jogja is less effective.

1. Introduction

The Yogyakarta Urbanized Area (YUA) emerged due to the expansion of the city of Yogyakarta towards the surrounding periphery. The area is currently quite crowded and growing. Moreover, the region is designated as a National Activities Center in the Spatial Plan of the Special Region of Yogyakarta. Therefore, the presence of facilities and supporting infrastructure is an absolute necessity, including the availability of public transportation services. Currently, to accommodate the movement in the YUA, Trans Jogja is already available, which applies the Bus Rapid Transit (BRT) concept.

The public transport in YUA is also needed to accommodate the movement of low-income groups. According to [1], most of the captive users in public transport are low-income groups. Captive users are a class of people who are forced to use public transportation because of the limitations of private vehicles. This gives low-income groups a low mobility because of their limited ability. Therefore, one of the main functions of public transportation is to narrow the gap between the mobility of high-income and low-income communities.

However, in many big cities, motorcycles are currently the main choice for the most of the middle-low income groups to meet their needs for movement [2]. Motorcycles are considered to have the advantages of a low price and high flexibility. However, the use of motorcycles as the main mode of transportation in low-income communities puts a financial burden on them [2]. This condition is caused because the low-income groups still have to bear the cost of private vehicles ownership. In



other words, low-income people are forced to use motorcycles and bear the costs due to the limited choice of modes for their movements.

The current dependence of low-income people on motorcycles indicates that the accessibility of public transport is lower than the access to motorcycle ownership. This condition is suspected to be an implication of the low effectiveness of Trans Jogja, which is a form of urban public transportation in the YUA. The low effectiveness of Trans Jogja is also coupled with the allegation that, currently, there's inequity in Trans Jogja services in the YUA, especially for low-income people. Therefore, this study will discuss the effectiveness of Trans Jogja's performance and assess whether the existing Trans Jogja services are already implemented fairly.

2. Transport Equity

Equity in transportation refers to the distribution and impacts of the transportation facilities and infrastructure in a region. To analyze transport equity, the indicators that are commonly used are accessibility and mobility. According to [3], transport equity is divided into three categories: horizontal equity, vertical equity with regard to income and social class, and vertical equity with regard to mobility needs and ability.

Horizontal equity considers that every group in the society in a region has equal ability and needs in terms of transportation. According to this definition, equal individuals and groups should be treated the same in the distribution of resources, benefits, and cost burdens. Vertical equity, or so-called social justice, is the distribution of the impact between different individuals and groups in terms of abilities and needs of transportation. Individuals or groups who have the same abilities and needs will get the same impact. Meanwhile, individuals or groups with different abilities and needs will feel different effects. Vertical equity itself can be divided into two groups, namely vertical equity with regard to income and social class and vertical equity with regard to mobility needs and abilities.

According to [4], the analysis of transport equity uses four variables namely affordability, availability, accessibility, and acceptability. Affordability refers to people's financial ability to reach public transport services. It also refers to the efforts made by the people to obtain the public transport services. Availability relates to the existence of routes, the frequency of public transport services and all things related to time, e.g., waiting time or headway. Accessibility describes the ease of a community in a region to obtain public transport services either in terms of distance or availability of information about the public transport services. Acceptability relates to user convenience and comes from the perception of the public transport users.

The concept of fairness in transportation is a concern both in developed and in developing countries. Inclusive transportation planning was introduced in transport planning in Europe and America [2]. Transport planning no longer focuses only on economic and environmental aspects but also on social aspects. It aims to anticipate the emergence of marginalized groups of transport services especially for women, children, the elderly, the disabled, and low-income communities.

3. Methods

3.1 Study Area and Design of the Research

The study area in this research is the Yogyakarta Urbanized Area (YUA). YUA is a functional area in the Special Region of Yogyakarta, which comprises the City of Yogyakarta and some sub-districts in the regencies of Bantul and Sleman. YUA emerged from the expansion of Yogyakarta City to the surrounding periphery. As a result of the development process, the suburbs of Yogyakarta city underwent a spatial transformation in the form of the built-up area around the city of Yogyakarta where the city of Yogyakarta, as the core, still affects the activities in the surrounding area. In the regional spatial structure plan, as stated in DIY Regional Regulation Number 2 of 2010, YUA will be developed into a National Activity Center. YUA's population was 1,439,898 in 2015 with an area of 324.91 km².

In this research, YUA is divided into seven zones based on the similarity of land use in each zone. The division is used to assess the effectiveness of Trans Jogja's performance.

Table 1. The division of the study area.

Zone	Location	Main activities
Central Area Zone (BWK 1)	Kraton and Malioboro Area	Commercial, offices, and social services
West Area Zone (BWK 2)	Tegalrejo Sub-district and the surrounding area	Residential, commercial, and offices
East Area Zone (BWK 3)	Gondokusuman Sub-district and the surrounding area	Residential, commercial, offices, and social services
Southeast Area Zone (BWK 4)	Umbulharjo Sub-district and the surrounding area	Residential, commercial, industry, and social services
Southwest Area Zone (BWK 5)	Mantirejon Sub-district and the surrounding area	Commercial and social services
Sleman Regency Zone	Depok, Gamping, Mlati, Ngaglik, and Ngemplak sub-districts	Educational, residence, and commercial
Bantul Regency Zone	Sewon, Banguntapan, and Kasihan Sub-districts	Educational and residence

In this research consists of the following steps to analyze spatial equity in Trans Jogja performance:

- Conducting data analysis from the field survey and questionnaire to assess the effectiveness of Trans Jogja performance. The assessment uses the Likert scale to score the Trans Jogja performance.
- Overlaying the results from the appraisal of Trans Jogja performance effectiveness with the distribution of low-income groups in YUA.
- Making interpretations and conclusions on from the analysis and appraisal of the spatial equity of Trans Jogja performance in the form of narration and maps.

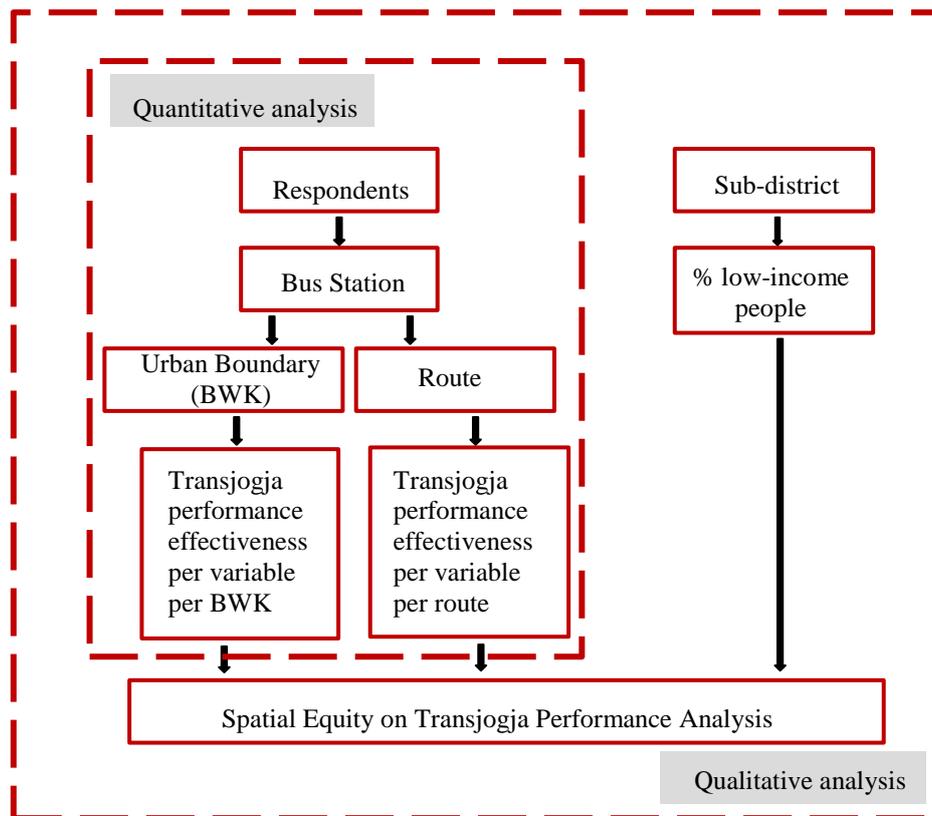


Figure 1. Data analysis scheme.

3.2 Trans Jogja performance effectiveness

The variables to analyze the effectiveness of Trans Jogja's performance are based on the literature review of theories concerning the criteria of public transport performance. It is based on several expert theories and standards of institutions in several countries, i.e., World Bank standards, MoUD India guidelines, the Decision of the Directorate General of Land Transportation Number SK.687/AJ.206/DRJD/2002, Government Regulation Number 10/2012 concerning Minimum Service Standards for Road-Based Mass Transit [5][6][8][9]. The selected variables and indicators are then used for collecting data through observations and the questionnaires.

The observations are conducted at bus stations to assess the Trans Jogja performance in the form of the areas covered, the frequency of service, headway, the number of vehicles in operation, passenger load factor, and bus station load factor. Meanwhile, questionnaires are used to gather data in the form of waiting time, fare, and distance to or from the nearest stop.

The population in this study includes Trans Jogja and also Trans Jogja users. To determine the sample at Trans Jogja stops and buses, the sampling method used is purposive sampling. Purposive sampling is used to determine which stops are used as samples by considering the distance between the locations of the stops to each other. The selected stops are not located close to each other, have diverse land uses, and are traversed by different routes. There are 112 Trans Jogja stations in the study area is. By using the reliability level of 0.1 then the sample size for Trans Jogja stops is 54 stations. Thus, in each zone, the number of stop samples was 7 to 8.

Meanwhile, to determine the sample of Trans Jogja users, the convenience sampling method was used. Three respondents are taken at each sample stop in the previous step. So, the total sample of Trans Jogja users is 162 respondents.

The Likert scale is used to process the data that has been obtained from the observation and questionnaires. With the Likert scale, the variables to be measured are divided into indicators and

parameters. Each parameter is given a score to be able to calculate the total score to measure the effectiveness of Trans Jogja performance on each variable. Table 2 shows the indicators for assessing the effectiveness of Trans Jogja performance along with the parameters and scores on each indicator.

Table 2. Variables, indicators, and criteria for Trans Jogja Performance Effectiveness.

Variable	Indicator	Criteria and <i>scoring</i>
Affordability	Fare ^(*)	<ul style="list-style-type: none"> • < 10% of total income = 3 • 10-25% of total income = 2 • >25% of total income = 1
	Area covered ^(**)	<ul style="list-style-type: none"> • >75% area covered = 3 • 50-75% area covered = 2 • <50% area covered = 1
Availability	Waiting time ^(*)	<ul style="list-style-type: none"> • <20 minutes = 3 • 20-30 minutes = 2 • >30 minutes = 1
	Frequency of service ^(**)	<ul style="list-style-type: none"> • >6 bus/hour = 3 • 4-6 bus/hour = 2 • <4 bus/hour = 1
	Headway ^(**)	<ul style="list-style-type: none"> • <15 minutes = 3 • 15-20 minutes = 2 • >20 minutes = 1
	Number of vehicles in operation ^(**)	<ul style="list-style-type: none"> • >82% vehicles in operation = 3 • 65-82% vehicles in operation = 2 • <65% vehicles in operation = 1
Accessibility	Walking distance to and from the bus station or terminal ^(*)	<ul style="list-style-type: none"> • <400 meters = 3 • 400-600 meters = 2 • >600 meters = 3
Acceptability	Passenger load factor ^(**)	<ul style="list-style-type: none"> • < 1,25 = 3 • 1,25 – 1,5 = 2 • >1,5 = 3
	Bus station load factor ^(**)	<ul style="list-style-type: none"> • <4 people/m² = 3 • 4-6 people/m² = 2 • >6 people/m² = 1

(*) The data that have obtained from questionnaire

(**) The data that have obtained from observation

3.3. Spatial Equity of Trans Jogja Performance

The analysis of the spatial equity of Trans Jogja uses the data of the distribution of low-income people in each sub-district and the effectiveness of Trans Jogja performance per variable for each BWK (urban boundary). The data of the distribution of low-income people is obtained as a secondary data

and the data of Trans Jogja performance effectiveness per variable for each BWK is obtained from the calculations in the previous step. The next step is to overlay both data using ArcGIS. The results of this process can be used to determine whether the existing Trans Jogja services have been implemented equally or not.

Table 3. Indicators of spatial equity in Trans Jogja performance in YUA.

		Low-income people		
		High	Moderate	Low
Effectivity Performance Trans Jogja	Effective			
	Moderately effective			
	Less effective			

The columns with the lightest colors illustrate equal conditions for regions with many low-income people and effective Trans Jogja performance. Meanwhile, the dark-colored columns illustrate the unequal condition, where a region has a high amount of low-income people but the Trans Jogja performance is classified as moderately effective and less effective.

4. Result

4.1 Characteristics of the Respondents

From the data of the questionnaires, most of the YUA community uses Trans Jogja to go to work or educational activities. As much as 46 percent of the respondents are students who use Trans Jogja to go to school and college, while the use of Trans Jogja for working is 27 percent. Beside these two activities, Trans Jogja also used by the community to go to social activities, health facilities, and as a connector mode of transportation to other cities or districts. By looking at the high number of trips for educational and work activities, the fluctuations of users of both types of activity is stable because both are routine and scheduled activities.

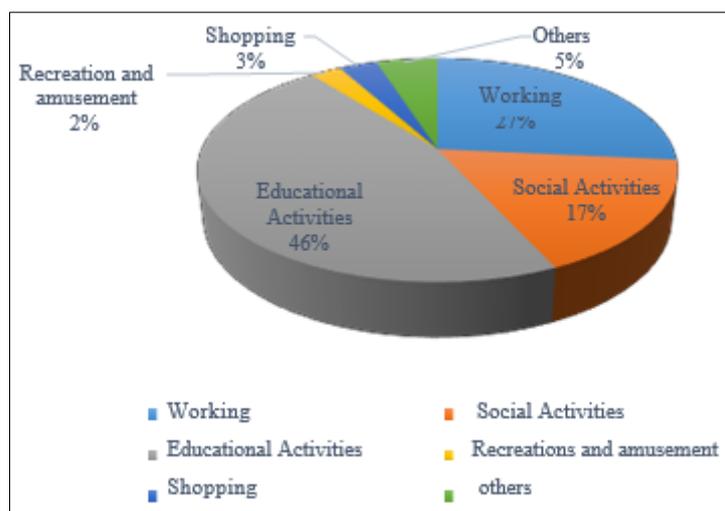


Figure 2. Trans Jogja user movement classification diagram.

Moreover, 65 percent of respondents use Trans Jogja every day. Most of them are students and people who use Trans Jogja to work. Meanwhile, 22 percent of the respondents use Trans Jogja 1-4 times per week. Most of the users who use Trans Jogja with a frequency of 1-4 times per week has the intention of traveling in the form of shopping, tutoring, or social activities such as visiting a friend's house. The rest are respondents who use Trans Jogja with less than once per week or not necessarily.

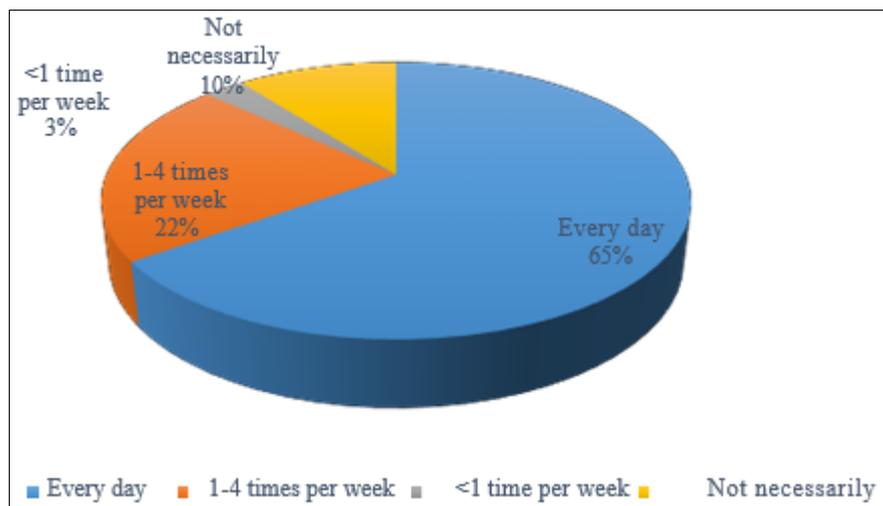


Figure 3. Percentage of travel frequency chart using Trans Jogja.

4.2 Trans Jogja performance effectiveness analysis

Trans Jogja's performance effectiveness is analyzed from the four criteria of equity in public transportation services: affordability, availability, accessibility, and acceptability. The four criteria will be discussed for each zone (BWK) and each existing Trans Jogja route. The Likert scale is used to determine the effectiveness of these criteria.

4.2.1 Trans Jogja performance effectiveness per variable per BWK

4.2.1.1 Affordability

The affordability of Trans Jogja is assessed from the fare adjustment indicator and the area covered by Trans Jogja routes. Fare adjustment is used as one indicator seen from the aspect of economic ability in reaching Trans Jogja. Meanwhile, the area covered is an indicator of the affordability of Trans Jogja in terms of radius coverage.

In terms of fare adjustment, it was found that in all BWK most of the respondents said that the cost for Trans Jogja is less than 10% of their total income. This makes Trans Jogja service effective in terms of fare suitability at all BWKs in YUA.

Table 4. Fare Effectivity Appraisal.

	<10% of total income (scoring)	10-25% of total income (scoring)	>25% of total income (scoring)	Maximum score	Total score (Effectivity level)
BWK 1	63	6	0	72	69 (Effective)
BWK 2	51	8	0	63	59 (Effective)
BWK 3	60	2	0	63	62 (Effective)
BWK 4	93	14	0	114	107 (Effective)
BWK 5 Sleman	24	2	0	27	26 (Effective)
Regency Zone Bantul	96	8	3	117	107 (Effective)
Regency Zone	24	2	0	27	26 (Effective)

To assess Trans Jogja in terms of service coverage, a buffer method is used with GIS. The first step is digitizing all bus stations located in the YUA. After that, each point was given a 600 meters buffer. This analysis shows a difference in the area covered in each BWK. Areas that are effective in terms of the area covered by Trans Jogja's are covered by more than 75 percent. The moderately effective and less effective areas are covered by 50 – 75 percent and less than 75 percent. BWK 1 has effective area coverage. Meanwhile, BWK 2, BWK 3, and BWK 4 are classified as moderately effective. The worst condition occurred in BWK 5 and the agglomerations of Sleman Regency and Bantul Regency. The total area covered by Trans Jogja in these three BWKs is only 45.45 percent, 20.4 percent, and 4.2 percent respectively, which is less effective coverage. Figure 4 shows the areas covered by Trans Jogja in each BWK.

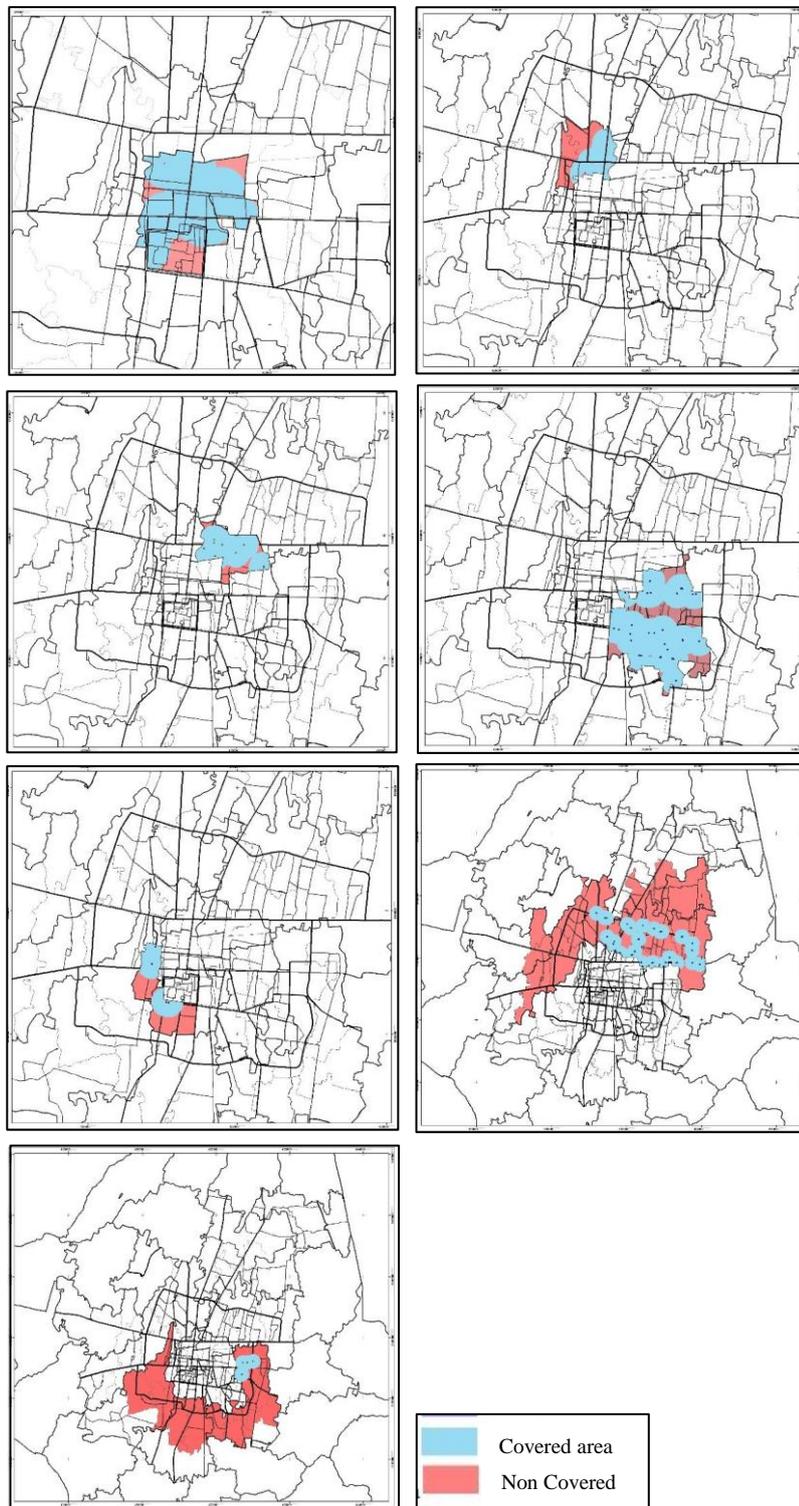


Figure 4. The area covered by Trans Jogja in each BWK

4.2.1.2 Availability

The variables used to assess availability are waiting times, headway, the frequency of service, and the number of vehicles operating. Waiting time is the time spent by Trans Jogja users from the moment of arrival at the bus stop until entering the Trans Jogja bus. This indicator of waiting time is one of the things that greatly affect people's interest to use Trans Jogja services. The results of the questionnaires showed that the average waiting time for all Trans Jogja routes ranged between 10-20 minutes at non-busy times and 15-30 minutes at busy times. Effective waiting times occurred at BWK 1, BWK 2, BWK 5, and the agglomeration of Bantul Regency. This can be caused by several factors such as the number of operating vehicles, travel speed, and traffic conditions. Meanwhile, a moderately effective waiting time occurred at BWK 3, BWK 4, and the agglomeration of Sleman Regency. Thus, the waiting time of Trans Jogja in YUA is moderately effective.

Table 5. Waiting time Effectivity Appraisal.

	<20 minutes (scoring)	20-30 minutes (scoring)	>30 minutes (scoring)	Max. score	Total score (effectivity level)
BWK 1	45	18	0	72	63 (Effective)
BWK 2	27	16	4	63	47 (Moderately Effective)
BWK 3	24	18	4	63	46 (Moderately Effective)
BWK 4	39	34	9	117	82 (Moderately Effective)
BWK 5	27	0	0	27	27 (Effective)
Sleman Regency Zone	75	16	6	117	97 (Moderately Effective)
Bantul Regency Zone	27	0	0	27	27 (Effective)

Other indicators used to assess availability are headway and service frequency. Headway is the time difference between the arrival of one bus and the next bus, while frequency is the number of Trans Jogja buses per hour. From the calculation showed that in all BWKs, Trans Jogja bus service headway is the moderately effective category. This shows that the average of Trans Jogja bus headways in all YUA areas ranges from 15-20 minutes. Meanwhile, the frequency of Trans Jogja services to all BWK is also classified as moderately effective. However, different conditions occur in BWK 3 where at 3 BWK Trans Jogja bus service frequency classified as less effective.

The last indicator to assess availability is the number of vehicles operating. The number of vehicles operating on each route can affect the waiting times, headways, and frequency of Trans Jogja busses. A higher number of vehicles operating can shorten the waiting time and headway. Thus, the bus service frequency can also be increased. The effectiveness of the number of vehicles that operate is calculated by comparing the number of vehicles that operate with the number of vehicles that should operate on each route according to the planning document. The planning document used is the Regulation of the Governor of Yogyakarta Special Region No. 22 of 2014 concerning Trans Jogja Urban Route Network. At each BWK the number of vehicles passing on each route is almost 100 percent of the planned number. However, on some routes, the number of vehicles operating is under the standard at 82 percent. The 3B route has the lowest percentage of vehicles operating. As this condition occurs thoroughly all BWKs, the overall classification for the effectiveness of the number of vehicles operating at each BWK is classified as moderately effective.

4.2.1.3 Accessibility

Accessibility describes the ease of the society in a region to obtain public transport services. Ease of obtaining public transportation services is assessed from the time the user goes to the station location from where they are doing the activity. Accessibility is also assessed from how far the location of public transport services is from the places of community activity and how to get to the transit location. The accessibility of Trans Jogja was analyzed by looking at the distance indicator to or the nearest Trans Jogja stop.

Table 6. Accessibility Effectivity Appraisal

	<400 meters (scoring)	400-600 meters (scoring)	>600 meters (scoring)	Max. score	Total scoring (effectivity level)
BWK 1	48	16	0	72	64 (Moderately effective)
BWK 2	42	8	3	63	53 (Moderately effective)
BWK 3	48	8	1	63	57 (Effective)
BWK 4	75	18	4	114	97 (Moderately effective)
BWK 5	12	4	3	27	19 (Moderately effective)
Sleman Regency Zone	6	14	12	117	86 (Moderately effective)
Bantul Regency Zone	12	4	3	27	19 (Moderately effective)

The analysis shows that in almost all BWKs the classification of Trans Jogja accessibility is moderately effective. The ideal distance that is used as a parameter for the measurement of accessibility to Trans Jogja is a maximum of 600 meters, which is an ideal distance to walk. At BWK 1 and BWK 3, the accessibility is effective. This indicates that the Trans Jogja stations at BWK 1 and BWK 3 are located close to where the community is moving. Meanwhile, the accessibility at other BWKs is moderately effective.

4.2.1.4 Acceptability

The indicators for measuring acceptability are the bus load factor and the stop load factor. The bus load factor is the ratio between the number of passengers on the bus and the capacity of the bus. Each Trans Jogja bus has a capacity of 40 passengers, consisting of 20 seated and 20 standing passengers. The calculation of bus load factor is done at three different times, i.e., morning, noon, and afternoon due to the difference in load factor at different times.

The bus load factor is below 100 percent on all Trans Jogja routes. This indicates that the load factor level of Trans Jogja busses on each route is still quite good. It also shows that the convenience of Trans Jogja buses is good because there is no occurrence of passenger accumulation. The 1 A route has the largest load factor of 40-60 percent on average. Meanwhile, the highest load factor is during the afternoon rush hour when the buses reach more than 50 on average. This is due to an increase in the number of users in the afternoon and coincides with the time of returning home. BWKs 1, 2, and 3, and the agglomeration of Sleman Regency have the largest load factor. There are many types of activities in those zones, especially activities that have a pull factor to travel in the morning and the push factor for travel in the afternoon. Therefore, Trans Jogja bus users in that BWK are quite many, resulting in a high load factor.

Meanwhile, the load factor of the bus stop is the stop fullness which is obtained by comparing the number of users in the bus stop with the size of the bus stop. The above load factor measurements are

taken during peak hours which represents the fullest condition. The stop fullness is measured at this time because if the load factor value in the peak hour is good, then the load factor at non-peak hours will also be good.

The calculations showed that the average load factor of stations in the YUA is 1-1.5 people/m². This is still below the station load factor comfort standard of 4 people/m². The low level of this load factor indicates that the stations in the YUA can accommodate the users of Trans Jogja quite comfortably. The BWKs with the highest station load factor are BWK 3, BWK 4, and the agglomeration of Sleman Regency. This is because there are several stops at that BWK that are used as transit locations such as hospital stops Bethesda, Condong Catur, and Yos Sudarso. With the conditions as described above, it can be said that the load factor stop effectiveness is classified as effective.

The following table shows Trans Jogja performance effectiveness per BWK.

Table 7. Compilation of Trans Jogja Performance Effectiveness per BWK.

Zone	Affordability		Availability			Accessibility	Acceptability	
	Fare	Area covered	Waiting time	Headway	Frequency	Walking distance	Load factor bus	Load factor station
BWK 1	●●●●	●●●●	●●●●	●●	●●	●●●●	●●●●	●●●●
BWK 2	●●●●	●●	●●●●	●●	●●	●●	●●●●	●●●●
BWK 3	●●●●	●●	●●	●●	●	●●	●●●●	●●●●
BWK 4	●●●●	●●	●●	●●	●●	●●	●●●●	●●●●
BWK 5	●●●●	●	●●●●	●●	●●	●●	●●●●	●●●●
Sleman Regency Zone	●●●●	●	●●	●●	●●	●●	●●●●	●●●●
Bantul Regency Zone	●●●●	●	●●●●	●●	●●	●●	●●●●	●●●●

●●●● = Effective
 ●●● = Moderate Effective
 ● = Less Effective

4.2.2 Trans Jogja performance effectiveness per variable per route

Table 8. Trans Jogja Performance per Route Appraisal.

Route	Waiting time	Headway	Frequency	Load factor bus
1A	Effective	Effective	Effective	Effective
1B	Moderately	Effective	Effective	Effective
2A	Effective	Effective	Effective	Effective
2B	Moderately effective	Moderately effective	Moderately effective	Effective
3A	Effective	Effective	Effective	Effective
3B	Moderately effective	Less effective	Less effective	Effective
4A	Effective	Less effective	Less effective	Effective
4B	Moderately effective	Less effective	Less effective	Effective

The table above is the result of Trans Jogja performance calculation per route using the Likert method, which was also used to calculate the effectiveness of Trans Jogja performance per BWK. The indicators are waiting time, headway, frequency, and bus load factor. The calculation of the waiting time shows that the waiting time on almost all of Trans Jogja routes is effective. Routes 1B and 2B are the two routes that are still classified as moderately effective. This indicates that the gap between one bus and the other bus on both routes ranges from 20-30 minutes. The longer waiting time for the 1B and 2B routes is thought to be due to the length of both routes and the number of buses operating so that one travel is relatively long compared to other routes. This is worse during the peak hour of the afternoon when the waiting time for each route can increase by about 5-10 minutes due to the more crowded traffic conditions at that hour when people return home from work and school.

Meanwhile, the calculation of headway and frequency of bus service Trans Jogja shows that routes 1A, 1B, 2A, and 2B are effective in terms of headway and frequency. Meanwhile, the less effective routes are 3B, 4A, and 4B. The headway is considered effective if it is less than 15 minutes and bad if it is more than 20 minutes. Meanwhile, the frequency of service is good if there are more than six buses per hour, and less effective the number of buses is less than three per hour. The length of the headway from one bus to another and the low frequency on the 3B route due to the length of the route makes travel time becomes longer. Meanwhile, on the 4A and 4B routes, the duration of headway and low frequency is due to the limited number of buses on both routes, i.e., only four buses per route. The condition of headway and frequency of Trans Jogja buses affects the waiting time that passengers spend.

Table 9. Load factor Effectivity Appraisal.

No	Route	Load Factor			Average
		Morning	Afternoon	Evening	
1	1A	27.3	45.9	65.0	46.0
2	1B	17.6	32.1	34.1	27.9
3	2A	24.0	38.8	53.3	38.7
4	2B	21.0	32.6	41.9	31.8
5	3A	24.5	42.6	59.2	42.1
6	3B	34.5	32.1	34.8	33.8
7	4A	15.6	20.3	26.4	20.8
8	4B	7.1	21.8	19.2	16.0

The last indicator used is the bus load factor, which is relatively low on each route. This confirms that currently, Trans Jogja is not the main choice of transportation in YUA. The lowest load factor average is on route 4B, which is suspected because it is influenced by the long headway between each bus that causes a long waiting time. In addition, on the routes with a low load factor value, the route is likely not long. It makes the route offered less varied and less able to reach a wider area. Meanwhile, the high load factor of the bus is on the 1A and 3A routes. This is because both routes have a wide range.

4.3 Spatial Equity in Trans Jogja Performance

Spatial equity means the distribution of impacts in accordance with socioeconomic conditions of the society in a region. In other words, equity is the vertical justice where there are certain groups that should gain more benefits than other community groups due to their limited economic ability. The spatial equity in Trans Jogja service in YUA is analyzed by overlaying Trans Jogja performance effectiveness with the distribution of low-income groups in YUA. Figure 5 shows the distribution of low-income people in each BWK in YUA.

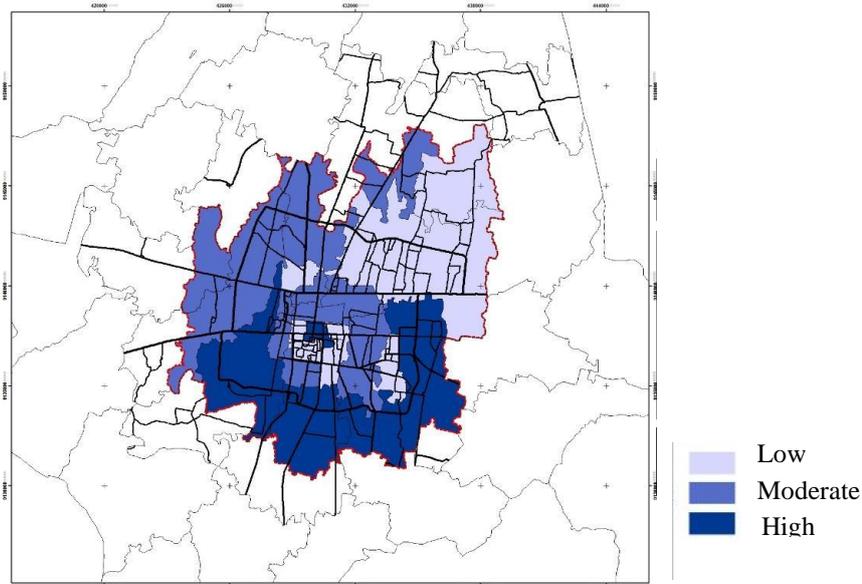
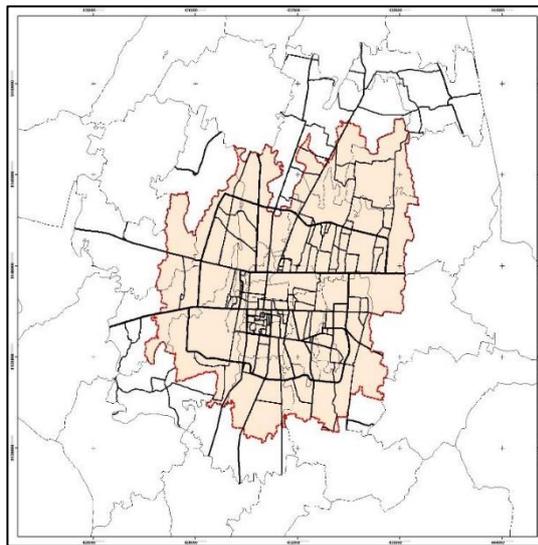


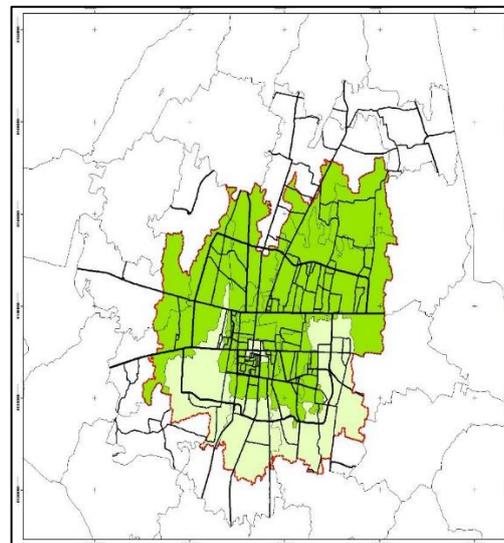
Figure 5. The distribution of low-income people in YUA

The map above shows that the concentration of the low-income people in YUA mostly occurs in the agglomeration of Bantul Regency, namely in Sewon District, Kasihan Sub-district, and Banguntapan District. Meanwhile, the lowest percentage of low-income people is in BWK 1, BWK 2, BWK 4, and the agglomeration of Sleman Regency. The other areas have a moderate classification. To conduct further analysis on spatial equity in Trans Jogja service in YUA, the data of low-income people is overlaid with Trans Jogja performance effectiveness. The aspect of spatial equity is assessed from each indicator on Trans Jogja's performance itself. Each indicator is discussed below.

4.3.1 Affordability



Light orange: Fare adjustment is effective



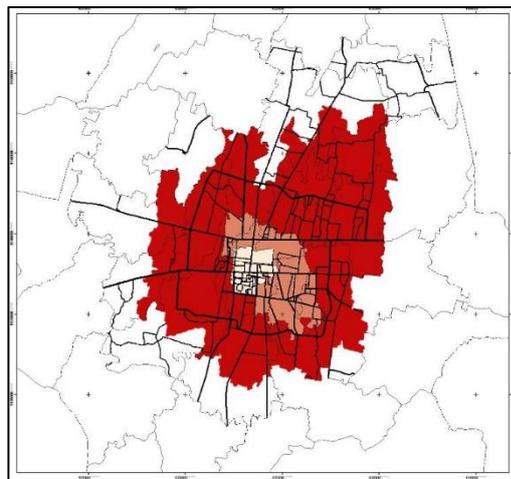
Light green: High amount of low-income people and fare is effective; Low low income people and fare is effective
 Darker green: Moderate amount of low-income people and fare is effective

Figure 6. Trans Jogja fair adjustment effectiveness in YUA.

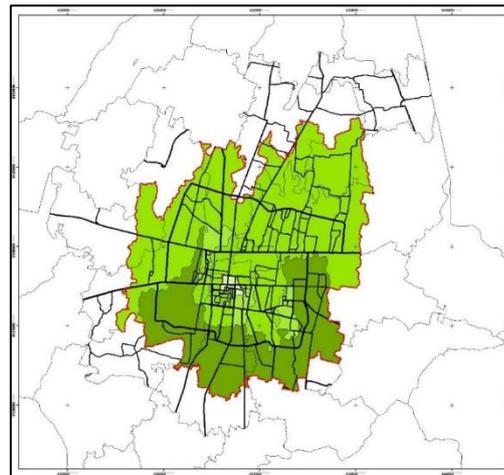
Figure 7. Spatial equity in term of fair adjustment in YUA.

From the result of the overlay between Trans Jogja effectiveness in terms of fare adjustment with the distribution of the low-income people, it is found that there is an inter-regional equity in terms of the fare adjustment. This is because in the areas with a high low-income population, the cost incurred to obtain Trans Jogja services is still moderately effective. In other words, the overwhelming majority of the public spends less than 10 percent of their total income on Trans Jogja. This can be seen from the areas that have a lighter color on the map above. In addition, this condition also implies that the current fare for obtaining Trans Jogja services are still relatively light and does not burden the public. Low-income people who are categorized as captive users in transportation can still reach Trans Jogja in terms of costs.

On the other hand, the overlay between the effectiveness of the area covered by Trans Jogja services with the distribution of low-income people is equal yet. This can be seen on the map below where the only area that is equal in terms of the area covered by Trans Jogja services (indicated by light colors) is the Gondomanan Sub-district in BWK 1. In addition, the darker color shows the areas that have a large number of low-income people but the areas covered by Trans Jogja services are less effective. This will increase inequality, especially when it is compared with the condition at the agglomeration of Bantul Regency where the number of low-income people is high and the area covered by Trans Jogja services is relatively small. Thus, in the agglomeration of Bantul Regency, the coverage of Trans Jogja must be further enhanced considering the large number of low-income people who are very dependent on the existence of such public transportation.



Moderate
Effective
Less



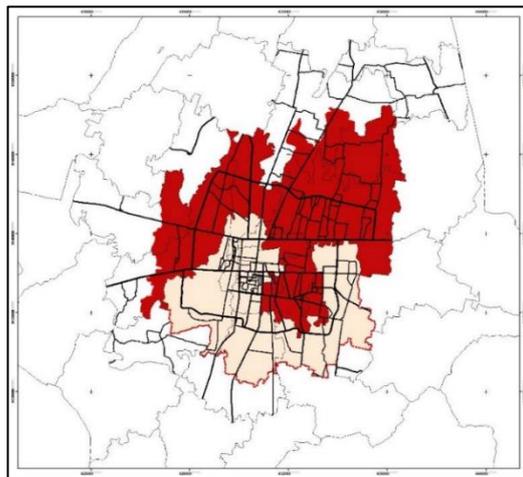
High amount low- income people and effective area coverage
Low amount of low-income people and area covered is moderately effective; Low low-income people and area covered is effective; Low low income people and area covered is moderately effective; Moderate low-income people and area covered is effective; Moderate low-income people and area covered is moderate effective; Moderate low- income people and area covered is less effective.
High low income people and area covered is less effective

Figure 8. The area covered of Trans Jogja effectiveness in YUA.

Figure 9. Spatial equity in term of the area covered in YUA.

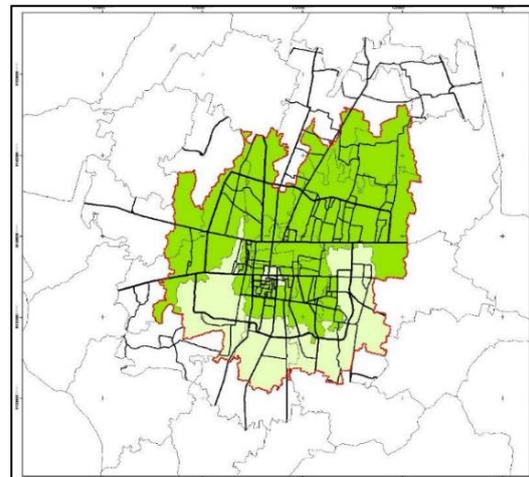
4.3.2 Availability

The first indicator to measure the availability of Trans Jogja performance is the waiting time. The overlay of the effectiveness of the Trans Jogja bus waiting time and the distribution of the low-income people shows that inter-regional equity has been achieved in terms of the effectiveness of Trans Jogja service waiting time. This can be seen on the map which shows that in areas where the number of low-income people is high the waiting time for Trans Jogja bus service is fast, i.e., less than 20 minutes. These conditions occur in the Gondomanan District in BWK 1 and in the agglomeration of Bantul Regency. Overall, the YUA has the same condition in terms of waiting time equity. There is no inter-regional inequality in terms of waiting time; each region gets a waiting time service in accordance with the conditions of low-income people in the region. However, the condition still needs to be improved considering the waiting time for Trans Jogja buses in almost all YUA areas is still classified as moderately effective.



■ Moderate
■ Effective

Figure 10. Waiting time of Transjogja effectiveness in YUA.

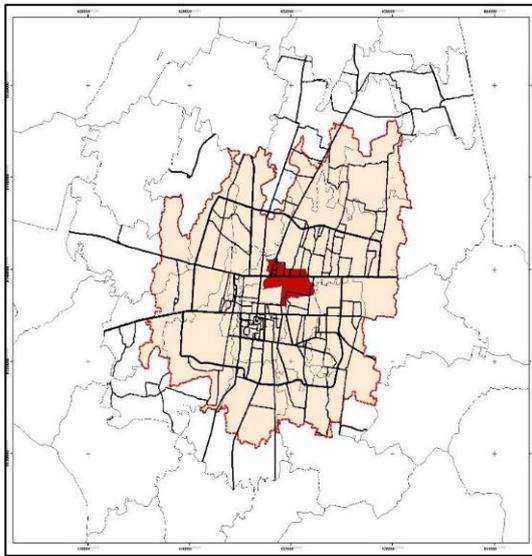


■ High low income people and waiting time is effective
■ Low low income people and waiting time is moderately effective; Low low income people and waiting time is effective; Moderate low income people and waiting time is effective; Moderate low income people and waiting time is moderate effective

Figure 11. Spatial equity in term of waiting time in YUA.

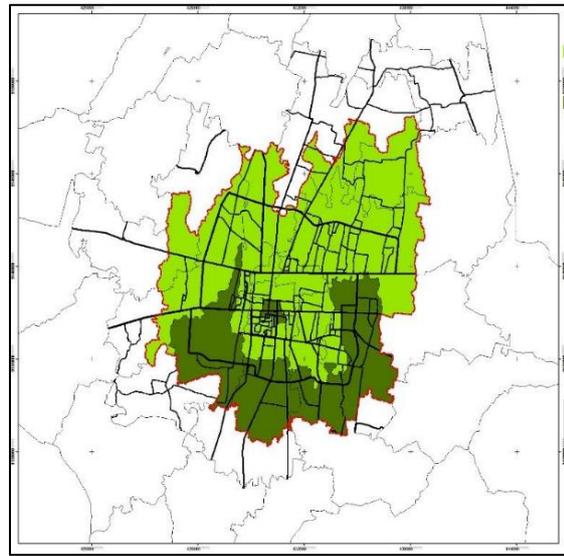
The frequency of Trans Jogja buses is classified as moderately effective. After overlaying it with the low-income people, it can be seen that there is a gap between regions. This can be seen from the map where the agglomeration of Bantul Regency has a dark color which means that in that region the number of low-income people is high but the frequency of Trans Jogja buses is less effective. This negatively affects people's mobility in that region. Meanwhile, in other BWKs, the conditions are good enough but not yet good because the frequency of Trans Jogja buses is not effective yet.

The same condition happened for the headway of Trans Jogja buses. The map shows inequity between regions in terms of effectiveness of Trans Jogja bus headway. In the agglomeration of Bantul Regency, the number of low-income people is high but is not supported by short Trans Jogja bus headway. The headway times should be improved in the areas where have the number of low-income people is high enough so that people do not have to wait long for Trans Jogja buses. Meanwhile, in other BWKs the conditions are better than in the agglomeration Bantul Regency. This is because in other BWKs the number of low-income people is moderate or low and the effectiveness of headway is also quite effective.



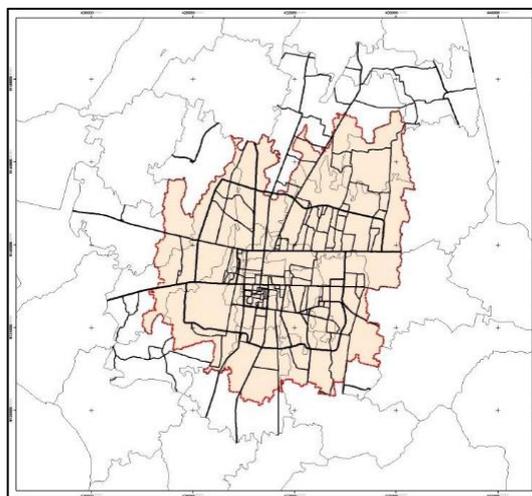
Moderate
 Less

Figure 12. Frequency of Transjogja effectiveness in YUA.



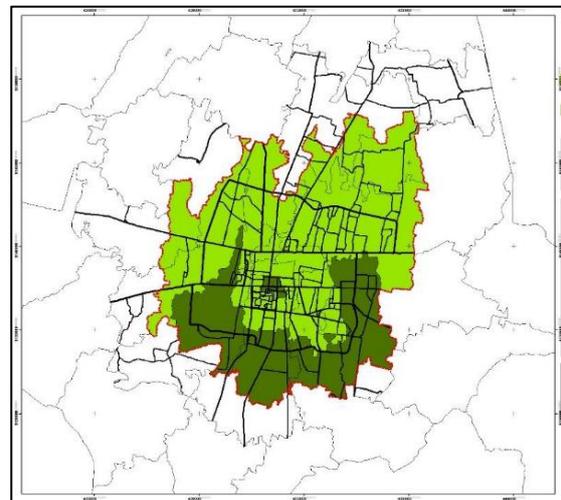
Low low income people and requery is moderately effective; Modarate low income people and requery moderately effective; Moderate low income people and requery moderately effective;
 High low income people and requery is moderately effective

Figure 13. Spatial equity in terms of frequency of Transjogja buses in YUA.



Moderate

Figure 14. Haedway of Transjogja effectiveness in YUA.

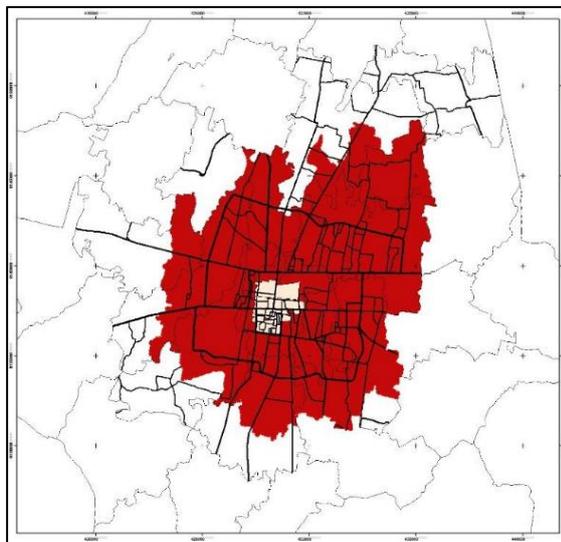


Low low income people and headway is moderately effective; Modarate low income people and headway moderately effective;
 High low income people and headway is moderately effective;

Figure 15. Spatial equity in terms of headway of Transjogja buses in YUA.

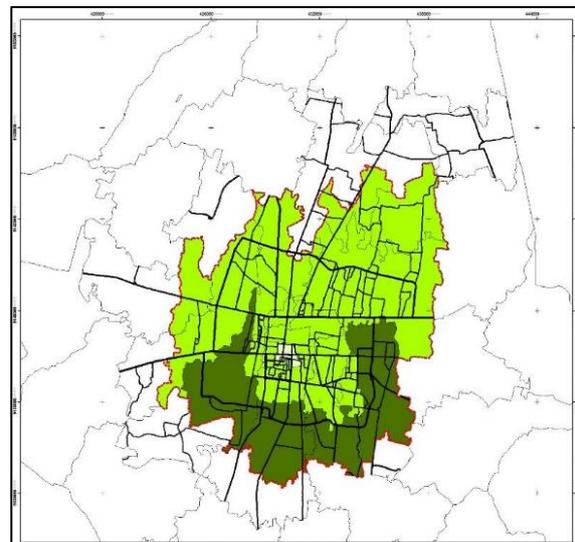
4.3.3 Accessibility

In terms of accessibility, the maps below show that there is inequity in terms of accessibility from and to the nearest Trans Jogja stops. The areas that are fair in terms of accessibility so far only reside in Gondomanan District in BWK 1. Although the low-income population is high in the area, this is supported by the proximity of the distance from and to the location of Trans Jogja shelter. Meanwhile, the opposite occurs in the agglomeration of Bantul Regency. In the maps below, the areas with the darkest color indicate that the number of low-income people is high but accessibility is classified as less effective. There should be an effort to make Trans Jogja more accessible especially in the areas where the amount of low-income people is high so that Trans Jogja could support their mobility in those areas.



■ Moderate
■ Effective

Figure 16. Accessibility of Transjogja services effectiveness in YUA.



■ High low income people and accessibility is effective
■ Low low income people and accessibility is moderately effective; Low low income people and accessibility is moderately effective; Low low income people and accessibility is effective; Moderate low income people and accessibility is moderately effective; Moderate low income people and accessibility is effective;
■ High low income people and accessibility is moderately effective

Figure 17. Spatial equity in terms of accessibility.

4.3.4 Acceptability

The first indicator used to assess equity in terms of acceptability is the bus load factor. The map below shows an inequity in all YUA areas in terms of Trans Jogja bus load factor. In the agglomeration of Bantul Regency, the existing condition is fair as the bus load factor is effective. This is because there has not been a buildup of passengers on buses that pass through the area, thus providing opportunities for low-income people to access the services. However, the condition also shows that Trans Jogja is not yet used massively by the people in YUA. This is reflected from the absence of buses on each route that exceeds the limits of bus load factor, especially during peak hours.

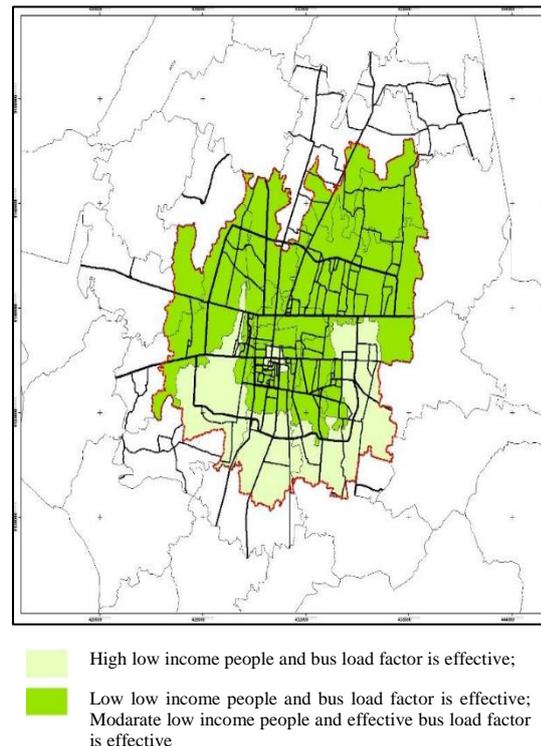
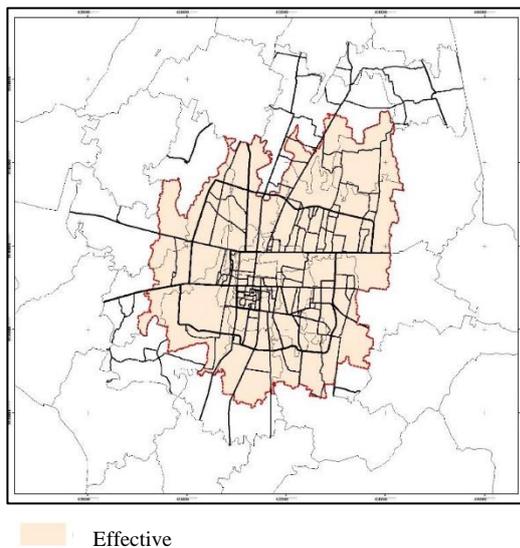


Figure 18. Bus load factor of Trans Jogja effectiveness in YUA.

Figure 19. Spatial equity in terms of bus load factor.

The same condition occurs in the indicator of the load factor of the bus stop. After overlaying the map of the distribution of low-income people and the effectiveness of the load factor of the stop, shown that there is an inequity in the load factor of the bus stop. In most BWKs conditions are classified as moderately effective, but in BWK 1 the condition is effective. This indicates that at BWK 1, the stops can already accommodate the movement of Trans Jogja users. Meanwhile, just like the value of the bus load factor, the value of the load factor of Trans Jogja bus stop in YUA is still low. This reinforces the indication that Trans Jogja is not currently the primary choice for the community.

5. Discussion

This research shows a gap between the northern and southern regions from the aspect of equity in Trans Jogja. The southern region especially in the agglomeration of Bantul Regency has a relatively high number of low-income people but is not balanced with effective Trans Jogja services. The opposite occurs in Jogja City and the northern areas (the agglomeration of Sleman Regency) where the concentration of low-income people is low and Trans Jogja service is effective and moderately effective. It indicates that the spatial equity of Trans Jogja in YUA area has not been achieved yet.

The assessment of the equity of Trans Jogja shows that on the covered areas, the frequency of bus services, bus headway, and accessibility is not equal. In the southern region (the agglomeration of Bantul Regency) the four variables of Trans Jogja are classified as less effective whereas the concentration of poor people in the region is high. This is a proof that the purpose or function of public transportation to accommodate the movement of captive user groups in society is still not well implemented in the YUA.

In addition to the fact that Trans Jogja's performance has not been effective in the south, urban public transport policy in Yogyakarta Province is focused more on accommodating the movement of society for education and tourism activities. Both activities are currently concentrated in the central and northern areas of Yogyakarta. This causes the southern region to lag behind in terms of availability of urban public transport services considering that there are not many educational and tourism activities because the area is more dominated by settlements.

The inequity of Trans Jogja's existing services has resulted in the high dependence of the people on motor vehicles. This is especially true in low-income communities with limited mobility options. It is also influenced by the difference between the costs incurred when using Trans Jogja with private vehicles, especially motorcycles. According to [10], the difference in costs incurred for work ranges from IDR 141,796 - 203,522 per month, while for educational activities the costs ranged from IDR 33,602 - 178,192 per month. This condition makes Trans Jogja service less competitive than motorcycles. The bigger cost that must be spent is because the Trans Jogja has not reached the area around the settlements yet so that additional costs are required to access Trans Jogja by other public transportation services such as city buses.

The dependence on private vehicles also presents a financial burden for low-income communities. However, due to the limited available options, these low-income communities still feel unencumbered with the financial burden they have to incur. In other words, dependence on private vehicles for low-income groups is a condition that forces them to use private vehicles. However, if the area around where the low-income people live has been traversed by an effective public transportation service, then the dependence on private vehicles will decrease and will indirectly ease the financial burden for low-income people.

The discussion above highlights some aspects that are still less effective. This research offers the following recommendations:

- Add routes and stops at BWK 5, the agglomeration of Sleman Regency, and the agglomeration of Bantul Regency. The Regulation of the Governor of Yogyakarta Special Region Number 22 of 2014 concerning the Trans Jogja Urban Route Network already includes plans for expanding the network to those areas. However, progress is constrained by funding problems in the procurement of buses and other supporting facilities.
- To overcome the condition of the point above temporarily, it is better to use feeder buses especially for the communities in the agglomerations of Sleman Regency and Bantul regency. It is also necessary to optimize the integration with other urban transport.
- Optimize the availability of park and ride facilities and infrastructure and increase the number of shelters with park and ride facilities aimed at improving the user's coverage.

6. Conclusion

From the discussion about spatial equity in Trans Jogja service in YUA, there are some things that can be concluded. Overall, Trans Jogja's performance in the YUA has different effectiveness scores. However, in BWK 5 and the agglomerations of Sleman Regency and Bantul Regency, Trans Jogja is still ineffective in covering all areas. This is due to the lack of stops in these three areas and the lack of routes that pass through BWK 5.

Meanwhile, the overlay of Trans Jogja service performance and the number of low-income people per BWK indicates that overall there is still inequity in Trans Jogja service. In some aspects of equity, the areas that are high in the number of poor people have not yet received an optimal service. Some

areas have not even been covered by Trans Jogja. This makes many low-income people unable and not wanting to use Trans Jogja. The agglomeration of Bantul Regency is classified as having inequity because the region has a relatively high number of low-income people but for some indicators, Trans Jogja is still less effective.

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