Predicting the influence area of access and egress of commuter train based on survey data of travel behavior characteristics

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Abstract. The main objective of this research is to predict the influence area of the SULAM Commuter Train when heading (Access) and leaving (Egress) the train station. The research method was carried out using an interview survey of SULAM commuter train passengers on weekdays in the morning departure hours (06.00-07.20) from Lamongan - Surabaya. Data on distance travel and connecting modes obtained from interview surveys are important data for calculating the influence area of the SULAM Commuter Train. The two data above are analysis gaps from the research. The influence area obtained from the Access-Egress interval, which is mostly chosen by SULAM Commuter train passengers, while data that is not widely selected can be ignored and considered as underserved territory. The value of the influence area can be viewed from each type of connection and is the renewal of this study. Planning new routes in underserved areas is a benefit of this research. Predictions about the influence area are important, given that the stretch of the commuter train service line in the city of Surabaya and its surrounding areas is still very limited.

1. Introduction
Traffic congestion in urban areas that almost occurs in all major cities of the world, is due to the increased use of private cars. Increased use of private cars, because the economic increase of people who drive people's purchasing power also increases [1, 2]. The availability of mass transportation services such as BRT and commuter trains to overcome traffic congestion in urban areas is also carried out [3-6].

Handling traffic congestion is not an easy thing to do, but it must be done and requires quite sophisticated and handling. The purpose of the availability of facilities at the train station is to make passengers feel comfortable and safe when using train services. The fact, many of the facilities available are not by accordance with the wishes of the passengers. In the results of previous studies related to the Commuter Train, the discussion so far has only been limited to setting the departure schedule [5] and willingness to pay the transfer facility fee around the train station [6]. The three studies above contain characteristics of travel behavior, such as age, gender, education, income, employment, travel destination, travel time, and connecting modes.
Previous research related to travel behavior only discussed the comparison of travel behavior between drivers of private vehicles (cars) and knew the value of accessibility of the mode contact when heading to facilities in the city center [7].

Research on Access and Egress has also been carried out by previous researchers, where the distance traveled to (Access) and from (Egress) was reviewed from users before and after using the BRT (Bus Rapid Transit) mode only. The distance of traveling by motorbike from a residential location < 400 meters to (Access) BRT (Bus Rapid Transit) terminal takes 1 minute. The travel distance from the BRT terminal (Egress) by walking to the destination with a distance range of 150 meters takes 2 minutes [4].

The influence area value can be known from the distance data and connecting modes when heading to and leaving the train station. Both of these data are part of the characteristics of travel behavior. Travel behavior is human behavior in carrying out its journey from origin to destination. In transportation research, interview surveys to passengers contained questions about the characteristics of the traveler and characteristics of travel behavior. Data on age, sex, occupation, travel destination, education, income, employment, the mode used, distance, and travel time are part of the travel behavior characteristic data [6, 8, 9].

The value of the influence area of the SULAM Railway Commuter from each use of the connecting mode is very important to know. The influence area, in the future, is very much related to planning new routes in underserved areas. Unserved areas can know if the influence area value can know in advance. The value of the influence area can be known from the distance data and connecting mode when heading (Access) and leaving the station (Egress). Both of these data are gap analyzes from this study. Therefore, research on the calculation of the influence area is important, as an effort to develop new lines of commuter train services in underserved areas. Planning new routes in underserved areas is important, given the limited commuter train services in the Surabaya City region and its surroundings have not been spread evenly throughout the region. Therefore, from that calculation, the area of influence is important to know and is a research update. Planning new routes in underserved areas is a benefit of research.

2. Methods

The research method was conducted by interviewing SULAM Commuter train passengers in Lamongan-Surabaya. The interview survey was conducted on weekdays in the hours of departure from 6 am to 7:20 a.m. The purpose of the interview is to find out the distance from passengers from the original location to Lamongan Station and from Pasar Turi Station to walk, use bicycles, rickshaws, motorbikes, cars and other public transportation. In this study, only passengers who climbed from Lamongan Station and down at Pasar Turi Station only. Passengers who go up and down at Sampayan Station, Cerme Station, Benowo Station, Kandangan Station, and at Tandes Station not examined. The result of calculating the number of passengers using the SULAM Commuter Train service at the time of departure in the morning from Lamongan-Surabaya is 295 passengers. The amount is the research population, while the study sample is 258 passengers who boarded from Lamongan Station and 250 passengers who descended at Pasar Turi Station.

3. Result and discussion

3.1. The influence area of SULAM commuter train

The influence area is the area where travelers feel comfortable by walking, using bicycles, pedicab, motorbikes, car and public transportation from the original location to the origin station (Lamongan Station) and from the destination station (Pasar Turi Station) to the destination location. The influence area can be known from the data of the distance between the trip and the mode of connection when going to and leaving the station. The travel distance interval that is most chosen by passengers when riding the Commuter Train from Lamongan Station is the value of the area of influence. Travel distance intervals that are not chosen by many passengers can be ignored and represent the value of the underserved region.
The influence area is in the highest percentage and is at a certain cumulative number. The cumulative value obtained from the sum of the percentage value of the trip distance interval. In the previous explanation, it explained that the distance travel and connecting modes data is a gap analysis of the research. Influence area (Access) of SULAM Commuter Train from the original location to Lamongan Station in terms of 258 passengers, it can be present in Table 1.

Table 1. The influence area (access) at the Lamongan Station.

| No | Connecting Modes | Travel Distance Interval (Km) | Amount (Person) | Total (Person) | Percentage (%) | Cumulative (%) | Description |
|----|------------------|-------------------------------|----------------|---------------|----------------|----------------|--------------|
| 1  | Walking          | 0.0 – 1.5                   | 1              | 2             | 50.00          | 50.00          | Influence area |
|    |                  | 1.5 – 3.0                   | 1              |               | 50.00          | 100.00         | Unserved area |
| 2  | Bicycle          | 0.0 – 2.0                   | 2              | 1             | 100.00         | 100.00         | Influence area |
|    |                  | 2.0 – 4.0                   | 0              | 4             | 0.00           | 25.00          | Unserved area |
|    |                  | 4.0 – 6.0                   | 2              |               | 50.00          | 75.00          | Influence area |
|    |                  | 6.0 – 8.0                   | 1              |               | 25.00          | 100.00         | Unserved area |
| 3  | Pedicab          | 0.0 – 10.0                  | 190            | 230           | 71.43          | 71.43          | Influence area |
|    |                  | 10.0 – 20.0                 | 29             | 32            | 20.71          | 92.14          | Influence area |
|    |                  | 20.0 – 30.0                 | 5              | 7            | 3.57           | 95.71          | Unserved area |
|    |                  | 30.0 – 40.0                 | 4              |               | 2.86           | 98.57          | Influence area |
|    |                  | 40.0 – 50.0                 | 1              |               | 0.71           | 99.29          | Unserved area |
|    |                  | 50.0 – 60.0                 | 1              |               | 0.71           | 100.00         | Influence area |
| 4  | Motorcycle       | 0.0 – 1.0                   | 1              | 1             | 11.11          | 11.11          | Influence area |
|    |                  | 1.0 – 2.0                   | -              |               | 0.00           | 11.11          | Unserved area |
|    |                  | 2.0 – 3.0                   | 6              | 9             | 66.67          | 77.78          | Influence area |
|    |                  | 3.0 – 4.0                   | 1              |               | 11.11          | 88.89          | Unserved area |
|    |                  | 4.0 – 5.0                   | 1              |               | 11.11          | 100.00         | Influence area |
| 5  | Car              | 0.0 – 5.0                   | 1              | 1             | 16.67          | 16.67          | Influence area |
|    |                  | 5.0 – 10.0                  | 3              | 6             | 50.00          | 66.67          | Influence area |
|    |                  | 10.0 – 15.0                 | -              |               | 0.00           | 66.67          | Influence area |
|    |                  | 15.0 – 20.0                 | 2              |               | 33.33          | 100.00         | Unserved area |
| 6  | Small public transport | 3.0 | 1 | 1 | 1.00 | 1.00 | Influence area |
| 7  | Microbus         | 3.0                         | 1              | 1             | 1.00           | 3.00           | Influence area |
| 8  | Bus Kota         | 0.0 – 10.0                  | 2              |               | 40.00          | 40.00          | Influence area |
|    |                  | 10.0 – 20.0                 | 1              |               | 20.00          | 60.00          | Unserved area |
|    |                  | 20.0 – 30.0                 | 1              | 5             | 20.00          | 80.00          | Influence area |
|    |                  | 30.0 – 40.0                 | -              |               | 0.00           | 80.00          | Unserved area |
|    |                  | 40.0 – 50.0                 | 1              |               | 20.00          | 100.00         | Unserved area |
|    |                  |                             |               |               |                |                |              |
|    |                  | **Total**                   | **258**        | **258**       |                |                |              |

The influence area (Access) at the Lamongan Station it can be present by walking (1.5 Km) has a cumulative value of 50%, bicycle (2.0 Km) has a 100% cumulative value, pedicab (6.0 Km) has a cumulative value of 75%, motorcycle (20.0 Km) has a cumulative value of 95.14%, car (3.0 Km) has a cumulative value of 77.78%, small public transportation (20.0 Km) has a cumulative value of 100%, microbus (3.0 Km) have a value cumulative 100%, and city bus (50.0 Km) have a value cumulative 100.

The influence area of the SULAM Commuter Train (Egress) from the destination station to the destination location is calculated only in the influence area at Pasar Turi Station. The value of the influence area calculated from the distance of passenger trips that descend at Pasar Turi Station by 250 people. The area of influence seen from various types of use of connecting modes such as walking, bicycles, pedicabs, motorbikes, cars, small public transportation, microbus, and city buses. The results of the calculation of the influence area in the form of percentages and cumulative values (%) shown in Table 2.
Table 2. Influence area (egress) in Pasar Turi Station.

| No  | Connecting Modes       | Travel Distance Interval (Km) | Amount (Person) | Total (Person) | Percentage (%) | Cumulative (%) | Description               |
|-----|-------------------------|-------------------------------|-----------------|---------------|----------------|----------------|---------------------------|
| 1   | Walking                 | 0.0 – 1.0                     | 28              | 30            | 93.33          | 96.67          | Influence area            |
|     | 1.0 – 2.0               | 1                             | 29              |               |                |                | Unserved area             |
|     | 2.0 – 3.0               | 1                             | 3.33            |               |                |                |                          |
| 2   | Bicycle                 | 0.0 – 2.0                     | 0               | 0             | 0.00           | 0.00           | Influence area            |
|     | 2.0 – 4.0               | 1                             | 50.00           |               |                |                | Unserved area             |
|     | 4.0 – 6.0               | 1                             | 50.00           |               |                |                |                          |
| 3   | Pedicab                 | 0.0 – 1.0                     | 1               | 1             | 50.00          | 50.00          | Influence area            |
|     | 1.0 – 2.0               | 0                             | 0.00            |               |                |                | Unserved area             |
|     | 2.0 – 3.0               | 1                             | 50.00           |               |                |                |                          |
| 4   | Motorcycle              | 0.0 – 3.0                     | 27              |               | 19.42          | 19.42          | Influence area            |
|     | 3.0 – 6.0               | 43                            | 30.94           |               | 50.36          |                |                          |
|     | 6.0 – 9.0               | 28                            | 20.14           |               | 70.50          |                |                          |
|     | 9.0 – 12.0              | 20                            | 14.39           |               | 84.89          |                | Unserved area             |
|     | 12.0 – 15.0             | 10                            | 7.19            |               | 92.09          |                |                          |
|     | 15.0 – 18.0             | 9                             | 6.47            |               | 98.56          |                |                          |
|     | 18.0 – 21.0             | 2                             | 1.44            |               | 100.00         |                |                          |
| 5   | Car                     | 0.0 – 7.0                     | 20              |               | 64.52          | 64.52          | Influence area            |
|     | 7.0 – 14.0              | 5                             | 16.13           |               | 80.65          |                |                          |
|     | 14.0 – 21.0             | 4                             | 12.90           |               | 93.55          |                | Unserved area             |
|     | 21.0 – 28.0             | 0                             | 0.00            |               | 93.55          |                |                          |
|     | 28.0 – 35.0             | 2                             | 6.45            |               | 100.00         |                |                          |
| 6   | Small public transportation | 0.0 – 5.0          | 1               |               | 16.67          | 16.67          | Influence area            |
|     | 5.0 – 10.0              | 3                             | 50.00           |               | 66.67          |                | Unserved area             |
|     | 10.0 – 15.0             | 0                             | 0.00            |               | 66.67          |                | 20 Km                    |
|     | 15.0 – 20.0             | 2                             | 33.33           |               | 100.00         |                |                          |
| 7   | Microbus                | 3.0                           | 1               | 1             | 100.00         | 100.00         | Influence area - Unserved area 3 Km |
| 8   | City bus                | 0.0 – 10.0                    | 2               |               | 40.00          | 40.00          | Influence area            |
|     | 10.0 – 20.0             | 1                             | 20.00           |               | 60.00          |                |                          |
|     | 20.0 – 30.0             | 1                             | 20.00           |               | 80.00          |                | Unserved area             |
|     | 30.0 – 40.0             | 0                             | 0.00            |               | 80.00          |                |                          |
|     | 40.0 – 50.0             | 1                             | 20.00           |               | 100.00         |                |                          |

The influence area (Egress) from Pasar Turi Station heading to the destination location in terms of 250 passengers, have the influence area of walking (1.0 Km), bicycle (4.0 Km), pedicab (1.0 Km), bicycle (0.0 - 12.0 Km), car (21.0 Km), small public transportation (20.0 Km), microbuses (3.0 Km), city buses (30.0 Km). The distance to walk to public transportation stops by BRT passengers is around 150 meters. The results of previous studies indicate that there is a difference in walking distance between BRT and SULAM Commuter train service passengers. This difference in walking distance occurs, the probability of the number of city bus services is more than the number of commuter train services.

3.2. New path planning SULAM commuter train services
Planning for new routes in underserved areas is important. In the previous explanation, it has explained that the stretch of commuter rail service has not been spread evenly throughout the region. This description of the problem is the basis of the research. The development of the Commuter Rail service must be reviewed on two sides of the passenger service to the station (Access) and leave the station (Egress). That certainly can be used as a foothold for policymakers to evenly distribute Surabaya Commuter services throughout the region. New path planning is outside the influence area and shown in Table 3 and Figure 1.
Table 3. New path planning SULAM commuter train.

| No. | Connecting Modes | New path planning (Access-Km) | New path planning (Egress-Km) | Description          |
|-----|------------------|-------------------------------|------------------------------|----------------------|
| 1   | Walking          | > 1.5                         | > 1.0                        | Access > Egress      |
| 2   | Bicycle          | > 2.0                         | > 4.0                        | Access < Egress      |
| 3   | Pedicab          | > 6.0                         | > 1.0                        | Access > Egress      |
| 4   | Motorcycle       | > 20.0                        | > 9.0                        | Access > Egress      |
| 5   | Car              | > 3.0                         | > 21.0                       | Access < Egress      |
| 6   | Small public transportation | > 20.0 | > 20.0 | Access = Egress |
| 7   | Microbus         | > 3.0                         | > 3.0                        | Access = Egress      |
| 8   | City car         | > 30.0                        | > 30.0                       | Access = Egress      |

Figure 1. Access and egress.

The unserved area is areas that are outside the influence area. The value of Access and Egress based on the calculation results in Table 3 and Figure 1 above can be seen several important things. The value of the influence area in terms of walking, bicycles, pedicabs, and the motorcycle has a value of the influence area (Access) greater than the value of the influence area (Egress). In some uses of connecting modes such as bicycle and car has a value of the area of influence smaller than the value of the area of influence (Egress). The value of the area of influence on small public transportation, microbus, and city buses has the value of the area of influence equal to the value of the area of influence (Egress). The difference in the value of the influence area of Access and Egress, in the future, requires further research related to the factors that influence the occurrence of these value differences. Other new research that can be produced from this study is being able to know the factors that influence the occurrence of differences in walking distance between BRT passengers and commuter train passengers. Based on the many new studies that can be produced, the research on the area of influence becomes important for the development of commuter rail services in all regions, especially in large cities. That is an effort to minimize the occurrence of traffic congestion. The discussion about handling traffic jams by calculating the area of influence has never done. The discussion of previous research relating to the handling of congestion, always states that the importance of the availability of mass transportation services, namely BRT and Commuter Train [5, 10-12].

4. Conclusions

The previous researcher about the influence area has never done. This can be proven from the results of previous studies which only discussed the catchment area of the 20 km LRT from the city center and the airport [3] and another discussion about the catchment area from the original location to the origin station (Access) for 10 Km without discussing the area of influence of leaving the station (Egress) [12, 13]. Based on this, the research that discusses the survey of characteristics of travel behavior which
contains data on distance and connecting modes (Access and Egress), to find out the influence area makes this study different from other previous studies. The results of the research can state that the influence area of Access and Egress can be known so that planning for new routes in underserved areas can also be known. In some modes used, it is known that there are differences in the Access and Egress values. The Access value on walking (1.5 Km), pedicab (6.0 Km), and motorcycle (20.0 Km) longer than the Egress value. The difference in the value of Access and Egress, in the future, can produce new research to find out the factors that influence these differences.

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