Comparative analysis on access and egress distances for Semi BRT Trans ‘Mamminasata’ and Commuter Train ‘SUSI’

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Abstract. The existence of the Semi Bus Rapid Transit (BRT) Network and the Commuter Train Network, as part of Urban Mass Transportation is developed with the aim of providing better service on commuter trips. To estimate passenger demands on new mass transit services, especially in areas without prior service, Access and Egress distances data are needed to design an appropriate mass transit. This underlies the reason why a comparative analysis of Access and Egress distance of BRT Trans ‘Mamminasata’ in Makassar and Commuter Train Surabaya – Sidoarjo was necessarily done. Which of the two had further Access or Egress distance; was it the BRT Trans ‘Mamminasata’ Makassar or the Commuter train Surabaya-Sidoarjo? Data were obtained through interviews and data management from related department. The results found that both Access and Egress of the BRT Trans ‘Mamminasata’ in Makassar was shorter than the Commuter Train Surabaya-Sidoarjo.

Keywords: Comparison, Access, Egress, BRT Trans Mamminasata, Commuter Train

1. Introduction
Increasing numbers of motorcyclists have caused traffic congestion in several major cities in Asia, such as Taiwan, Indonesia, Malaysia and Vietnam [1]. This problem, of course, requires the city mass transport services, such as BRT (Bus Rapid Transit) and commuter (urban train). In several major cities in Asia, such as in Bangkok Thailand, BRT services have been developed and equipped with park and ride facilities [2]. However, in Makassar Indonesia, the BRT Trans ‘Mamminasata’ services are still in the developmental stages [3]. While in Surabaya Indonesia, commuter service (Surabaya-Sidoarjo) is also in the developmental stage similar to the BRT Trans ‘Mamminasata’ in Makasar. As part of Urban Railway in Surabaya, this mode is far from being evenly extended throughout the region [4].

Developing mass transit services, such as BRT Trans ‘Mamminasata’ in Makassar and commuter train Surabaya-Sidoarjo in underserviced areas need to be executed in order to minimize the possible issues, such as high-cost construction, human resources, as well as city layout.

Underserviced area is an area that has not been served by any mass transportation and located in the skirt of influenced area. While, the influenced area is an area where travellers (passengers) are comfortably to head and leave the stations/shelter on foot, by motorbikes, cars, or other public
transportation [5]. The influenced area is measured from the distance between the designated location and stations/shelter or the contrary. The distance from stations/shelters to designated area is called as the Access distance, while the distance from designated area to stations/shelter is called the Egress distance (i.e [2][6][7]).

On the BRT Trans ‘Mamminasata’ in Makassar, Access and Egress data were only limited to Access distance from residential areas to BRT stops (shelter) approximately 400 meters and the Egress distance from residential areas to BRT stops (shelter) approximately 150 meters [2]. Several factors affecting Access distance in the BRT Trans ‘Mamminasata’ were parking capacity, parking facilities, and shelter location [8]. The one of the importance of Access distance data is to actualize the City Park Accessibility Concept [9] and to estimate the Catchment Area from mass-transit stops [5].

Following the prior studies, another study on mass transportation in Aceh found that the Trans Koetaradja has longer Access distance (0 - 1.5 km) than its Egress distance (0 - 1 km) [7]. This results were supported the Access and Egress of BRT Trans ‘Mamminasata’ in Makassar where the Access distance was provably longer than the Egress distance. The fact in which the Access distance was longer than the Egress distance became an interesting issue that can be developed and examined further. This study was to compare the Access and Egress distances of two different mass-transit modes, BRT (Bus Rapid Transport) Trans ‘Mamminasata’ in Makassar) and Commuter Train Surabaya-Sidoarjo in Surabaya. As for the further purpose, it is to provide data for both academic purposes in transportation and developmental purposes to help government or related parties to develop mass-transport and urban layout design.

2. Methods
Data were taken from prior studies of the BRT Trans ‘Mamminasata’ in Makassar (i.e. [3] [7]) and from interviews of 50 passengers of the commuter train Surabaya-Sidoarjo on March 29, 2017. These interviews obtained the passengers experiences from-to shelters/stations (commuter stops). Data obtained were tested using Chi Square statistical test to determine whether there was difference among the observed frequency [10] and Curve Pattern Acceptance (CPA) Test to determine the acceptance of curve patterns. Both were used to compare standard deviation values of the data analyzed (i.e. [11] [12]). The purposes of both tests were to figure out whether or not there was differences on both Access and Egress on the BRT Trans ‘Mamminasata’ in Makassar and on the Commuter Train Surabaya-Sidoarjo; to find the length of the difference; to find out the factors that may influence in this condition; and to synthesize the result into percentage and cumulative point to record the Access and Egress of two modes.

3. Result and discussion
3.1. Access distance and egress distance on BRT Trans ‘Mamminasata’ Makassar at morning departure hours
Figure 1 shows the trip network model heading to the original station was called the H trip to the Main Mode (PHK), while the trip leaving the designated station called the Connecting Trip from Main Mode (PHD) (i.e [6] [13]). The Access distance was longer than the Egress distance. The Access distance in corridor 1 and corridor 2 was about 1-2 km with total percentage of 48% (see Table 1). The Egress distance was shorter than the Access distance. The Egress distance in corridor 1 and corridor 2 was about 0.0-0.5 km with total percentage of 71% (see Table 2) [3].
Figure 1. A Travel Network Model

Source:[6.13]

Table 1. Access distance of BRT Trans ‘Mamminasata’ Makassar

| No. | Distance | Corridor 1 | Corridor 2 | Total | Percentage | Cumulative (%) |
|-----|----------|------------|------------|-------|------------|----------------|
| 1.  | 0.0 – 1.0 Km | 12         | 17         | 29    | 36%        | 36%            |
| 2.  | 1.0 – 2.0 Km | 20         | 18         | 38    | 48%        | 84%            |
| 3.  | 2.0 – 3.0 Km | 8          | 5          | 13    | 16%        | 100%           |
|     | **Total**   | **40**     | **40**     | **80**| **100%**   |                |

Source:[3]

Table 2. Egress distance of BRT Trans ‘Mamminasata’ Makassar

| No. | Distance | Corridor 1 | Corridor 2 | Total | Percentage | Cumulative (%) |
|-----|----------|------------|------------|-------|------------|----------------|
| 1.  | 0.0 – 0.5 Km | 29         | 28         | 57    | 71%        | 71%            |
| 2.  | 0.5 – 1.0 Km | 11         | 6          | 17    | 21%        | 92%            |
| 3.  | 1.0 – 1.5 Km | 0         | 6          | 6     | 8%         | 100%           |
|     | **Total**   | **40**     | **40**     | **80**| **100%**   |                |

Source: [3]

3.2. Access and egress distance on Commuter Train Surabaya-Sidoarjo

The interview conducted on 50 passengers of Commuter Train Surabaya-Sidoarjo found that the Access distance was about 4.0-50 km with a cumulative percentage of 78% longer than the Egress distance which was about 3.0-4.0 km with a cumulative percentage of 86% [4] (see Table 3, Table 4 and Figure 2).

Table 3. Access distance of Commuter Train Surabaya - Sidoarjo

| No. | Distance | Commuter Train Surabaya-Sidoarjo (org) | Percentage | Cumulative |
|-----|----------|---------------------------------------|------------|------------|
| 1   | 0.0 - 1.0 | 6                                     | 12%        | 12%        |
| 2   | 1.0 - 2.0 | 5                                     | 10%        | 22%        |
| 3   | 2.0 - 3.0 | 9                                     | 18%        | 40%        |
| 4   | 3.0 - 4.0 | 8                                     | 16%        | 56%        |
| 5   | 4.0 - 5.0 | 11                                    | 22%        | 78%        |
| 6   | 5.0 - 6.0 | 0                                     | 0%         | 78%        |
| 7   | 6.0 - 7.0 | 2                                     | 4%         | 82%        |
| 8   | 7.0 - 8.0 | 5                                     | 10%        | 92%        |
| 9   | 8.0 - 9.0 | 4                                     | 8%         | 100%       |
|     | **Total** | **50**                                 | **100%**   |            |

Source: [4]
### Table 4. Egress Distance of Commuter Train Surabaya-Sidoarjo

| No. | Distance (Km) | Commuter Train Surabaya-Sidoarjo (org) | Percentage | Cumulative |
|-----|---------------|----------------------------------------|------------|------------|
| 1   | 0.0 - 1.0     | 20                                     | 40%        | 40%        |
| 2   | 1.0 - 2.0     | 8                                      | 16%        | 56%        |
| 3   | 2.0 - 3.0     | 6                                      | 12%        | 68%        |
| 4   | 3.0 - 4.0     | 9                                      | 18%        | 86%        |
| 5   | 4.0 - 5.0     | 3                                      | 6%         | 92%        |
| 6   | 5.0 - 6.0     | 0                                      | 0%         | 92%        |
| 7   | 6.0 - 7.0     | 2                                      | 4%         | 96%        |
| 8   | 7.0 - 8.0     | 2                                      | 0%         | 100%       |
|     | **Total**     | **50**                                 | **100%**   |

Source: [4]

### 3.3. Comparison between access and egress distance of BRT Trans ‘Mamminasata’ Makassar and Commuter Train Surabaya-Sidoarjo

Study to compare the Access and Egress distances between BRT Trans ‘Mamminasata’ in Makassar and Commuter Train Surabaya-Sidoarjo was carried out in order to find out the longer distance for both types of mass transportation (see Figure 2).

![Figure 2. The Access and Egress of BRT Trans ‘Mamminasata’ Makassar and Commuter Train Surabaya-Sidoarjo](image)

The results showed that there was different point of Access and Egress of the BRT Trans ‘Mamminasata’ Makassar and the Commuter train Surabaya-Sidoarjo. The Access distance of BRT Trans ‘Mamminasata’ was 0-2 km (cumulative 84%) and the Egress distance of BRT Trans ‘Mamminasata’ was 0-0.5 km (cumulative 75%). While the Access distance of Commuter Train Surabaya-Sidoarjo was 4.0-5.0 km (cumulative 78%) and the Egress distance of Commuter Train Surabaya-Sidoarjo was 3.0-4.0 km (cumulative 86%). The difference of Access and Egress distances were analyzed using Chi Square statistical test. The difference was synthesized if $H_0: \chi^2 \leq \chi^2_{\text{table}}$ and the difference was not synthesized if $H_1: \chi^2 > \chi^2_{\text{table}}$ (i.e. [11] [12]).

Table 5 shows the comparison of the Access distance. The results of the Access distance of BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo were $H_1: \chi^2 (46.016) > \chi^2_{\text{table}} (14.1)$, meaning that the Access distance of both mass transportation could not be synthesized (see Table 6). Table 7 shows the comparison of the Egress distance. The results of the Egress distance of BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo were $H_1: \chi^2 (43.675) > \chi^2_{\text{table}} (11.1)$ meaning that the Egress distance could not be synthesized. Table 8 shows the calculation of the Egress distance on BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo.
Table 5. Comparison access distances between BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo

| No. | Distances (Km) | BRT Trans Mamminasata (org) | Commuter SUSI Surabaya-Sidoarjo (org) |
|-----|----------------|-------------------------------|----------------------------------------|
| 1   | 0.0 - 1.0      | 29                           | 6                                      |
| 2   | 1.0 - 2.0      | 38                           | 5                                      |
| 3   | 2.0 - 3.0      | 13                           | 9                                      |
| 4   | 3.0 - 4.0      | 0                            | 8                                      |
| 5   | 4.0 - 5.0      | 0                            | 11                                     |
| 6   | 5.0 - 6.0      | 0                            | 0                                      |
| 7   | 6.0 - 7.0      | 0                            | 2                                      |
| 8   | 7.0 - 8.0      | 0                            | 5                                      |
| 9   | 8.0 - 9.0      | 0                            | 4                                      |
|     | Total          | 80                           | 50                                     |

Source: [3, 4]

Table 6. Calculation of access distance of BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo

| No. | Distance Interval | % Distribution | Calculation $\chi^2$ |
|-----|-------------------|----------------|----------------------|
|     | Ref BRT Mamminasata Person | SUSI Commuter Surabaya-Sidoarjo Person | $\chi^2$  |
|     | Km Person %       | %              |                      |
| 1   | 0.0 - 1.0         | 29 36.25       | 6 12                 | 16.222 |
| 2   | 1.0 - 2.0         | 38 47.5        | 5 10                 | 29.605 |
| 3   | 2.0 - 3.0         | 13 16.25       | 9 18                 | 0.188  |
| 4   | 3.0 - 4.0         | 0 0            | 8 16                 | 0.000  |
| 5   | 4.0 - 5.0         | 0 0            | 11 22                | 0.000  |
| 6   | 5.0 - 6.0         | 0 0            | 0 0                  | 0.000  |
| 7   | 6.0 - 7.0         | 0 0            | 2 4                  | 0.000  |
| 8   | 7.0 - 8.0         | 0 0            | 5 10                 | 0.000  |
| 9   | 8.0 - 9.0         | 0 0            | 4 8                  | 0.000  |
| Total| 80                | 100            | 50 100               |
| CPA | $u = 7$           |                | 46.016               |
| CPA | $\chi^2(\alpha=0.05) = 14.1$ | | Rejected $H_0$ |

Source: Data Analysis, 2018

Table 7. Comparison egress distances between BRT Trans ‘Mamminasata’ and Commuter Train Surabaya-Sidoarjo

| No. | Distance (Km) | BRT Trans Mamminasata (org) | SUSI Commuter Surabaya-Sidoarjo (org) |
|-----|---------------|-------------------------------|----------------------------------------|
| 1   | 0.0 - 1.0     | 74                            | 20                                     |
| 2   | 1.0 - 2.0     | 8                             | 8                                      |
| 3   | 2.0 - 3.0     | 0                             | 6                                      |
| 4   | 3.0 - 4.0     | 0                             | 9                                      |
| 5   | 4.0 - 5.0     | 0                             | 3                                      |
| 6   | 5.0 - 6.0     | 0                             | 0                                      |
| 7   | 6.0 - 7.0     | 0                             | 2                                      |
| 8   | 7.0 - 8.0     | 0                             | 2                                      |
|     | Total         | 80                            | 50                                     |

Source: [3, 4]
Table 8. Calculation of Egress distance of BRT Trans ‘Mamminasata’ and Commuter train Surabaya-Sidoarjo

| No. | Distance Interval | % Distribution | Calculation $\chi^2$ |
|-----|-------------------|----------------|----------------------|
|     | Km                | Person %        | Person %             | $\chi^2$         |
| 1   | 0.0 - 1.0         | 74 92.5        | 20 40               | 29.797           |
| 2   | 1.0 - 2.0         | 6 7.5          | 8 16                | 9.633            |
| 3   | 2.0 - 3.0         | 0 0            | 6 12                | 0.000            |
| 4   | 3.0 - 4.0         | 0 0            | 9 18                | 0.000            |
| 5   | 4.0 - 5.0         | 0 0            | 3 6                 | 0.000            |
| 6   | 5.0 - 6.0         | 0 0            | 0 0                 | 0.000            |
| 7   | 6.0 - 7.0         | 0 0            | 2 4                 | 0.000            |
| 8   | 7.0 - 8.0         | 0 0            | 2 4                 | 0.000            |
|     | Total             | 80 100         | 50 100              |                   |
| CPA |                   | $\chi^2$ tabel (6,95%) = 12.6 |                   | 39.431            |

Source: Data Analysis, 2018

3.4. Analysis result of access and egress distances on BRT Trans ‘Mamminasata’ in Makassar and Commuter Train Surabaya-Sidoarjo

The Chi Square statistical tests showed that there was a difference in the distance between the BRT Trans ‘Mamminasata’ in Makassar and the Commuter Train Surabaya-Sidoarjo. The Access and Egress distances on BRT Trans ‘Mamminasata’ in Makassar were shorter than on Commuter Trains Surabaya-Sidoarjo. The Access distance of BRT Trans ‘Mamminasata’ in Makassar was 0-2 km with a cumulative of 84% and was shorter than Access distance of the Commuter Train Surabaya-Sidoarjo by 0.0-5.0 km with a cumulative of 78%. The Egress distance of the BRT Trans ‘Mamminasata’ in Makassar was 0.0 - 0.5 km with a cumulative of 75% and was shorter than the Egress distance of the Commuter Train Surabaya-Sidoarjo by 0.0 - 4.0 km with a cumulative of 86% (see Table 9 and Figure 3). The cumulative percentage value is used as reference to determine the influence area. Due to less than 100% cumulative percentage of influence area of mass transportation, the influence area with 100% cumulative percentage was ignored. Figure 4 shows an overview of the boundaries between the influence area and underserved areas, while Figure 5 shows the benefits of this study.

Figure 3. Cumulative value of access and egress BRT Trans ‘Mamminasata’ and Commuter train Surabaya-Sidoarjo
Table 9. Comparison of the access and egress distances on BRT Trans ‘Mamminasata’ Makassar and ‘SUSI’ Commuter Train

| BRT Trans Mamminasata Makassar | SUSI Commuter Train |
|-------------------------------|---------------------|
| **Access (Km)** | **Egress (Km)** | **Benefits** | **Access (Km)** | **Egress (Km)** | **Benefits** |
| 0.0 – 2.0 (84%) | 0.0 – 0.5 (78%) | 1. Knowing the influence area from the original location to the original bus station | 0.0 – 5.0 (78%) | 0.0 – 4.0 (86%) | 2. Knowing the influence area from the designated station to the designated location |
| 1. Knowing the influence area from the original location to the original bus station | 2. Knowing the influence area from the designated station to the designated location |

Access and Egress on BRT Trans Mamminasata Makassar and SUSI Commuter Train on 100% cumulative

| Access (Km) | Egress (Km) | Benefits |
|-------------|-------------|----------|
| 0.0 – 3.0 (100%) | 0.0 – 2.0 (100%) | The Access distance was longer than the Egress distance |
| 0.0 – 9.0 (100%) | 0.0 – 8.0 (100%) | The Access distance was longer than the Egress distance |

Result on Statistical Test obtained the H$_0$: $\chi^2 \geq \chi^2_{tabel}$, meaning that it cannot be synthesized due to the high different of Access and Egress distance between BRT Trans ‘Mamminasata’ Makassar and ‘SUSI’ Commuter Train

Source: [3], Primary Survey, 2017; and Data Analysis, 2018

Figure 4. Influence area and underserved area
4. Conclusion
Comparison of the Access and Egress Distance between BRT Trans ‘Mamminasata’ in Makassar and commuter train Surabaya-Sidoarjo found:

- Access distance on BRT Trans ‘Mamminasata’ in Makassar was 0–2 km (75%) shorter than Access distance on Commuter train Surabaya-Sidoarjo as 0–5 Km (78%).
- Egress distance on BRT Trans ‘Mamminasata’ in Makassar was 0 – 0.5 Km (71%) shorter than Egress distance on Commuter train Surabaya-Sidoarjo as 0 – 4 Km (86%).
- Generally viewed from 100% cumulative, there was different on Access and Egress distances between BRT Trans ‘Mamminasata’ in Makassar and Commuter train Surabaya-Sidoarjo as follow:
  1. Access distance of BRT Trans ‘Mamminasata’ in Makassar from 100% cumulative was about 0–3 km, while on Commuter train Surabaya-Sidoarjo was about 0–9 km.
  2. Egress distance of BRT Trans ‘Mamminasata’ in Makassar from 100% cumulative was about 0–2 km, while on Commuter train Surabaya-Sidoarjo was about 0–8 km.

This study found that the Access and Egress distances between BRT Trans ‘Mamminasata’ in Makassar was shorter than Commuter train Surabaya-Sidoarjo. Therefore, further research is needed to find out the factors causing the Access and Egress distances from each mode.

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