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Performance Evaluation of Bus Rapid Transit (BRT) Trans Medan and Service Analysis Using The Customer Satisfaction Index (CSI) Method

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Customer Satisfaction Index;
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ABSTRACT
Medan City faces increasing traffic congestion due to rapid urbanization and the growth in vehicle numbers. To address this issue, the city government implemented the Bus Rapid Transit (BRT) system to encourage a shift from private vehicles to public transportation. This study evaluates the operational performance and service quality of the Trans Medan BRT Corridor K2 J-City–Merdeka Square. Data were collected through field surveys, questionnaires from BRT users, and assessments by four experts. The evaluation was based on national transportation regulations and The BRT Standard 2016, while service quality was analyzed using the Customer Satisfaction Index (CSI) and Analytical Hierarchy Process (AHP). Results show an average load factor of 21%, travel time of 15.35 minutes, waiting time of 7.4 minutes, circulation time of 1.2 hours, and average speed of 25.5 km/h. The corridor obtained a total score of 38, indicating that it does not meet the minimum bronze BRT standard. Nevertheless, CSI results reveal that 85.18% of users are very satisfied with the service. AHP analysis identifies key priority factors influencing service performance, including service quality, safety assurance, passenger comfort, responsiveness, and the availability of officers on site.

INTRODUCTION

The growth of major cities in Indonesia, including Medan, presents serious challenges in the transportation sector, particularly in providing efficient and sustainable public transportation services. As the third-largest metropolitan city in Indonesia after Jakarta and Surabaya, Medan is experiencing rapid urbanization, high population growth, and a significant increase in the number of motorized vehicles every year (Fernandes et al., 2023; Herold & Lee, 2017; Prasetyo et al., 2023; Sun et al., 2021). As a result, various strategic points in the city experience severe congestion, increased travel times, and wasted energy. According to the 2024 TomTom Traffic Index survey, Medan ranks second among the most congested cities in Indonesia, with an average 10-km travel time of 32 minutes and 3 seconds, a congestion level of 40%, and time wasted during rush hour reaching 111 hours per year.

Existing public transportation systems, such as angkot, no longer meet the needs of the community. Low public interest in public transportation is caused by factors such as lack of

comfort, inaccuracy, inefficient routes, and a lack of intermodal integration (Achimba & Iwasokun, 2023; Liu et al., 2024; Maruyama & Seo, 2023; Owais et al., 2021). To address these issues, the Medan City Government launched the Trans Medan Bus Rapid Transit (BRT) service as an efficient and environmentally friendly mass transportation solution (Deni Turio et al., 2025; Suryati et al., 2025; Turio & Nuraini, 2024). BRT is a bus-based mass transportation system with high capacity, high speed, and affordable costs (ITDP, 2016).

Trans Medan BRT began operations on August 20, 2024, with 60 electric buses serving five main corridors: K1 (Terminal Amplas–Terminal Pinang Baris), K2 (J-City–Lapangan Merdeka), K3 (Belawan–Lapangan Merdeka), K4 (Medan Tuntungan–Lapangan Merdeka), and K5 (Tembung–Lapangan Merdeka).

One of the main routes is Corridor K2, which connects densely populated residential areas in J-City with the center of Medan City, crossing economic, educational, and government areas. This route is considered the most strategic for analysis because it reflects public mobility patterns comprehensively. Although it has been operating for more than one year, Trans Medan BRT still faces challenges related to operational performance, time efficiency, and user satisfaction, which need to be evaluated comprehensively. This performance evaluation is important to assess the extent to which the service has met indicators such as time accuracy, departure frequency, passenger occupancy level (load factor), comfort, and customer satisfaction.

To evaluate user satisfaction, the Customer Satisfaction Index (CSI) method is used because it effectively measures the level of importance and satisfaction across various service aspects (Achmadi & Widiarto, 2025; Nuriyana & Hermawansyah, 2022a, 2022b; Umam & Hariastuti, 2018). This method is efficient, simple, and saves time and cost (Wonga et al., 2020). Previous research by Ginting (2022) also used CSI to evaluate passenger satisfaction with Trans Metro Deli BRT and showed a “very satisfied” category. However, CSI only measures satisfaction without prioritizing performance improvements. Therefore, additional methods such as the Analytic Hierarchy Process (AHP) are needed to determine priority criteria for improving public transportation services.

Thus, this research is crucial for evaluating the performance of Trans Medan BRT, particularly on the K2 Corridor. The results are expected to provide a realistic picture of service effectiveness and efficiency while also identifying factors influencing operational success and challenges. This evaluation is also expected to serve as a basis for improving the public transportation system, enhancing service quality, and encouraging people to shift from private vehicles to public transportation, leading to a modern and sustainable urban mobility system.

METHOD

This research method was conducted on the Trans Medan Bus Rapid Transit (BRT) service, Corridor K2 (J City – Merdeka Square), with the aim of evaluating operational performance, user satisfaction levels, and service performance priorities. The study was conducted in October 2025 through three main stages: a field survey, questionnaire distribution, and data analysis. Primary data were obtained through static survey, survey dynamic in the bus, as well as distribution questionnaire to users BRT services with technique convenience sampling as many as 100 respondents, and the distribution questionnaire to 4 experts for

determination priority performance service. Meanwhile that is secondary data obtained from studies literature and documents agency related.

Data analysis was performed through a number of Methods. First, operational performance analysis based on Decree of the Director General of Land Transportation No. 687 of 2002, Regulation of the Minister of Transportation of the Republic of Indonesia No. 10 of 2012 and Regulation of the Minister of Transportation No. 98 of 2013. Second, the assessment of the suitability of BRT services using The BRT Standard 2016. Third, user satisfaction measurement using the Customer Satisfaction Index (CSI) method through instrument validity and reliability testing using SPSS. Finally, the determination of service performance improvement priorities was carried out using the Analytic Hierarchy Process (AHP) method involving four experts in the field of transportation. This approach aims to produce comprehensive recommendations for improving the quality of service and management of the Trans Medan BRT in a sustainable manner.

RESULTS AND DISCUSSIONS

Operational Performance

Based on results analysis in accordance with provisions of the Director General's Decree Transportation Land No. 687 of 2002, Indonesian Minister of Transportation Regulation No. 10 of 2012, and Indonesian Minister of Transportation Regulation No. 98 of 2013 , then obtained results indicator attached in table 1.

Table 1Operational Performance of Trans Medan BRT Corridor K2

Indicator	nit	Information	Research result	Director General's Decree Transportation Land No. 687 of 2002	Regulation of the Minister of Transportation of the Republic of Indonesia No. 10 of 2012	Regulation of the Minister of Transportation of the Republic of Indonesia No. 98 of 2013
Load Factor			1	≥ 70		
Headway	inute	Condition Peak	4.5	-5		15
		Non- peak conditions	6.2	-10		30
Waiting Time	inute	Peak Condition	.2	-10	7	
		Non- Peak Conditions	.1	-10	15	
Circulation Time	'clock	Average	.2	– 1.5		
		Maximum	.7	2-3		
Speed	m/Hour	Condition Peak	5.62	-	30	
		Non- Peak Conditions	6.89	-	50	

From table 1, it can be concluded that on the BRT Trans Medan Corridor K2 the time between, time wait, time circulation and speed Already according to with applicable provisions, meanwhile factor fit Still Far under required standards.

Operational Performance Based on The BRT Standard 2016

Table 2BRT Trans Medan performance results according to the 2016 BRT Standard

Element	Category	Maximum Value	Mark
BRT Basics	Bus Dedicated Lane	8	0
	Bus Lane Placement	8	0
	Off-Road Tariff Collection	8	8
	Intersection Settings	7	0
	Platform-level boarding	7	7
Service Planning	Multi Route	4	4
	Express, limited-stop, and local services	3	0
	Control center	3	3
	Located in the top 10 corridors	2	0
	Request profile	3	0
	Operating Hours	2	1
	Multi-Corridor Network	2	2
Infrastructure	Overtaking line at bus stop	3	0
	Minimizing bus fleet emissions	3	3
	Distance of the bus stop from the intersection	3	3
	Median bus stop	2	0
	Road pavement quality	2	0
Stop	Distance between bus stops	2	2
	Safe and comfortable bus stop	3	0
	Number of doors on a bus	3	3
	Docking bays and substops	1	1
	Sliding doors at bus stops	1	0
Communication	Branding	3	3
	Passenger information	2	2
Access and Integration	Public access	3	3
	Integration with other modes of transportation	3	3
	Pedestrian access and safety	4	1
	Parking security	2	2
	Bicycle lane	2	0
	Bike-sharing integration	1	0
Reduction in Operational Value	Commercial speed	-10	0
	Passengers per hour per direction during peak hours	-5	-5
	Less sterile bus lanes	-5	-5
	Significant gap between the bus floor and the platform	-5	0
	Overcrowding	-5	0
	Poor Maintenance of Bus Routes, Fleet, Bus Stops, and Technology Systems	-14	0
	Low Frequency during Peak Hours	-3	-3
	Low Frequency Off-peak Hours	-2	0
	TOTAL VALUE I		**38**

Based on the results of the analysis of Trans Medan BRT performance on Corridor K2 (J-City–Lapangan Merdeka) in accordance with The BRT Standard 2016, as shown in Table 2, the Trans Medan BRT Corridor K2 fulfills 15 out of 30 criteria. These include off-road fare

collection, platform-level boarding, multi-route service, central control, a multi-corridor network, minimization of bus fleet emissions, distance of stops from intersections, distance between bus stops, number of doors on buses, docking bays and sub-stops, branding, passenger information, universal access, integration with other modes of transportation, and secure parking.

However, BRT Trans Medan also received a deduction of 13 points due to the low number of passengers during peak conditions, non-sterile bus lanes, and insufficient bus frequency during peak hours (less than 8 buses per hour). The total score obtained by Trans Medan BRT Corridor K2 is 38. Based on The BRT Standard 2016, this corridor has not yet met the minimum requirements to be classified as a BRT system

Reliability Test

The number of sample members used in this study was 100 respondents. These respondents were then used to conduct validity and reliability tests using IBM SPSS Statistics 30. Based on the results of the validity and reliability tests for the performance level and the level of expectations, it was found that r count > r table and Cronbach's alpha value > significant level (attached in table 3). So it can be concluded that the question variables used are valid and reliable.

Table 3Reliability test

Reliability Test	Item	Cronbach's alpha	Significace	Conclusion
Expectation Level	26	0.968	0.6	Reliable
Performance Level	26	0.913	0.6	Reliable

Satisfaction Data Analysis and Processing Trans Medan BRT users

The calculation of Trans Medan BRT Corridor K2 user satisfaction in this study uses five variables: Tangible, Reliability, Responsiveness, Empathy , and Assurance . Each variable has subvariables that serve as assessment attributes. There are a total of 26 assessment attributes: Tangible (7 attributes), Reliability (6 attributes), Responsiveness (5 attributes), and Empathy (3 attributes), and Assurance (5 attributes). The results of the analysis calculations are described in Table 4.

Table 4Customer Satisfaction Index (CSI) BRT Trans Medan Corridor K2

Variables	Attribute	MIS	WF(%)	MSS	WS
Tangible	A1	4.87	3.90	4.72	18.42
	A2	4.83	3.87	4.64	17.95
	A3	4.75	3.81	3.95	15.03
	A4	4.77	3.82	3.93	15.02
	A5	4.84	3.88	4.32	16.75
	A6	4.78	3.83	3.89	14.90
	A7	4.87	3.90	4.55	17.75
Reliability	B1	4.85	3.89	4.61	17.91
	B2	4.74	3.80	4.11	15.61
	B3	4.82	3.86	4.36	16.84
	B4	4.73	3.79	3.82	14.48
	B5	4.78	3.83	3.89	14.90

Variables	Attribute	MIS	WF(%)	MSS	WS
	B6	4.79	3.84	4.14	15.89
Responsiveness	C1	4.84	3.88	4.29	16.63
	C2	4.80	3.85	4.22	16.23
	C3	4.77	3.82	4.15	15.86
	C4	4.82	3.86	4.28	16.53
	C5	4.86	3.89	4.46	17.37
Empathy	D1	4.76	3.81	4.22	16.09
	D2	4.80	3.85	4.39	16.88
	D3	4.78	3.83	4.37	16.73
Assurance	E1	4.76	3.81	3.84	14.64
	E2	4.76	3.81	4.25	16.21
	E3	4.83	3.87	4.41	17.06
	E4	4.82	3.86	4.42	17.07
	E5	4.80	3.85	4.46	17.15
TOTAL		124.82			425.90
Customer Satisfaction Index					**85.18**

According to Table 4, the CSI value calculation for the BRT Trans Medan Corridor K2 service is 85.18%. When compared with Table 3.6, the satisfaction of BRT Trans Medan Corridor K2 users is categorized as "Very Satisfied." The calculation and construction of matrices, including the pairwise comparison matrices for criteria and subcriteria, the normalization matrices for criteria and subcriteria, and the combined matrices of criteria and subcriteria, were conducted for each respondent. The combined matrix, however, represents the aggregation of responses from four respondents. In the following subchapter, the example of the criteria and subcriteria comparison matrix is taken from the first respondent, namely the Head of the Traffic and Transportation Sector of the Land Transportation Agency of Medan City.

Matrix Comparison Criteria

Table 5. AHP Research Structure

CRITERIA	Tangible	Reliability	Responsiveness	Empathy	Assurance
Tangible	1	1/5	2	3	1/4
Reliability	5	1	6	5	3
Responsiveness	½	1/6	1	1	1/3
Empathy	1/3	1/5	1	1	1/5
Assurance	4.00	1/3	3	5	1
TOTAL	10.83	1.90	13.00	15.00	4.78

To make reading easier, Table 5 is used as an example for comparing the values of Criteria 1 (tangible) and Criteria 2 (reliability). The comparison between the tangible and reliability criteria shows that reliability is more important than tangible, as it has a value of 5 in the gray cell. The comparison mark between the criteria being compared is indicated by a line in the row, whereas the comparison mark is in the column.

Matrix Normalization Criteria

Table 6. Matrix Normalization Criteria

CRITERIA	Tangible	Reliability	Responsiveness	Empathy	Assurance	K. Tangible	K. Reliability	K. Responsiveness	K. Empathy	K. Assurance	Total Normalization	VP
Tangible	1.00	0.20	2.00	3.00	0.25	0.09	0.11	0.15	0.20	0.05	0.60	0.12
Reliability	5.00	1.00	6.00	5.00	3.00	0.46	0.53	0.46	0.33	0.63	2.41	0.48
Responsiveness	0.50	0.17	1.00	1.00	0.33	0.05	0.09	0.08	0.07	0.07	0.35	0.07
Empathy	0.33	0.20	1.00	1.00	0.20	0.03	0.11	0.08	0.07	0.04	0.32	0.06
Assurance	4.00	0.33	3.00	5.00	1.00	0.37	0.18	0.23	0.33	0.21	1.32	0.26
Total	10.83	1.90	13.00	15.00	4.78	1.00	1.00	1.00	1.00	1.00	5.00	1.000
Normalization	0.09	0.53	0.08	0.07	0.21						CI	0.09
Lambda Max	1.31	0.92	0.90	0.96	1.26				Total	5.35	CR	0.08

The normalized total value (the second column from the right) is obtained from the sum of the shaded gray cells. The priority value (VP) is calculated by dividing the total normalized value of each criterion by the total normalized value of all criteria. Furthermore, the maximum lambda (λmax) value is obtained by multiplying the total value by the VP value for each criterion.

The total value represents the sum of the five criteria, while the Consistency Index (CI) and Consistency Ratio (CR) are used to measure consistency. The CI value is calculated by subtracting the number of criteria (5) from the total λmax value, then dividing the result by 4 (i.e., the number of criteria minus one). The CR value is then obtained by dividing the CI value by the Random Index (RI) of 1.12 for five criteria, as shown in Table 3.7. If the resulting CR value is less than 10% or 0.1, the comparison and matrix calculation process can be considered consistent. The same calculation is applied to each criterion and sub-criterion, as well as to each respondent.

Matrix Combined Criteria

The calculation matrix combination is almost the same as the normalization matrix; however, the difference lies in the value comparison, which is calculated as the geometric mean from all respondents.

Table 7. Matrix Combined Criteria

CRITERIA	Tangible	Reliability	Responsiveness	Empathy	Assurance	K. Tangible	K. Reliability	K. Responsiveness	K. Empathy	K. Assurance	Total Normalization	VP	VP (%)
Tangible	1.00	0.18	1.86	2.21	0.21	0.08	0.09	0.15	0.15	0.06	0.53	0.11	10.52
Reliability	5.48	1.00	5.23	5.00	1.86	0.45	0.47	0.41	0.34	0.53	2.20	0.44	44.06
Responsiveness	0.54	0.19	1.00	1.19	0.26	0.04	0.09	0.08	0.08	0.07	0.37	0.07	7.35
Empathy	0.45	0.20	0.84	1.00	0.19	0.04	0.09	0.07	0.07	0.06	0.32	0.06	6.43
Assurance	4.73	0.54	3.87	5.14	1.00	0.39	0.25	0.30	0.35	0.28	1.58	0.32	31.64
Total	12.20	2.11	12.81	14.55	3.53	1.00	1.00	1.00	1.00	1.00	5.00	1.00	100.00
Normalization	0.08	0.47	0.08	0.07	0.28						CI	0.05	
Lambda Max	1.28	0.93	0.94	0.93	1.12				Total	5.20	CR	0.05	

Determination criteria that become priorities can be seen in the VP (%) column; the higher the percentage mark, the more a criterion becomes the main priority (gray column). From Table 7 above, it can be concluded that the order of priority for the criteria based on the AHP analysis results is as follows: first, reliability; second, assurance; third, tangibility; fourth, responsiveness; and last, empathy.

Matrix Combined Subcriteria Tangible

Table 8 Matrix Combined Subcriteria Tangible

CRITERIA	1	2	3	K.1	K.2	K.3	Total Normalization	VP	VP (%)
1	1.00	0.21	3.22	0.17	0.16	0.28	0.60	0.20	19.94
2	4.73	1.00	7.48	0.78	0.74	0.64	2.17	0.72	72.19
3	0.31	0.13	1.00	0.05	0.10	0.09	0.24	0.08	7.87
Total	6.04	1.35	11.71	1.00	1.00	1.00	3.00	1.00	100.00
Normalization	0.17	0.74	0.09				CI	0.05	
Lambda Max	1.20	0.97	0.92		Total	3.10	CR	0.08	

According to table 8, the priority order of sub-criteria in the *responsiveness criteria* is firstly, prompt and appropriate service, secondly, the friendly and polite attitude of the officers and the last priority is the driver's skill in driving.

Matrix Combined Subcriteria Reliability

Table 9. Matrix Combined Subcriteria Reliability

CRITERIA	1	2	3	4	5	K.1	K.2	K.3	K.4	K.5	Total Normalization	VP	VP (%)
1	1.00	4.36	0.31	4.47	4.40	0.20	0.38	0.17	0.35	0.28	1.37	0.27	27.47
2	0.23	1.00	0.20	1.41	2.45	0.05	0.09	0.11	0.11	0.15	0.51	0.10	10.10
3	3.22	5.00	1.00	5.48	6.24	0.66	0.44	0.54	0.42	0.39	2.45	0.49	48.97
4	0.22	0.71	0.18	1.00	1.86	0.05	0.06	0.10	0.08	0.12	0.40	0.08	8.00
5	0.23	0.41	0.16	0.54	1.00	0.05	0.04	0.09	0.04	0.06	0.27	0.05	5.46
Total	4.90	11.4	1.85	12.90	15.9	1.00	1.00	1.00	1.00	1.00	5.00	1.00	100.00
Normalization	0.20	0.09	0.54	0.08	0.06						CI	0.08	
Lambda Max	1.35	1.16	0.91	1.03	0.87				Total	5.32	CR	0.07	

The priority order according to table 9 below is the first is the ability to provide the best service to passengers (subcriteria 3), the second is the fare price (subcriteria 1), the third is the punctuality of departure (subcriteria 2), the fourth is the waiting time between buses (subcriteria 4) and the last is the duration of stopping and picking up passengers (subcriteria 5).

Matrix Combined Subcriteria *Responsiveness*

Table 10 Matrix Combined Subcriteria *Responsiveness*

CRITERIA	1	2	3	K.1	K.2	K.3	Total Normalization	VP	VP (%)
1	1.00	5.18	3.13	0.66	0.56	0.70	1.93	0.64	64.22
2	0.19	1.00	0.33	0.13	0.11	0.07	0.31	0.10	10.37
3	0.32	3.00	1.00	0.21	0.33	0.22	0.76	0.25	25.40
Total	1.51	9.18	4.46	1.00	1.00	1.00	3.00	1.00	100.00
Normalization	0.66	0.11	0.22				CI	0.03	
Lambda Max	0.97	0.95	1.13		Total	3.06	CR	0.05	

According to table 10, the priority order of sub-criteria in the *responsiveness criteria* is firstly, prompt and appropriate service, secondly, the friendly and polite attitude of the officers and the last priority is the driver's skill in driving.

Matrix Combined Subcriteria Empathy

Table 11. Matrix Combined Subcriteria Empathy

CRITERIA	1	2	3	K.1	K.2	K.3	Total Normalization	VP	VP (%)
1	1.00	3.94	2.71	0.62	0.50	0.67	1.78	0.59	59.41
2	0.25	1.00	0.33	0.16	0.13	0.08	0.36	0.12	12.17
3	0.37	3.00	1.00	0.23	0.38	0.25	0.85	0.28	28.42
Total	1.62	7.94	4.04	1.00	1.00	1.00	3.00	1.00	100.00
Normalization	0.62	0.13	0.25				CI	0.04	
Lambda Max	0.96	0.97	1.15		Total	3.08	CR	0.07	

According to table 11, the priority order of the sub-criteria in the *empathy criteria* is that the first is that the officer is ready to be on site when needed, the second priority is the

officer's willingness to serve and prioritize the needs of passengers, and the last priority is the officer's honesty and patience in providing service.

Matrix Combined Subcriteria *Assurance*

Table 12. Matrix Combined Subcriteria *Assurance*

CRITERIA	1	2	3	K.1	K.2	K.3	Total Normalization	VP	VP (%)
1	1.00	2.91	5.92	0.66	0.69	0.57	1.92	0.64	64.15
2	0.34	1.00	3.46	0.23	0.24	0.33	0.80	0.27	26.62
3	0.17	0.29	1.00	0.11	0.07	0.10	0.28	0.09	9.23
Total	1.51	4.20	10.38	1.00	1.00	1.00	3.00	1.00	100.00
Normalization	0.66	0.24	0.10				CI	0.02	
Lambda Max	0.97	1.12	0.96		Total	3.05	CR	0.04	

According to table 12, the priority order of sub-criteria in the *assurance criteria* is the first is the availability of insurance or safety guarantees, the second priority is the availability of equipment to deal with emergency situations and conditions (fire extinguishers, first aid kits, etc.) on the bus, and the last priority is the communication skills of the officers.

CONCLUSION

The operational performance analysis of the Trans Medan BRT Corridor K2 (J-City–Merdeka Square) shows that while variables like time between buses, waiting time, circulation time, and speed meet standards, the load factor does not; per the BRT Standard 2016, the corridor satisfies 15 of 30 criteria (e.g., off-road fare collection, platform-level boarding, and multimodal integration) but incurs a 13-point deduction due to low peak-hour ridership, unsterilized bus lanes, and insufficient rush-hour frequency, yielding a total score of 38 that falls short of true BRT qualification. User satisfaction via the Customer Satisfaction Index (CSI) is very high at 85.18%, fueled by cleanliness and comfort, while AHP prioritization ranks reliability (44.06%) first, followed by assurance (31.64%), tangibility (10.52%), responsiveness (7.35%), and empathy (6.43%), emphasizing service quality, safety, comfort, promptness, and staff availability. For future research, investigators could explore targeted interventions like dynamic bus scheduling algorithms and dedicated lane enforcement to boost load factors and peak-hour performance, potentially elevating the corridor to full BRT compliance.

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