
DECISION SUPPORT SYSTEM FOR PRIORITIZING FEEDER BATIK SOLO TRANS SERVICE IMPROVEMENTS USING ANALYTICAL HIERARCHY PROCESS

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ABSTRACT

Surakarta City faces a significant annual increase in vehicle volume, prompting the local government to develop a Bus Rapid Transit-based public transportation system, Batik Solo Trans (BST), supported by a Feeder service that connects residential areas with the main corridor. However, the Feeder service still faces various complaints, including inaccurate arrival times, long waiting times, limited fleet availability, and safety and security aspects that need improvement. This study aims to design a decision support system for determining priorities for improving the BST Feeder service in Surakarta City using the Analytical Hierarchy Process (AHP) method. Data were obtained from four expert respondents, consisting of one supervisory manager and three drivers, selected through purposive sampling using pairwise comparison questionnaires based on Saaty's 1-9 scale. The results identified three main criteria, namely Safety and Security, Punctuality, and Fleet Availability, with Fleet Availability obtaining the highest weight of 0.6638 (66.38%). All pairwise comparison matrices were consistent, with a Consistency Ratio (CR) below 0.1. The Global Priority synthesis shows that Driver Training and Supervision ranks first (0.450; 45%), followed by Schedule Improvement (0.334; 33.4%) and Fleet Addition (0.216; 21.6%), indicating that improving driver human resources should take precedence over adding new fleet units.

KEYWORDS

Decision Support System, Analytical Hierarchy Process, Feeder Service, Improvement Priority



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INTRODUCTION

Surakarta City's rapid growth has driven a sharp rise in vehicle volume, with daily traffic projected to reach 653,820 units by 2025 against a population of about 589,242, raising congestion, pollution, and accident risks (Dewi & Krisdiyanto, 2023). Public transport is intended to ease this burden by offering the community a convenient, less congested alternative to private vehicles (Zulkarnain et al., 2023)., (Syafira, 2022). To this end, Surakarta operates the Bus Rapid Transit system Batik Solo Trans (BST) with 71 buses across 5 corridors, reinforced by a 42-unit Feeder service on routes K7, K8, K9, K10, and K12 that connects residential areas to the main corridor and reduces private-vehicle dependence (Kasiani & Widiyarta, 2023). However, the Feeder service still faces complaints over inaccurate schedules, long waiting times, limited fleet numbers, and inadequate safety and security (Saputri & Agusti, 2025), and since service quality strongly shapes user satisfaction and mode choice (Febriyanti et al., 2023), (Riawan, 2018), a systematic approach is needed to prioritize its improvement.

Multi-criteria decision-making methods offer such an approach for problems involving several competing criteria (Saragih, 2013), and the Analytical Hierarchy Process (AHP) is widely applied in Industrial Engineering for this purpose, structuring decisions through hierarchies, pairwise comparisons, and priority (Yanto, 2021), (Abdullah et al., 2022). Because decisions based on intuition alone, without systematic analysis, often prove suboptimal (Hendri et al., 2023), this study applies AHP to design a decision support system for prioritizing BST Feeder service improvements in Surakarta City, aiming to produce objective, structured, and academically accountable recommendations.

Various studies have examined the optimization of public transportation systems using multi-criteria decision-making methods. (Lin et al., 2024) emphasized the integration of AHP and ANP methods to overcome the weaknesses of a single approach in transportation network evaluation. (Kriswardhana et al., 2025) presented a systematic review over two decades regarding trends in the use of AHP in the transportation sector, while (Amankwah-Nkyi et al., 2025) applied AHP to estimate the criticality level of road infrastructure assets based on stakeholder input. (Lin et al., 2022) integrated AHP with Multi-Aspiration-Level Goal Programming to optimize public transport network performance. A number of researchers have also incorporated fuzzy logic into the AHP framework, such as (Tiwari et al., 2023) who assessed bus service attributes in Kathmandu, (Al-Zibaree & Konur, 2023) who used Fuzzy AHP for a sustainable transportation system, and (Garside et al., 2023) who utilized Intuitionistic Fuzzy AHP and WASPAS to evaluate the service quality of online transportation.

In addition to hierarchy-based approaches, (Putri et al., 2025) evaluated the service quality of Feeder buses by combining the Customer Satisfaction Index (CSI) and Importance Performance Analysis (IPA), while (Setiawan et al., 2024) analyzed mode selection for the Pekanbaru-Medan route using an integration of AHP and ELECTRE. The SERVQUAL approach is also widely used, as seen in studies (Nursifa & Ekawati, 2024), (Nisa et al., 2023), (Bua et al., 2025), and (Wahyuni et al., 2026), which highlight various dimensions of public service quality. A qualitative descriptive study by (Cafiyanti & Parwiyanto, 2025) showed that the fare integration strategy of Batik Solo Trans in Surakarta has been aligned with public service standards, although periodic evaluation remains necessary.

Specifically, the Feeder service in Surakarta City has been the subject of research by (Prihatiningtyas et al., 2025), who evaluated the performance of the Corridor 7 BST Feeder using Importance Performance Analysis, finding that service performance had not yet reached the company's standard. (Naibaho et al., 2023) applied AHP to analyze

community preferences in choosing intercity transportation modes, while (Khairani et al., 2022) identified priority factors influencing the interest of Medan residents in using the Trans Metro Deli bus. (Rhamadan et al., 2024) proposed the development of feeder route networks in Tangerang City, and (Rohmah et al., 2024) emphasized the urgency of intermodal integration in Surakarta as a rapidly urbanizing city, reinforced by (Suryadi & Ningsih, 2024) regarding the importance of improving bus-stop infrastructure. These various studies confirm a research gap in developing a more comprehensive decision support system for determining Feeder service improvement priorities, and this study aims to fill that gap using the AHP method.

Public transportation is a mode of transportation used collectively by the community by paying a fee, and is very important for human mobility (Yulianto & Yahya, 2018). Communities need public transportation alongside private vehicles to support their daily needs (Permini & Junaedi, 2023). An urban transportation system is the coordination of passenger and/or goods movement activities utilizing infrastructure as a means to carry out the transportation process (Novemberiandi, 2023). From an Industrial Engineering perspective, a transportation system is considered a system that requires optimization and management efficiency to provide optimal service with limited resource utilization.

Feeder transportation is a type of transportation that operates as a link between residential areas and main transportation modes, such as Bus Rapid Transit (Putra et al., 2025). This service functions not only as an additional means of transportation, but also as an integral part of a sustainable transportation development strategy that prioritizes efficiency, better access, and sustainability (Abdillah et al., 2024). In a BRT system such as Batik Solo Trans, the function of the Feeder service is to realize the first mile and last mile concept, so that without an optimal Feeder service, the transportation system cannot operate effectively due to limitations in service coverage.

Service quality is the service provided by a provider to customers, covering facilities, infrastructure, staff friendliness, as well as the products and services offered. The assessment of service quality is influenced by how the service provider operates, customer expectations, and the actual service received (Purnandika & Septiana, 2024). According to (Ayuningtias et al., 2023), service quality can be measured through reliability of service as promised, responsiveness in meeting user needs, staff friendliness and competence, empathy for individual needs, and the appearance of transportation facilities that influence customer perception.

A Decision Support System (DSS) is a system that uses information technology to provide information, models, or algorithms for decision-makers facing complex and semi-structured problems, and can be applied in various fields including the transportation sector (Sarwandi et al., 2023). A DSS aims to provide information, guide, predict, and direct users in making more appropriate choices (Fahmi et al., 2022). In this study, a DSS is applied to establish the order of priority for improving Feeder service quality based on predetermined criteria, so that the decisions made become more structured, clear, and data-driven.

The Analytical Hierarchy Process (AHP) method is an approach developed by Thomas L. Saaty in the 1970s to address multi-criteria decision-making problems, and is commonly applied in the fields of management, engineering, economics, and social sciences. The basic principle of AHP is based on the view that successful decision-making involves structured comparisons between criteria and alternatives (Sutrisno et al., 2023). The AHP method was chosen because of its ability to solve problems involving multiple objects and criteria through preference comparisons of each element within a hierarchical structure (Suarnatha, 2022), with stages including the development of a hierarchical structure, the construction of pairwise comparison matrices, the calculation of priority

weights, and consistency testing. This method uses a pairwise comparison scale, or Saaty Scale (1-9), in the development of hierarchy-based questionnaires.

RESEARCH METHOD

This study was conducted at the Surakarta City Transportation Agency (Dinas Perhubungan), located on Jl. Menteri Supeno No. 7, Manahan, Banjarsari District, Surakarta City. This location was chosen because Surakarta has implemented an integrated public transportation system based on Bus Rapid Transit (BRT) equipped with a Feeder service, yet issues related to service quality as perceived by users still remain.

Primary data were obtained through field observations of the operations of 42 Feeder vehicle units across 5 active routes (K7, K8, K9, K10, and K12), as well as pairwise comparison questionnaires completed by supervisory management and Feeder drivers. Secondary data include official documents regarding travel routes, the number of active fleets, and literature studies from previous research relevant to the AHP method and public transportation service quality.

The study population consisted of 63 people, comprising 18 supervisory management personnel and 45 BST Feeder drivers. The sample was selected using a non-probability sampling technique with a purposive sampling approach, since the AHP method emphasizes the quality of respondent judgment (expert judgment) rather than a large number of respondents. The research sample consisted of 4 respondents, namely 1 Head of Supervisory Management and 3 Feeder drivers representing different work tenure groups (5-6 years, 3-4 years, and 0-2 years), selected because they had experience across all Feeder routes and were recommended by field supervisors. Data validity in the AHP method is determined by the level of judgment consistency, measured through the Consistency Ratio (CR), with the requirement that $CR \leq 0.1$ for the judgment to be declared consistent and usable in the analysis.

Data collection was carried out through three techniques: a literature study by reviewing scientific journals, books, and Transportation Agency regulatory documents; pairwise comparison questionnaires based on the Saaty scale (1-9) distributed to respondents selected through purposive sampling; and field observations to validate user complaints related to safety and security, punctuality, and fleet availability. Data analysis was carried out through the stages of AHP, beginning with problem definition and the development of a hierarchical structure consisting of the goal, criteria, sub-criteria, and alternatives. The criteria and sub-criteria structure of the study is presented in Table 1.

Tabel 1 Research Criteria and Subcriteria

Criteria	Sub-Criteria
Safety and Security	Driver Behavior Compliance with Traffic Regulations
Punctuality	Arrival Time Accuracy Waiting Time
Fleet Availability	Number of Operating Fleet Units Fleet Availability during Peak Hours

Source: Processed by the Researcher, 2026

These three criteria were then compared against three improvement alternatives, namely Driver Training and Supervision, Schedule Improvement, and Fleet Addition. Questionnaire data were processed into an $n \times n$ pairwise comparison matrix, where the value a_{ij} represents the importance level of criterion i relative to j , with the reciprocal value

$a_{ji} = 1/a_{ij}$. Since the study involved 4 respondents, the judgment results of each respondent were combined using the geometric mean before normalization.

Matrix normalization was carried out by dividing each element in a column by the total sum of that column, after which the priority weight was calculated as the row average of the normalized matrix. The consistency of the judgments was tested using the Consistency Ratio (CR), obtained by comparing the Consistency Index (CI) with the Random Index (RI) according to the matrix size. If $CR \leq 0.1$, the judgment is declared consistent and suitable for analysis; if $CR > 0.1$, the respondent is asked to complete the questionnaire again. The final stage of the analysis is the Global Priority synthesis, namely the tiered multiplication of the weights of criteria, sub-criteria, and alternatives, summed across all sub-criteria to obtain the final priority value of each improvement alternative.

RESULT AND DISCUSSION

The study involved 4 respondents selected through purposive sampling, consisting of 1 Head of Supervisory Management and 3 drivers representing different work tenure groups, namely 5-6 years, 3-4 years, and 0-2 years, with experience across all Feeder routes (K7, K8, K9, K10, and K12). Before use, the research instruments were validated by experts. The AHP questionnaire validation obtained a score of 90% in the Very Good category, while the observation checklist validation obtained a score of 90.63%, also in the Very Good category, so both instruments were declared suitable for use in data collection. The consistency of the judgments of the four respondents was tested using the Consistency Ratio (CR) at all matrix levels, from the main criteria to the sub-criteria and alternatives. The test results showed that all pairwise comparison matrices obtained a CR value ≤ 0.1 , so all judgments were declared consistent and suitable for use in further AHP analysis. Pairwise comparisons among the three main criteria, namely Safety and Security, Punctuality, and Fleet Availability, were carried out by combining the judgments of the four respondents through the geometric mean. The resulting criteria priority weights are presented in Table 2.

Table 2 Priority Weights of the Main Criteria

No	Criteria	Weight (W)	Percentage (%)
1	Fleet Availability	0.6638	66.38%
2	Safety and Security	0.2329	23.29%
3	Punctuality	0.1033	10.33%

$\lambda_{max} = 3.0056$; $CI = 0.0028$; $CR = 0.0048$ (Consistent)

Source: Processed by the Researcher, 2026

Based on the analysis results, the Fleet Availability criterion had the highest weight (66.38%), followed by Safety and Security (23.29%), and Punctuality (10.33%). This result indicates that Fleet Availability is the most crucial factor in Feeder service quality according to respondents' judgments, as the limited number of operating units is felt to be the most fundamental obstacle in daily operations. Pairwise comparisons were also carried out at the sub-criteria level for each main criterion. A recapitulation of the sub-criteria weights is presented in Table 3.

For the Safety and Security criterion, the Compliance with Traffic Regulations sub-criterion had the highest weight (71.55%) compared to Driver Behavior (28.45%). For the Punctuality criterion, the Arrival Time Accuracy sub-criterion was more dominant (72.91%) compared to Waiting Time (27.09%). Meanwhile, for the Fleet Availability criterion, the Number of Operating Fleet Units sub-criterion obtained the highest weight

(57.94%) compared to Fleet Availability during Peak Hours (42.06%). All sub-criteria matrices were declared consistent, with CR values below 0.1.

Table 3 Recapitulation of Sub-Criteria Priority Weights

Criteria	Subcriteria	Weight (W)	CR
Safety and Security	Compliance with Traffic Regulations	0.7155 (71.55%)	0.000
	Driver Behavior	0.2845 (28.45%)	0.000
Punctuality	Arrival Time Accuracy	0.7291 (72.91%)	0.000
	Waiting Time	0.2709 (27.09%)	0.000
Fleet Availability	Number of Operating Fleet Units	0.5794 (57.94%)	0.000
	Fleet Availability during Peak Hours	0.4206 (42.06%)	0.000

Source: Processed by the Researcher, 2026

The next stage was to compare the three improvement alternatives, namely Driver Training and Supervision, Schedule Improvement, and Fleet Addition, against each sub-criterion. A recapitulation of the alternative weights against all sub-criteria is presented in Table 4.

Table 4 Recapitulation of Alternative Weights against All Sub-Criteria

Subcriteria	Driver Training & Supervision	Schedule Improvement	Fleet Addition	CR
Driver Behavior	0.2127	0.6511	0.1362	0.0003
Compliance with Traffic Regulations	0.3178	0.5324	0.1498	0.0007
Arrival Time Accuracy	0.2540	0.4773	0.2687	0.0280
Waiting Time	0.4605	0.1047	0.4348	0.0236
Number of Operating Fleet Units	0.5036	0.3273	0.1691	0.0006
Fleet Availability during Peak Hours	0.5633	0.1321	0.3046	0.0148

Source: Processed by the Researcher, 2026

All pairwise comparison matrices among alternatives showed a CR value ≤ 0.1 , and were therefore declared consistent and suitable for use in calculating the Global Priority. The Global Priority (GP) value was obtained through the tiered multiplication of the weights of the criteria, sub-criteria, and alternatives, which were then summed across all sub-criteria. The final Global Priority synthesis results are presented in Table 5.

Table 5 Final Global Priority Results and Alternative Ranking

No	Service Improvement Alternative	Global Priority	Percentage (%)	Rank
1	Driver Training and Supervision	0.450	45%	I
2	Schedule Improvement	0.334	33.4%	II
3	Fleet Addition	0.216	21.6%	III

Source: Processed by the Researcher, 2026

Based on the final synthesis results, the Driver Training and Supervision alternative ranked first with the highest Global Priority value (45%), as it dominated almost all sub-criteria, particularly the Number of Operating Fleet Units and Fleet Availability during Peak Hours. This indicates that improving driver competence, discipline, and supervision is the most crucial factor in comprehensively enhancing Feeder service quality. Schedule Improvement ranked second (33.4%), dominating the Driver Behavior and

Compliance with Traffic Regulations sub-criteria, indicating that schedule inaccuracy is closely related to driver behavior in the field. Fleet Addition ranked third (21.6%), with the largest contribution coming from the Fleet Availability during Peak Hours sub-criterion, indicating that fleet addition is most needed to address vehicle shortages during peak hours.

Conclusion

Based on the results of data processing involving four expert respondents, several conclusions can be drawn. The factors influencing Feeder service quality were successfully identified through three main criteria, namely Safety and Security, Punctuality, and Fleet Availability. Fleet Availability obtained the highest weight of 0.6638 (66.38%), followed by Safety and Security at 0.2329 (23.29%), and Punctuality at 0.1033 (10.33%), confirming that the limited number of operating fleet units is the most keenly felt issue among both supervisors and drivers in the field.

The designed decision support system was successfully tested through the complete AHP stages, from the development of the hierarchical structure and the distribution of pairwise comparison questionnaires, to the calculation of weights and consistency testing. All comparison matrices at the criteria, sub-criteria, and alternative levels obtained a Consistency Ratio (CR) below 0.1, so all judgments were declared consistent and suitable as a basis for decision-making. The tiered application of the AHP method was able to transform various qualitative complaints, such as undisciplined driver behavior or frequently inaccurate schedules, into measurable and academically accountable priority scores.

The final results show that among the three alternatives analyzed, Driver Training and Supervision ranked first with a Global Priority value of 0.450 (45%), followed by Schedule Improvement at 0.334 (33.4%), and Fleet Addition in third place at 0.216 (21.6%). These findings are consistent with service user complaints, in which issues of driver discipline and competence were felt to be more urgent to address before increasing the number of fleet units.

For the Surakarta City Transportation Agency, given that Driver Training and Supervision is the top priority, a routine training program for Feeder drivers should be implemented promptly, covering discipline, friendliness, and compliance with traffic regulations, accompanied by strengthened driver performance supervision through periodic evaluation or monitoring technology. Improving departure and arrival schedules should be the next prioritized step once driver resource management is underway, taking into account passenger density patterns on each route, especially during morning and afternoon peak hours. Fleet addition remains worth considering as a medium- to long-term step to address unit shortages during peak hours, although it need not be prioritized before human resource and scheduling improvements are completed. For future researchers, the number of respondents in this study was relatively limited due to reliance on an expert judgment approach; future research could expand the number and scope of respondents, for example by involving passengers as direct service users, and combine AHP with other approaches such as Fuzzy AHP or Importance Performance Analysis to capture uncertainty in judgments more comprehensively.

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