MICROBUS STOP OPTIMIZATION BASED ON GIS FOR BUS FEEDER ON THE GUNUNG ANYAR – KENJERAN ROUTE

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Abstract: The Surabaya City Government aims to improve public transportation such as the bus, and microbus. The current condition of the Gurung Anyar - Kenjeran route lacks intermodal connectivity. Therefore, establishing adequate intermodal connectivity is expected to boost the demand for buses operating on this route. This research focuses on planning the Microbus Stop as a feeder stop for the bus, aiming to determine the range of Microbus Stop services required by the community. One of the locations chosen for this research is the Gunung Anyar - Kenjeran route. Activities carried out include conducting surveys of people who are active on and through the Gunung Anyar - Kenjeran route, planning the alternative Microbus Stop location based on demand and infrastructure data, and analyzing service coverage using the service area method. It was found that most of the community made the move from Rungkut Sub-District to Gubeng Sub-District and Genteng Sub-District to Wonorejo Sub-District. Alternative Microbus Stop locations are divided into 2 schemes: demand-based and infrastructure-based. The demand-based Microbus Stop Scheme has 97 stop points while the infrastructure-based Microbus Stop scheme has 1270 stop points. Based on the results of the analysis of microbus bus stop service coverage, it shows that the infrastructure-based scheme has a better service area that meets community expectations, ie 5,299.99 ha compared to the needs-based scheme, which is only 1,873.73 ha. The cause for the demand-based scheme to have a small service coverage area is due to the lack of demand data in the Bulak District.

Keywords: *Service area, bus, feeder, demand, coverage*

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INTRODUCTION

The city of Surabaya is recorded to have a population of 2,874,314 people, this number consists of 1,425,148 male residents and 1,449,146 female residents [1]. The strategic location of the city of Surabaya is rapidly increasing the need for travel. This can be seen from the development of the industrial sector, trade, educational facilities as well as community activities that continue to increase. The increased need for travel has resulted in increased use of private modes of transportation such as cars and motorbikes. The ever-increasing number of modes of private transportation resulted in congestion in the city of Surabaya.

The Surabaya City Government is trying to reduce the level of congestion in the City of Surabaya by widening the road, building a frontage road, and building a ring road. Increasing road capacity causes the use of transportation modes to increase as well. In other words, the wider the road, the higher the vehicle speed and the lower the time taken to drive [2]. In addition to increasing road capacity, one of the efforts that can be made to reduce congestion is to use public transportation modes. Congestion occurs if the service level or level of service of the road section is more than 0.7 or includes the level of service level D. This class of service level has the characteristics of unstable traffic speed, drivers limiting speed, the reduced opportunity to overtake, and volume traffic is close to road capacity but acceptable in the short term. The greater the volume and capacity values, the more severe the traffic jam on that road [3]. This has encouraged the Surabaya City government to continue to seek the procurement of city facilities and infrastructure to provide transportation services to support community activities in the City of Surabaya. Public transportation modes available in the city of Surabaya include City Buses, City Transportation (Microbus/bemo), Trains, Commuter Trains, Ferries, Airplanes, Buses, Pedicabs, Intercity Buses, and School Buses [4]. One of the public transportation that is being developed by the Surabaya City government is the Bus.

According to Rohani (2013), The condition that is often experienced by buses today is the low level of service provided by public transportation to the public users of these public transportation services. Factors that can affect the level of service that is less, among others, include (1) Low levels of service, indicated by high waiting times, long travel times, and lack of comfort and safety in public transport. (2) The level of accessibility is low, indicated by the fact that there are still many parts of urban areas that have not been served by public transport and also that the ratio of the length of roads in urban areas is still below 70%. (3) High costs occur as a result of the lack of accessibility and poor public transport service network which results in users having to change transport several times to reach travel destinations. From Rohani's explanation, one of the conditions experienced by the Bus is the lack of accessibility or lack of access to Bus services. This can be solved by providing minibusses or smaller vehicles to serve as feeders for the Bus [5].

One alternative public transportation that can be used as a feeder for the Bus is Microbus. Surabaya Microbus is one of the public transportation facilities that is still operating in the Surabaya City area and its surroundings. It operates every day from morning to night. Currently, Microbus has 58 routes covering the entire area of Surabaya City with a total of 4,667 units operating [6]. With such a large number, the City of Surabaya can see an example that has been implemented by the City of Jakarta in the Jak Lingko program, or what is commonly called OK-OTRIP to make Microbuses a feeder for Trans Jakarta.

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From the results shown by Jak Lingko's performance to increase public interest in taking the Jakarta Bus, the researcher wants to apply the same thing to Buses and Microbus. For this reason, researchers utilized Network Analyst tools to plan new Microbus routes. Furthermore, the researchers also wanted to know the possibility of modal shifts and the willingness of the community to use Microbuses as Bus feeders by distributing questionnaires.

Network Analysis (Network Analyst) in ArcGIS software is an extension for network-based spatial analysis such as routes, travel directions, nearby facilities, and service coverage area analysis. This allows users to dynamically model realistic network conditions, such as enhanced, speed limits, height limits, and traffic conditions at different times of the day [7]. Network analysis will be used to determine alternative routes for Microbuses as feeders for the Bus. In addition, this analysis is also used to determine the range of services from each Microbus stop. To find out the service coverage of each Microbus bus stop, a service area method will be used. The service area method is better than the buffer method in knowing the range of services because the service area method considers the characteristics of the road network while the buffer method does not consider the characteristics of the road network. Further explanation can be seen in Figure 1.[8].

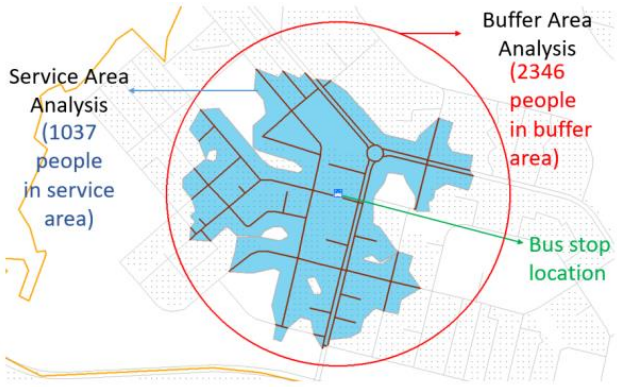

Figure 1 Comparison of buffer and service area analysis

In this study, the Gunung Anyar – Kenjeran Route was chosen as the route to be investigated. This is motivated by the lack of mass transportation modes that are side by side with the Bus on the Gunung Anyar - Kenjeran route. The mass transportation that operates side by side with the Bus is the Microbus. However, the route taken by the Microbus does not include Suroboyo bus stops, so people still have to walk quite a distance to get to the nearest bus stop. Unlike the North-South Route via the Bungurasih Terminal to Rajawali, on this route, there are city buses, school buses, and Microbuses. This is what underlies the researchers to choose the Gunung Anyar - Kenjeran Route as the location to be studied.

RESEARCH SIGNIFICANCE

This study aims to determine the best scheme that has a range of services that meet community expectations. In addition, this study aims to plan the Microbus Stop as a stop location if the Microbus is to be used as a feeder for the Bus. The results of the Microbus stop will be analyzed for its service coverage using the Service Area method. This research can be used as a reference for the application of minibusses and/or Microbuses as feeders for other public transportation in other cities.

METHODOLOGY

A. DATA COLLECTION

The data needed for this thesis consists of primary data and secondary data. Primary data is data collected directly in the field, while secondary data in the work on this thesis was obtained from the Surabaya Transportation Agency as the manager of the Bus and the Geospatial Information Agency as Indonesia's provider of geospatial information.

1. Primary Data
   In compiling this thesis primary data is needed, where the primary data taken using the Google form is obtained from the results of interviews with the people of Surabaya City, both students and workers. Primary data required include:
   a. Demographic data
   b. Socioeconomic data
   c. Travel characteristic data
2. Secondary Data
   In compiling this thesis secondary data is needed as supporting data from an analysis. Secondary data in writing this thesis were obtained from the Surabaya Transportation Agency and the Geospatial Information Agency. Secondary data required include:
   a. Surabaya City administration area shapefile data
   b. City of Surabaya infrastructure shapefile data
   c. Shapefile data for the location of the Bus Stop

Sampling in this study was used to determine the sample area from all research areas. The sampling technique used is the area sampling method. The factor used in determining the sample area in this study is the village administrative boundaries. The village is assumed to be a research zone in this study. Sampling in this study was also used to determine the number of household respondents from each sample area. The sampling technique used is the probability proportionate to size sampling (PPS) method or better known as the proportional random sampling method.

The proportional random sampling method is the result of the development of the cluster sampling method (cluster sampling) in which the sample size can be determined with the assumptions of grouping the samples and distributing them evenly throughout the group according to the comparison of the size (size) of the sub-populations between the sample group units. In cluster random sampling, the sample is obtained from only one representative group so that the large differences between groups are not visible, while in proportional random sampling, the number of samples is distributed according to the number of different sub-populations [9].

The proportional random sampling method is calculated using the following sampling formula as shown in Eq. 1 and Table 1:

$$N' = \frac{N}{1 + N(e)^2} \quad (1)$$

N’ = Number of household respondents
N = Number of households in the district
e = Standard error used (0.1 or 10%)

Table 2 Number of samples calculation

District	Household	Number of Samples
Gunung Anyar	18,617	9
Rungkut	37,319	18
Sukolilo	36,091	17
Mulyorejo	28,897	14
Bulak	13,979	7
Tambaksari	75,657	36
Total	210,56	100

B. DATA ANALYSIS

Analysis of travel demand patterns was carried out to describe the travel demand patterns of the people of Surabaya City. This description of travel demands for the people of Surabaya City will explain daily movement patterns based on a travel diary questionnaire. The results of the analysis of travel demand patterns are made into a Desire Line Map. The Desire Line map explains travel patterns based on the thickness and thickness of the desire line, where the thicker the desire line means the greater the frequency of people's movements from one location to another.

Analysis of determining the location of the Microbus Stop is carried out to determine the potential stop location if the Microbus is used as a feeder for the Bus. In determining the potential stopping locations for Microbus Stops, the data used is travel demand data obtained from the results of the travel diary questionnaire that has been carried out and added to the location of Surabaya City infrastructure. In this study, 2 schemes will be made, ie:

1. Microbus Stop Scheme Based on Community Demand
   This scheme is carried out to find out the range of route services based only on travel demand data expected by the community.

2. Microbus Stop Scheme Based on Surabaya City Demand and Infrastructure Data
   This scheme is carried out to determine the range of route services based on a combination of travel demand data and the spatial infrastructure of the City of Surabaya.

The details regarding the infrastructure used for demand-based stop point schemes and infrastructure can be seen in Table 2. Table 2 describes the classification of urban infrastructure used in determining stop points in demand-based and infrastructure schemes. The majority of infrastructure in this research area is mosques with a total of 270 and schools with a total of 202.

Analysis of the range of Microbus Stop services is carried out to determine the range of Microbus Stop services to meet the needs of the community. To find out the community's expectations regarding the maximum distance from the house to the stopping location, the results of the questionnaire will be used.

RESULTS AND DISCUSSIONS

The sample size used to distribute this questionnaire was calculated using the Slovin equation, which is the equation for determining the minimum sample size (N'). In determining the sample data that must be determined is the value of the error that can be tolerated is 5% to 10%. In this

Table 1 Details of city infrastructure

Category	Count
Bank	25
Bus station	3
Church	41
Clinics	54
Communication Towers	69
District Office	5
Electric Towers	5
Fire Department	2
Gas Station	15
Government Offices	37
High School	10
Hospital	10
Kindergarten	136
Market	10
Monastery	1
Mosque	270
Police station	3
Powerhouse	3
Pump house	16
Residential office	71
School	202
Sluice	3
Sports Center	10
Sports field	50
Stadium	1
Station	1
Subdistrict Office	34
Supermarket	11
Temple	2
University	23
Grand Total	**1123**

thesis, a tolerance value of 10% is used. In addition to determining the sample size, the population size of the object to be analyzed is required. In this journal, the population used is the number of heads of families living in Rungkut, Gunung Anyar, Sukolilo, Mulyorejo, Bulak, and Tambaksari sub-districts in 2021, ie 210,560 family heads. Then the determination of the sample is as follows in Eqn. (2) to (4):

$$N' = \frac{N}{1 + N(e)^2} \tag{2}$$

$$N' = \frac{210,560}{1 + 210,560\,(0.1)^2} \tag{3}$$

$$N' = 100 \tag{5}$$

From the formula above, it is obtained that the minimum sample size required in this study is 100 respondents. While the results of the travel diary survey using Google Forms that have been carried out obtained 292 respondents. This cannot be separated because, for the analysis process, more samples are needed to minimize the answers of respondents who are incomplete/valid respondents.

The reliability test is carried out by combining the sub-indicators of the questionnaire so that it can be said to be valid by knowing the Cronbach Alpha. The reliable test is declared valid if the Cronbach Alpha value is more than the r table as shown in Table 3 and 4 [10].

Table 3 Reliability test

Category	Cronbach's Alpha	R Table	Remark
Gender	0.345	0.096	Reliable
Age	0.328	0.096	Reliable
last education	0.337	0.096	Reliable
Work	0.232	0.096	Reliable
Income	0.343	0.096	Reliable
Number of Family Members	0.3	0.096	Reliable
Private vehicle	0.347	0.096	Reliable
Type of Private Vehicle	0.339	0.096	Reliable
Number of Private Vehicles	0.253	0.096	Reliable
Origin District	0.445	0.096	Reliable
Destination District	0.41	0.096	Reliable
Travel Purpose	0.286	0.096	Reliable
Trip Frequency	0.248	0.096	Reliable
Travel Mode	0.257	0.096	Reliable
Travel expense	0.227	0.096	Reliable
Travel time	0.313	0.096	Reliable
Ever Ride the Bus	0.338	0.096	Reliable
Want to Ride the Bus	0.328	0.096	Reliable
Never Ride a Microbus	0.329	0.096	Reliable
Want to Ride a Microbus?	0.338	0.096	Reliable
Want to Ride a Microbus with a New Route	0.36	0.096	Reliable
Recommendation Range	0.428	0.096	Reliable
Recommendation Waiting Time	0.368	0.096	Reliable
Recommended Travel Time	0.277	0.096	Reliable
Want to Ride If Not Charged	0.329	0.096	Reliable
Want to Ride if the Payment using E-Money	0.342	0.096	Reliable
Want to Ride if the Payment using Cash	0.345	0.096	Reliable
Want to Ride After Renovation	0.342	0.096	Reliable
Want to move if the Microbus becomes a feeder	0.331	0.096	Reliable

Table 4. Reliability test statistics

Reliability Statistics	
Cronbach's Alpha	ÍN of Items
0.337	29

From the results of the table 4, information is obtained that the Cronbach Alpha reliability value obtained is 0.337. Because the results of the Cronbach Alpha reliability test from the questionnaire have a value of more than the r table, i.e. 0.096, it can be concluded that the questionnaire data is reliable.

Based on the results of the questionnaire that has been carried out, information is obtained that the majority of respondents are between 15 and 30 years old, so to describe the pattern of travel demands in the desired line, the percentage of trip frequency data is calculated for the population in the age range of 15 to 30 years for each sub-district that has data of origin and travel destination.

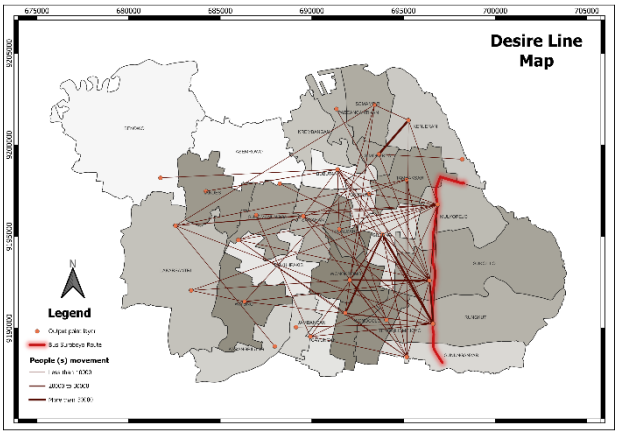

Figure 2 Desire line map

The results of the travel diary interview obtained information about the origin and destination of each respondent's trip. The origin and destination data are then converted into the origin and destination matrix form. The origin-destination matrix is used to explain the distribution of community movements represented by the respondents. As for the origin-destination matrix that has been calibrated for the sample to the population in the productive age and classified by district, it can be seen in Table 5.

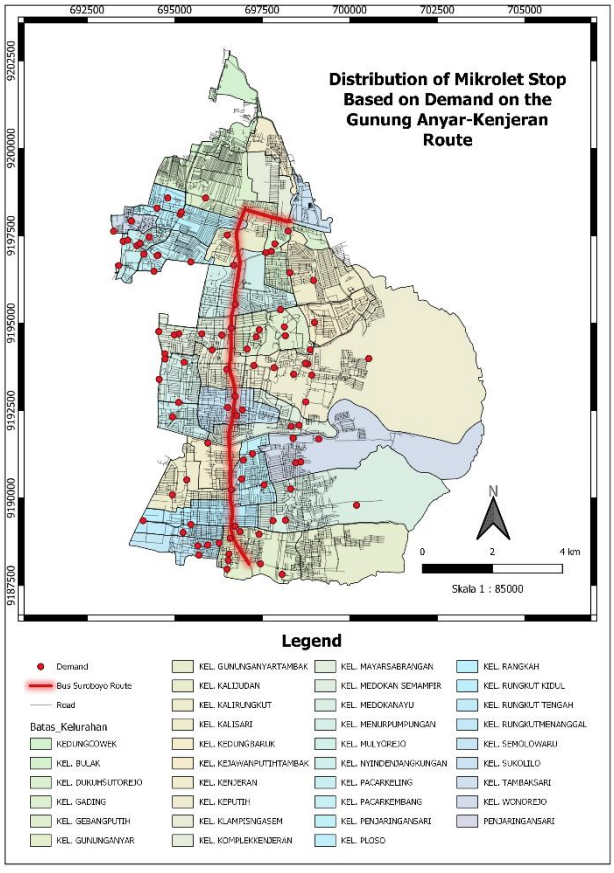

Figure 3 Distribution of microbus stop based on demand on the Gunung Anyar - Kenjeran route

Table 5 Origin-destination matrix based on productive age population

	Asemrowo	Benowo	Bubutan	Bulak	Dukuh Pakis	Gayungan	Genteng	Gubeng	Gunung Anyar	Kenjeran	Lakarsantri	Mulyorejo	Pabean Cantikan	Rungkut	Sambikerep	Sukolilo	Sukomanunggal	Tambaksari	Tandes	Tegalsari	Tenggilis Mejoyo	Wiyung	Wonocolo	Wonokromo
Bubutan	0	2071	0	0	0	0	2071	0	0	0	0	0	0	2071	0	0	0	0	6212	0	2071	0	0	0
Dukuh Pakis	0	0	0	0	0	0	0	0	2071	0	10354	4141	0	0	0	0	0	8283	0	0	0	0	0	0
Gayungan	0	0	0	0	0	0	0	0	2071	0	0	0	0	6212	0	2071	4141	0	0	0	0	0	0	0
Genteng	0	0	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	0	0
Gubeng	2071	0	2071	0	0	2071	0	0	2071	0	0	0	0	31061	0	12424	0	0	0	14495	0	0	24849	2071
Gunung Anyar	0	0	0	0	0	10354	0	4141	0	2071	0	0	0	0	0	14495	0	8283	0	2071	0	0	0	0
Jambangan	0	0	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	0	0
Karang Pilang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	0
Kenjeran	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	0	0	0	0
Lakarsantri	0	0	0	0	0	0	0	0	0	0	0	6212	0	0	0	0	0	0	0	0	0	0	0	0
Mulyorejo	0	0	2071	0	0	0	2071	12424	0	0	0	0	0	2071	0	8283	0	0	0	2071	0	0	0	0
Rungkut	0	0	0	0	0	0	2071	4141	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	2071	0
Sambikerep	0	0	0	0	0	0	0	0	0	0	0	6212	0	2071	0	10354	0	4141	0	0	0	0	0	0
Sawahan	0	0	2071	0	0	0	0	0	2071	0	0	0	0	10354	2071	2071	0	0	0	0	0	0	0	0
Semampir	0	0	0	0	0	0	0	0	0	4141	0	0	0	0	2071	0	0	0	0	2071	0	0	2071	0
Simokerto	0	0	0	2071	0	0	0	0	0	35203	0	0	0	0	0	2071	0	0	0	0	0	2071	0	0
Sukolilo	0	0	2071	0	2071	0	0	6212	2071	0	0	4141	2071	26920	0	4141	0	0	0	18637	0	6212	0	20707
Sukomanunggal	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0	0	0	0	0
Tambaksari	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2071	0	0	0	0	0	0	0	0
Tegalsari	0	0	2071	0	0	0	14495	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tenggilis Mejoyo	0	0	0	0	0	0	0	18637	0	0	0	2071	0	0	0	0	0	0	0	0	0	0	0	0
Wiyung	0	0	0	0	0	0	0	0	12424	0	2071	0	0	4141	0	0	0	0	0	0	0	0	0	0
Wonocolo	0	0	0	0	2071	0	0	0	4141	0	0	0	0	4141	0	0	0	0	0	0	0	0	0	0
Wonokromo	0	0	0	0	0	0	8283	0	16566	0	2071	0	0	14495	0	4141	0	0	0	14495	2071	0	0	0

The frequency of people moving from one district to another district is depicted in the form of a desire line (brown line), where the thickness of the desire line describes the frequency of people moving on a trip. There are 4 classes generated, i.e. Less than 10000 people, 10000 to 20000 people, 20000 to 30000 people, and more than 30000 people. In Figure 2 it can be seen regarding the results of plotting the distribution table data of origin and destination in the form of a Desire Line Map.

Based on these results it can be seen that the most displacement came from Gubeng District to Rungkut District and Simokerto District to Kenjeran District with a frequency of movement of 30,000 people.

The results of the location determination analysis described in Figure 3 are the distribution of stopping points based on travel demand data, where there are a total of 97 stop locations around the work area of the Bus for the Gunung Anyar - Kenjeran Route. The figure also shows that there are still sub-districts that have not been served by demand-based Microbus Stops.

The results of the location determination analysis described in Figure 4 are the distribution of stop points based on Infrastructure and Demand data, in which there are a total of 1270 stop locations where 97 of which are Demand data, and the rest are Infrastructure data. around the work area of the Bus for the Gunung Anyar – Kenjeran route. The figure also shows that there are still sub-districts that have not been served by demand-based Microbus stops.

Service coverage analysis is carried out to determine the service coverage for each Microbus stop. The radius limits used for this analysis were obtained from data from the questionnaire results regarding recommendations for service coverage where there were 6 categories, i.e.:

1. Less than 100 meters
2. 101 – 200 meters

3. 201 – 300 meters
4. 301 – 400 meters
5. 401 – 500 meters
6. More than 500 meter

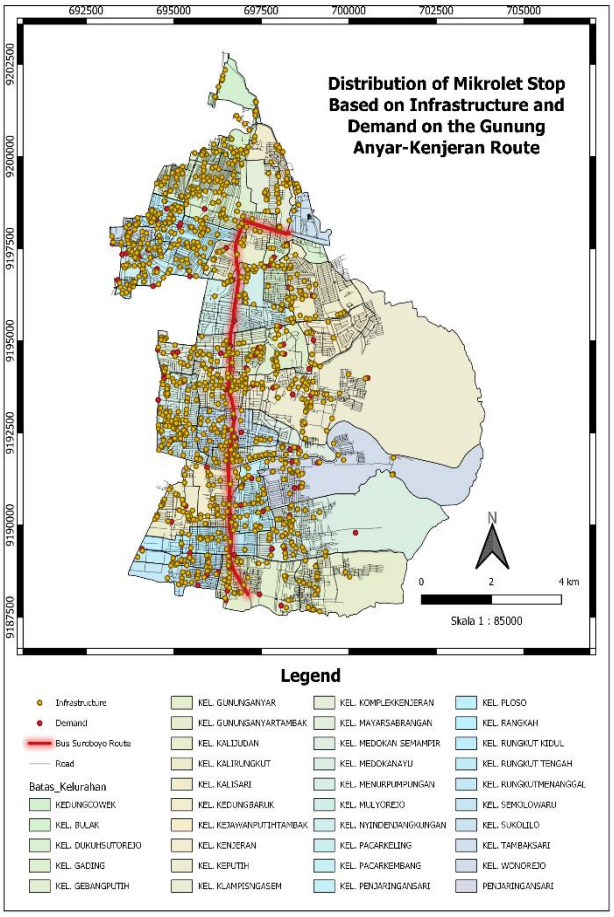

Figure 4 Distribution of microbus stop based on infrastructure and demand on the Gunung Anyar - Kenjeran route

Table 6 Distribution of service coverage recommendation

Parameters	Details	Count	Percentage
Service Coverage	100 meters	51	17%
	200 meters	50	17%
	300 meters	43	15%
	400 meters	58	20%
	500 meters	86	29%
	More than 500 meters	4	1%

The results show that most respondents prefer the distance from their place of residence to the Microbus Stop to be at a distance of approximately 500 meters (29.5%). From these results, it can be said that the range of Microbus Stop services expected by the community is less than 500 meters. This can be seen in Table 7 regarding the distribution of service coverage recommendations.

Based on the data in Table 7, each Microbus stop scheme will be tested for the suitability of service coverage to community expectations. Figure 5 explains the results of the service coverage of the Microbus Stop distribution scheme based on travel demand on the Gunung Anyar – Kenjeran route.

Figure 5 explains the range of Microbus Stop services based on demand on the Gunung Anyar - Kenjeran route using the Service Area. To find out the range of services to community expectations, the intersect analysis is used. The data sources used for the intersect analysis are the sub-district administration boundary polygon vectors and the service coverage area polygon vectors. The results of this analysis can then be seen in Table 8.

Table 8 shows that the total area with service coverage in line with community expectations is 1873,73 ha, below 500 m. Meanwhile, the total area that is not well served is 7606,27 ha, of which 34.07% is a service range of 500 meters to 1 km while the remaining 65.93% is not served at all. Judging from these results, the majority of areas that are not served at all are Bulak District and green open space at the eastern end of Surabaya City.

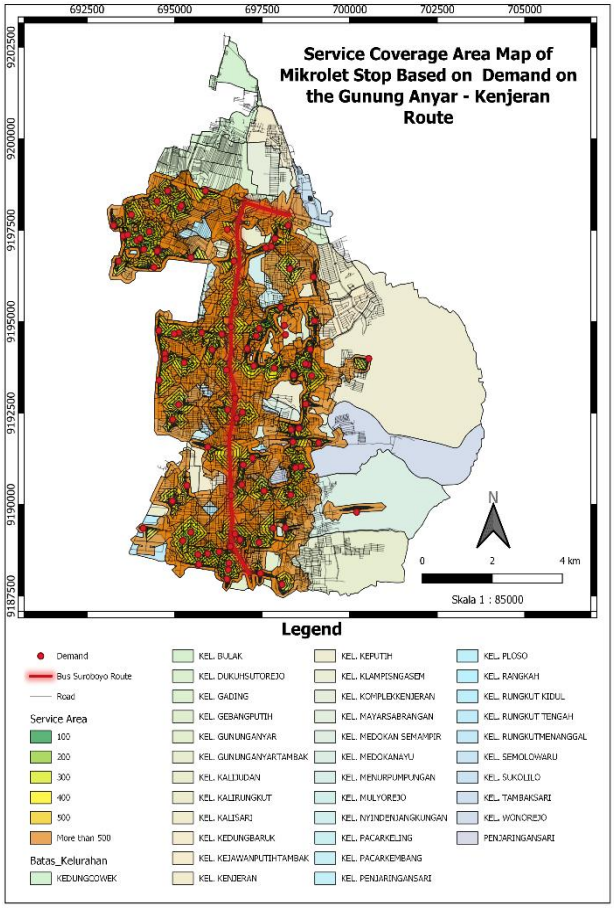

Figure 5 Service coverage area map of microbus stop based on demand on the Gunung Anyar - Kenjeran route

Figure 6 is the result of an analysis of the range of services for the Microbus Stop scheme based on a combination of infrastructure and demand. Service coverage for the Microbus Stop scheme based on a combination of infrastructure and demand on the Gunung Anyar – Kenjeran route is carried out using the same method, ie the Service Area. To find out the range of services to community expectations, the intersection analysis is used. The data sources used for the intersection analysis are the district administration boundary polygon vectors and the service coverage area polygon vectors.

Table 7 Suitability of demand-based microbus stop service coverage to community expectations

District	Coverage Area (ha)							
	Less than 100 m	100 to 200 m	200 to 300 m	300 to 400 m	400 to 500 m	More than 500 m	District Total Area	Unserved
Bulak	-	-	0.10	1.49	3.31	47.51	626.00	573.58
Gunung Anyar	16.67	47.11	58.96	62.63	59.04	237.33	1023.00	541.26
Mulyorejo	16.14	46.25	75.38	100.21	116.07	550.35	1667.00	762.60
Rungkut	17.93	51.37	84.64	112.47	136.68	649.29	2281.00	1228.62
Sukolilo	29.03	86.02	124.05	150.61	166.36	799.62	2989.00	1633.29
Tambaksari	17.49	49.81	71.87	83.22	88.79	307.16	894.00	275.65
Grand Total	**97.27**	**280.56**	**415.00**	**510.64**	**570.26**	**2591.26**	**9480.00**	**5015.01**

Table 8 Suitability of infrastructure-based microbus stop service coverage to community expectations

District	Coverage Area (ha)							
	Less than 100 m	100 to 200 m	200 to 300 m	300 to 400 m	400 to 500 m	More than 500 m	District Total Area	Unserved
Bulak	103.41	89.52	46.59	31.90	70.58	139.46	626.00	145.00
Gunung Anyar	140.17	140.41	104.61	98.55	97.66	157.73	1023.00	284.00
Mulyorejo	228.13	275.21	143.95	230.58	134.32	211.74	1667.00	443.00
Rungkut	361.02	314.19	154.58	108.64	199.75	199.88	2281.00	943.00
Sukolilo	456.94	340.51	185.12	54.19	303.84	256.31	2989.00	1392.00
Tambaksari	414.85	176.40	30.74	19.56	244.06	8.70	894.00	0.00
Grand Total	**1704.52**	**1336.24**	**665.59**	**543.42**	**1050.21**	**973.81**	**9480.00**	**3206.20**

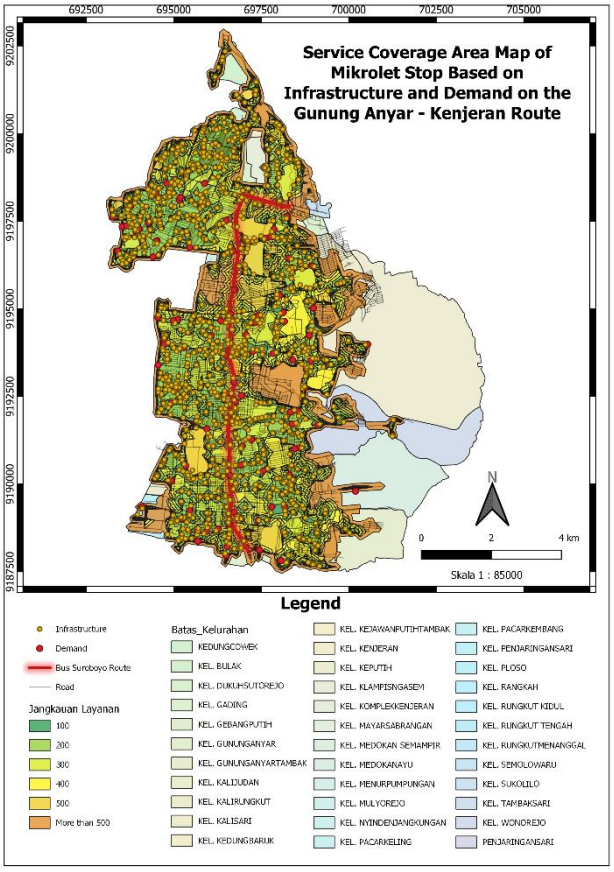

Figure 6 Service Coverage Area Map of Microbus Stop Based on Infrastructure and Demand on the Gunung Anyar - Kenjeran Route

It shows that the total area with service coverage in line with community expectations is 5299.99 ha, below 500 m. Meanwhile, the total area that is not well served is 4180.01 ha, of which 23.30% is a service range of 500 meters to 1 km while the remaining 76.70% is not served at all. In contrast to the demand-based Microbus Stop scheme, the demand-based Microbus Stop scheme for the majority of areas has met community expectations. The value 76.70% of the unserved area is a green open space at the eastern end of Surabaya City.

CONCLUSIONS

Conclusions that can be drawn from this research include:

1. Desire Line Map shows that the majority made the move from the Gubeng district to the Rungkut district and Simokerto district to the Kenjeran district with each having a travel frequency of around 30,000 residents who travel.
2. Making alternative Microbus Stop locations is divided into 2 schemes: demand-based and infrastructure-based. The demand-based Microbus Stop Scheme has 97 stop points while the infrastructure-based Microbus Stop scheme has 1270 stop points.
3. Based on the results of the analysis of the service coverage of Microbus Stop, it shows that the infrastructure-based scheme has a better service area that meets community expectations, ie 5299.99 ha compared to the demand-based scheme which is only 1873.73 ha. The thing that causes the demand-based scheme to have a small service coverage area is due to the lack of demand data in the Bulak District.

REFERENCES

[1] B. P. S. K. Surabaya, Surabaya Municipality in Figures, Surabaya: BPS Kota Surabaya, 2021.

[2] K. Hymel, "If you build it, they will drive: Measuring induced demand for vehicle travel in urban areas," Transport Policy, vol. 76, pp. 57–66, Apr. 2019, doi: 10.1016/j.tranpol.2018.12.006.

[3] Oglesby and H. Clarkson, Teknik Jalan Raya. Jakarta: Erlangga, 1999.

[4] P. K. Surabaya, "Transportasi," 2015. https://www.surabaya.go.id/page/0/8263/transportasi (accessed May 02, 2021).

[5] M. Rohani, D. C. Wijeyesekera, and A. T. A. Karim, "Bus Operation, Quality Service and The Role of Bus Provider and Driver Bus Operation, Quality Service and The Role of Bus Provider and Driver," Procedia Engineering, vol. 53, pp. 167–168, Dec. 2013.

[6] D. Surabaya, Data Jumlah Microbus di Kota Surabaya 2017, Surabaya: BPS Kota Surabaya, 2017.

[7] I. Pasha, "Ambulance Management System Using GIS," Universitetsbibiliotek, p. 78, 2006.

[8] H. Aslan and H. Kocaman, "GIS Based Bus Stop Optimisation for Sakarya Public Transportation System," Sakarya University Journal of Science, pp. 1–1, Oct. 2018, doi: 10.16984/saufenbilder.394911.

[9] H. S. Yunus, Metodologi Penelitian Wilayah Kontemporer. Yogyakarta: Pustaka Pelajar, 2010.

[10] V. Sujarweni and Wiratna, Metode Penelitian: Lengkap, Praktis, dan Mudah Dipahami. Yogyakarta: Pustaka Baru Press, 2014.