

Bus Stop Location Evaluation of New Bus Transportation System in Makassar, Indonesia

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1. Introduction

Compared to the megacities such as Manila or Bangkok, Makassar is only a large city in the east part of Indonesia. Trying to copycat the success of Trans-Jakarta in Jakarta, Makassar developed the new bus system in 2014. With its 1.8 millions of population, the government tried to make more people to use public transportation so that the number of private vehicle such as cars, can be reduced and the road can have less congestion. However, there is a trend that the number of passenger in this new bus system is decreasing every year.

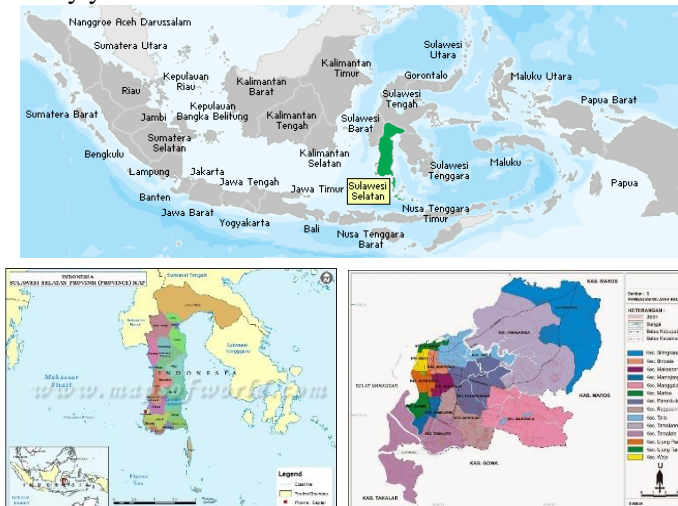


Figure 1. The Map of Makassar, South Sulawesi, Indonesia
This research aims to evaluate the locations of bus stops based on its land use and to evaluate the characteristics of the bus passengers in Makassar.

The research problems of this study are:

1. How is the location of the bus stop based on its land use?
2. How is the characteristics of the bus passengers in Makassar?

2. Methodology

The 7 selected bus stops will be discussed out of 36 bus stops in Makassar based on its number of passengers. This selected bus stops are buffered to evaluate its land use from 300, 500, 700, 900, and 1,100 meters by using GIS software. This research used a quantitative method by using regression analysis to see the correlation between the

number of passengers and its land use in its buffer area and also descriptive statistics to analyze the characteristics of bus passengers in Makassar. However, the bus stop that will be discussed in this research only 1 bus stop, that is MP (Panakukang) bus stop.

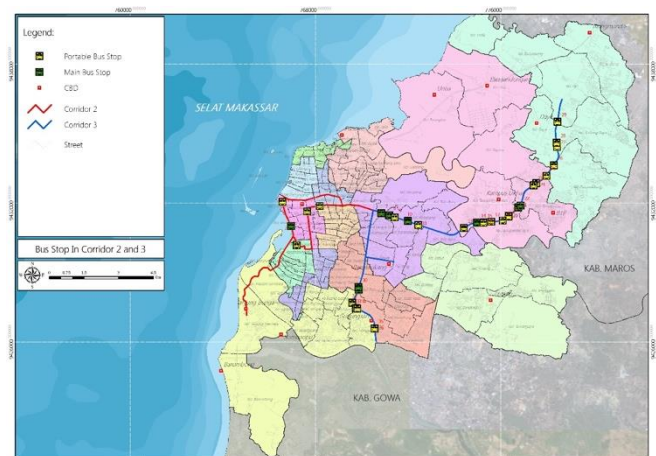


Figure 2. Map of the bus stops location in Makassar

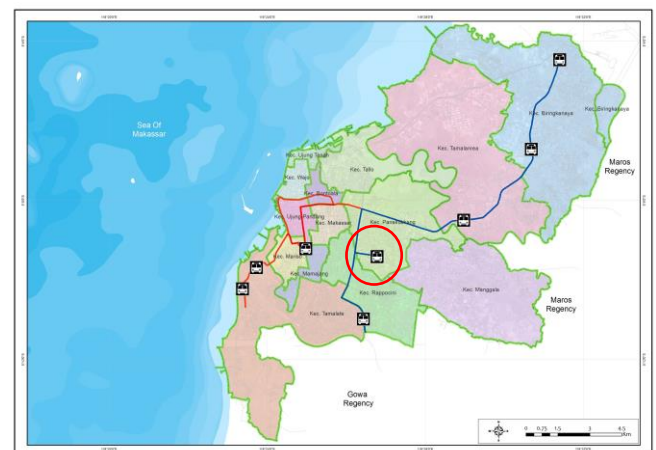


Figure 3. Map of selected bus stops location in Makassar

3. Collecting Data

3.1 Time of Survey

The survey was conducted on August 11 – 14th in 2017 and October 2 -10th in 2017. The survey was conducted from around 8 or 9 AM on return trip route, depend on the bus schedule (there was no fix schedule). The target of the respondent is the bus passengers so the interview was conducted on the bus. The number of respondents was 104

people.

3.2 Questions in the Survey

The questions of survey tried to identified the passengers gender, age, occupation, trip origin, trip destination, the mode used to the origin bus stop, distance from the origin of the trip to the bus stop, how far the passengers want to walk to the bus stop, mode used from the destination bus stop, distance from the destination bus stop to final destination trip, and how far the passengers want to walk from the bus stop.

4. Results of the Analysis

4.1 Location of Bus Stop based on its Land Use

The bus stop that will be buffer from radius 300, 500, 700, 900, and 1100 meters was MP bus stop. The map of its land use in 300, 500, 700, 900, and 1,100 meters buffer can be seen in Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8 respectively. This map are made from the existing land use map of Makassar city and then overlaid by the GIS software.

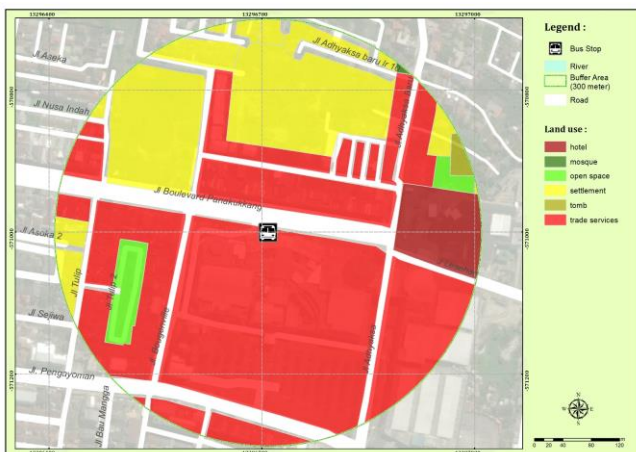


Figure 4. 300 meters buffer land use area

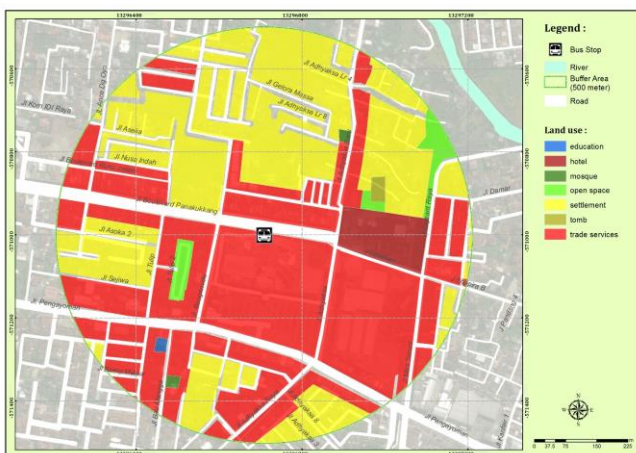


Figure 5. 500 meters buffer land use area

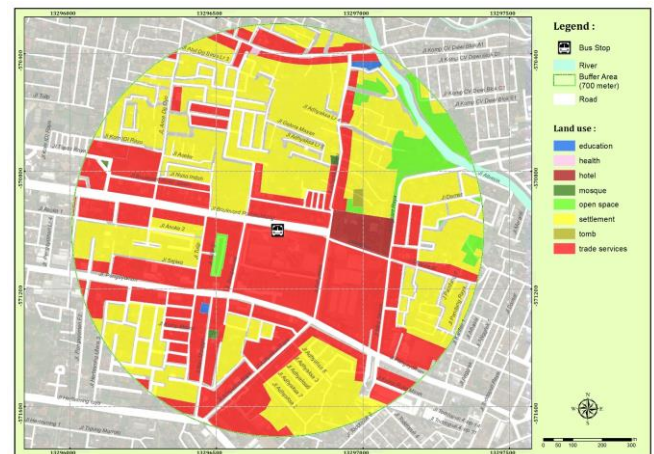


Figure 6. 700 meters buffer land use area

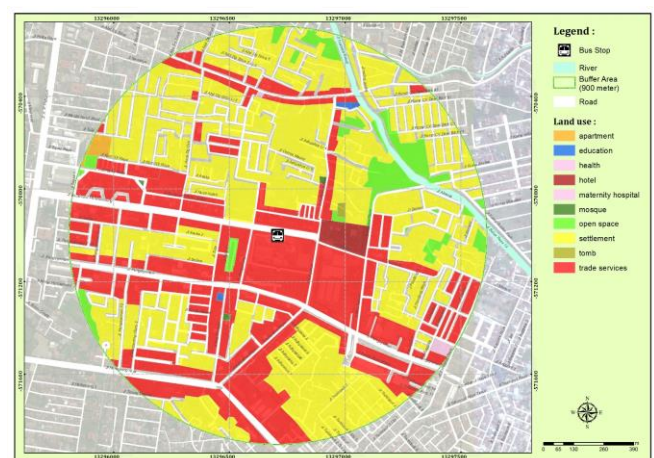


Figure 7. 900 meters buffer land use area

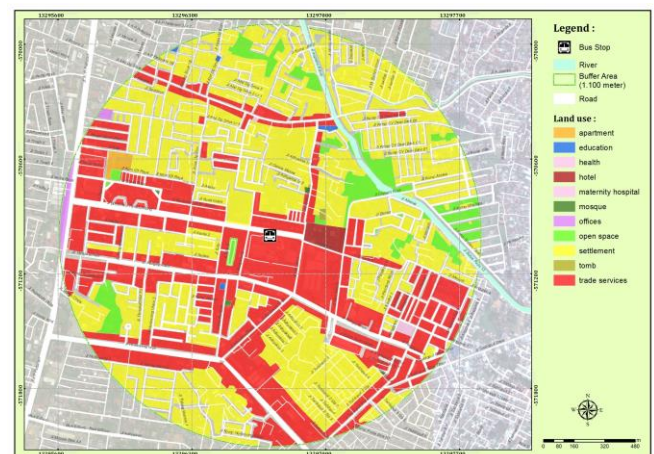


Figure 8. 1,100 meters buffer land use area

From the maps above, we could see that the MP bus stop was located in the mix land use area that dominated by commercial area if it was seen from 300 and 500 meters buffer. However, the residential area significantly took more places than the commercial area in 700, 900, and 1100 meters buffer. Moreover, the other land use (other

than commercial and residential) only took little space in the buffer area. The detailed can be seen in Fig. 9 and Fig. 10 respectively. From the Figure 10, it could be seen that in 300 meters buffer, the commercial area took more than 60% ratio of buffer area meanwhile in 1100 meter buffer, it only used up to 40% area. The same proportion for both areas was on 700 meters buffer.

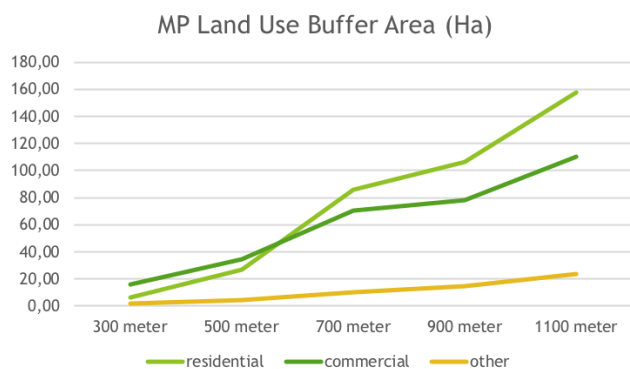


Figure 9. The land use buffer area in MP bus stop

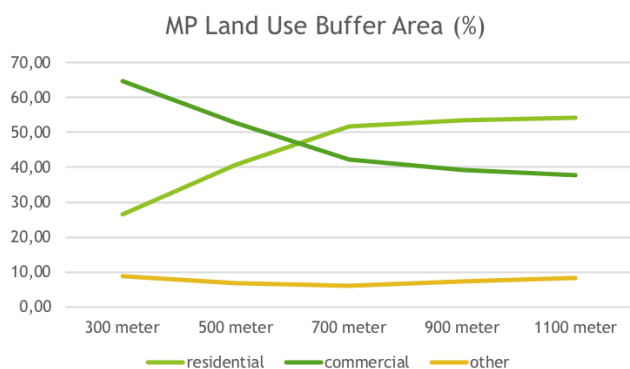


Figure 10. The proportion of land use buffer area in MP bus stop

By using regression analysis on all selected bus stop, we tried to find the corellation between the number of passengers and its land use in its buffer area. The analysis was conducted in with stepwise method. From the result, it showed that only commercial area that had significant result in every buffer. The detail can be seen in Table 1.

Table 1. The Model Summary (n = 7)

Buffer area	R	R Squared	Adjusted R Squared	Std. Error of the Estimate
300	.790 ^a	0.624	0.548	12.67302
500	.868 ^a	0.754	0.705	10.24628
700	.881 ^a	0.776	0.732	9.76633
900	.847 ^a	0.718	0.661	10.97651
1100	.913 ^a	0.833	0.800	8.43459

From Table 1, we can see that every buffer area obtained the significant result. The R and R squared were significantly higher in 1100 meters buffer which means it have strong relationship between independent variabels to dependent variabel. Tha adjusted R square means that the highers the adjusted R square means the better the regression model. The model in 1100 meter buffer had adjusted R square as 0.800 which means this model is better than other model to explain the correlation between the number of passenger and its land use in its buffer.

Tabel 2. Estimated Coeffients

Model	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
300 (Constant)	-29.661	18.384	-1.613	.168
Commercial_area(ha)	4.357	1.514	2.878	.035
500 (Constant)	-13.041	9.620	-1.356	.233
Commercial_area(ha)	1.731	.442	3.915	.011
700 (Constant)	-2.868	6.900	-.416	.695
Commercial_area(ha)	.773	.185	4.168	.009
900 (Constant)	-2.057	7.785	-.264	.802
Commercial_area(ha)	.641	.180	3.565	.016
1100 (Constant)	-.926	5.492	-.169	.873
Commercial_area(ha)	.500	.100	4.999	.004

4.2 The Characteristics of The Bus Passengers In Makassar

From questionnaire survey, it was observed that most of the riders were female. The proportion of male passengers was Only 17%. The age varied from less than 20 years old to more than 50 years old. The group more than 50 years old was only around 7% of the respondents. Younger respondents from group 14-20, 21-30, and 31-40 years old were dominant. The occupation of the respondents was dominated by housewife and college student, 35% and 26%, respectively.

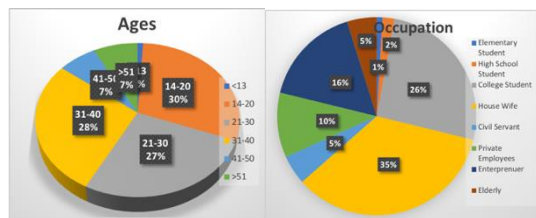


Figure 11. Ages and Occupation Composition

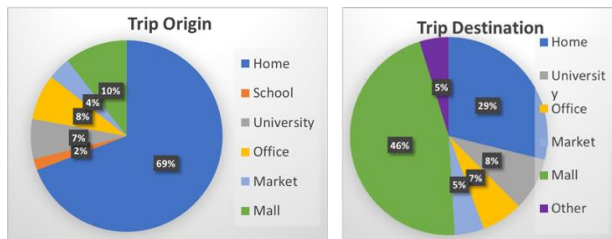


Figure 12. Trip Origin and Destination

Most of trip origin was from home (69%) and from mall (10%). However, the trip destination was varied from mall (46%), home (29%), and office/campus (15%). There is no school as destination for the passengers because most student in Makassar went to school with their parents or by other vehicles and this bus system is not operated before the school hour. Therefore, the students cannot use the bus to go to school.

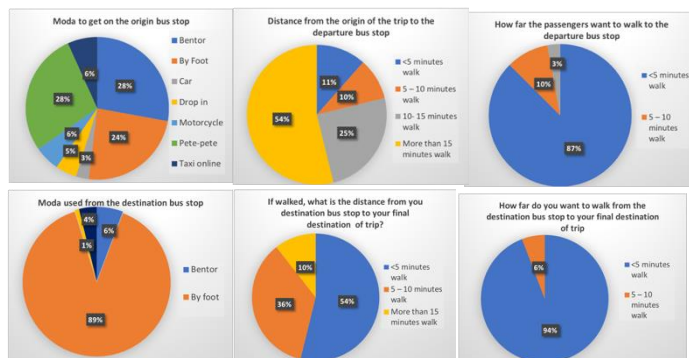


Figure 13. Moda that the passengers used, their distance, and their willingness to walk

Most people reached the bus stop not only by walking (24%) but also by using bentor (28%). Bentor is non-formal transportation in Makassar along with pete-pete. It is very different from Japan, people in Makassar can access to the bus stop by using various vehicles not only by walking. But in Japan, mostly people go to the nearest bus stop by walking. Therefore, in Makassar, the people from far away neighborhood can use the bus stop. That could be the reason why the model 1100 meters buffer had more significant result compare to other models.



Figure 14. Bentor and Pete-pete as Non-formal Moda of Transportation

It can be seen in the figure that 54% people came from the distance than took more than 15 minutes-walk and after they arrived in destination, they only walked within 5 minutes-walk from the bus stop to their destination (also 54%). From their willingness to walk, people in Makassar prefer to walk only if the distance is around less than 15 minutes-walk. That is why people in Makassar went to bus stop by other vehicles.

5. Conclusion

The bus stop that have highest number of passengers was MP bus stop. If it is seen from 300 meters buffer, the area was dominated by commercial area around three-quarter of its area. On the other hand, it is seen from 1100 meters buffer, the residential area took space more than 50% in the buffer. Based on regression analysis, the model 1100 meters buffer have the highest adjusted R square which mean it is the best model compare to explain the regression formula compare to another buffer.

It is necessary to consider mixed land use as a point that can affect the number of passengers. Due to the characteristics of bus passengers in Makassar, that they tend to avoid walk in a long distance. They prefer to go to bus stop by using other vehicles such as car, motorcycle, bentor, and pete-pete to reach their destination even if they have to spend money.

Most of passengers that used bus came from area that if they walked, it will take more than 15 minutes to walk, which it answered why people prefer not to walk to the bus stop. The condition road in Makassar also not convenient to walk in their pedestrian.

For the next bus stop construction, it should consider mixed land use that is seen from wider buffer at least for 1100 meter so not only focus on the specific main attraction on that area.