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Integration of Intelligent Intermodal River and Land Transportation in Banjarmasin

Yuli Susanto, Juny Andry Sulistyo, Hermin Poedjiastoeti

Master of Civil Engineering Study Program, Sultan Agung Islamic University, Semarang, INDONESIA

E-mail: yulisusanto2015@gmail.com, juny.andry@unissula.ac.id, hermin@unissula.ac.id

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ABSTRACT

Banjarmasin City as a river city has great potential to integrate river and land transportation modes, but the current system performance is still hampered by weak schedule synchronization, minimal transfer facilities, and the digital divide between modes. This study used a descriptive approach, using a questionnaire with 100 respondents, field observations, and interviews with stakeholders. Analysis was conducted descriptively and percentage-wise and triangulated with qualitative findings to map travel efficiency, comfort and safety, level of integration, and the implementation of intelligent transportation technology. The results showed that in terms of efficiency, 73% of respondents experienced intermodal waiting times of more than 20 minutes and only 5% less than 10 minutes, while 66% considered intermodal transfers still difficult. Comfort and safety on land transportation were relatively good, with 87% of respondents feeling comfortable and 92% feeling safe. However, river transportation lagged behind, with 58% rating comfort as low and 63% stating that standard security facilities were not yet available. Network integration remains fragmented, with only 14% of respondents rating intermodal schedules as integrated, and 81% stating that integrated ticketing was not yet available. Technology implementation was also uneven, with 89% of respondents on land transportation accessing real-time information and 84% using QRIS, while on river transportation only 9% had ever received digital schedule information and none used cashless payments. These findings indicate the need for a development strategy that includes schedule synchronization, the construction of physical connectors such as disabled-friendly gangways and pedestrian paths, the digitalization of kelotok services including real-time information and electronic payments, institutional strengthening and control centers, and education to increase literacy in the use of smart intermodal modes.

Keywords: intermodal integration, intelligent transportation, technology, network, Banjarmasin.

INTRODUCTION

Kalimantan, as the largest island in Indonesia, has a strategic role in strengthening national connectivity through the integration of land and river transportation. Banjarmasin, as one of the main intermodal transportation hubs, utilizes the characteristics of a river city to efficiently connect inland and coastal areas, thereby contributing to regional economic development. However, the transportation system in this region still faces challenges in the form of limited supporting infrastructure, low accessibility, and weak cross-modal coordination. These obstacles result in high logistics costs and long travel times, while the vast potential of the main rivers has not been optimally utilized [1], [2].

In an urban context, the integration of river and land transportation modes in Banjarmasin plays a crucial role. River transportation modes include kelotok, traditional boats used by riverbank communities, and speedboats for longer-distance travel. Land transportation modes include Trans Banjarmasin (BRT), a public transportation system that acts as a feeder, and online transportation services to support short-distance connectivity, both first- and last-mile. This integration aims to build a smart transportation system that is efficient, affordable, and user-friendly, reducing dependence on private vehicles.

The government has taken strategic steps by building an integrated shelter in Banjarmasin, equipped with bus stops, gangways, sidewalks, and information boards. This facility is expected to increase transportation efficiency and accessibility for residents and tourists [3], [4].

The concept of smart mobility or intelligent transportation is a proposed solution, in line with the six dimensions of a smart city [5]. Smart transportation aims to minimize movement, reduce obstacles, and shorten travel times [6]. The application of technologies such as Intelligent Transportation Systems (ITS), satellite communications, and intermodal integration is key. Successful integration requires the integration of time, routes, and supporting facilities [7], [8].

The case study of Surabaya demonstrates the relevance of this strategy. The implementation of ITS-ATCS in the city enables real-time traffic management. Buses such as the Suroboyo Bus are equipped with real-time tracking technology and automation integrated with the traffic system. Despite its efficiency, Surabaya still faces challenges such as network overlap, a lack of feeder transportation, and inadequate bus stop infrastructure [9], [10]. This situation mirrors similar challenges in Banjarmasin.

Banjarmasin has great potential to develop intelligent-based intermodal integration, with a comprehensive evaluation of operational efficiency, accessibility, and user experience. Digital technologies such as real-time information applications and electronic payment systems can be catalysts for performance improvement. If managed well, intelligent-based intermodal transportation in Banjarmasin can increase national logistics competitiveness while supporting sustainable development [2], [4].

As a river mobility hub in South Kalimantan, Banjarmasin has the potential to become a national model for intermodal transportation management. Improving integrated shelter management will strengthen regional connectivity, reduce logistics costs, and encourage inclusive economic growth. Intermodal transportation has also been shown to reduce costs and operational delays compared to unimodal transportation due to the flexibility in selecting routes and modes according to the type of commodity within a given network [11].

This study aims to evaluate the performance of river and land intermodal integration in Banjarmasin, identify obstacles, assess the implementation of intelligent transportation technology, and develop recommendations for technology-based connectivity development strategies in the future.

RESEARCH METHODS

This research approach refers to the concept [12] which emphasizes that a research approach is a systematic plan and procedure that includes paradigms, designs, and research methods. The method used is a mixed method by utilizing primary data from interviews and field observations, as well as secondary data from literature studies. Qualitative analysis is carried out inductively through the stages of data reduction, data presentation, and drawing conclusions/verification [13], [14]. This approach combines quantitative, qualitative, and mixed methods components to provide a comprehensive picture of the research process and context, and supports understanding of the results obtained.

Location and Time of Research

This research was conducted in Banjarmasin City, South Kalimantan, as a case study location for the integration of river and land transportation. Banjarmasin was chosen because of its unique characteristics as a river city with a transportation network that involves both river modes (kelotok, fast boats) and land modes (BRT Trans Banjarmasin, public transportation, motorcycle taxis/online taxis). Field data collection was conducted from April to June 2025.

Research Approach

The research method uses a quantitative and qualitative descriptive approach (mixed methods) to obtain a comprehensive picture of the performance, constraints, and opportunities for intermodal transportation integration.

Data Types and Sources

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The data used in this study consists of primary and secondary data. Primary data was obtained through questionnaires, field observations, and in-depth interviews with users, operators, and related parties. Meanwhile, secondary data was obtained from local government documents, transportation statistics reports, regulations related to intermodal transportation, and previous research results.

Data collection technique

Data collection methods in this study included field observations to identify the physical conditions of integration facilities such as shelters, bus stops, piers, gangways, sidewalks, and information boards; a questionnaire survey to obtain quantitative data on user perceptions and experiences; and in-depth interviews with the Transportation Agency, transportation operators, and user communities.

Population and Sample

The research population was users of intermodal transportation services in Banjarmasin, both river and land transportation. The sampling technique used purposive sampling with 100 respondents selected based on the following criteria: (1) having used both river and land transportation in one trip, and (2) residing in Banjarmasin.

Research Instruments

The questionnaire instrument was designed to measure intermodal integration performance indicators, including intermodal waiting times, comfort and safety, ease of mode transfer, route accessibility and integration, and the use of intelligent transportation technologies such as real-time information and electronic payment systems. In-depth interviews were also conducted to gather qualitative information regarding policies, constraints, and development opportunities.

Data Analysis Techniques

Data analysis was conducted using descriptive analysis–percentage to process quantitative data from questionnaires, qualitative analysis for interview and observation data with triangulation techniques to validate the findings, and SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis to formulate a strategy for developing intermodal transportation integration based on smart technology in Banjarmasin.

Research Framework

The research framework illustrates the relationship between the potential of intermodal transportation in Banjarmasin, the obstacles faced, the implementation of intelligent transportation technology, and proposed development strategies. The research stages range from problem identification, data collection, performance analysis, to the formulation of strategic recommendations.

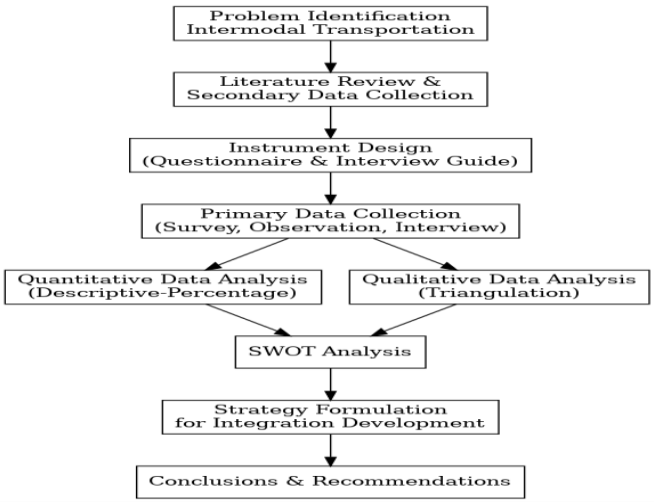

Figure 1. Flow Chart of Intermodal Transportation Research

RESULTS AND DISCUSSION

Geographical Description of Banjarmasin Nol Kilometer Shelter

Geographically, the Nol Kilometer Shelter is located on Jalan Jenderal Sudirman in Central Banjarmasin, directly adjacent to the Martapura River to the east. This area is a densely populated commercial and tourist area, where economic, transportation, and social activities are high. This geographical location supports the potential for intermodal integration, as it allows direct connections between river transportation (kelotok, jukung) and land transportation such as the Trans Banjarmasin BRT and Trans Banjarbakula BTS.

This bus stop is easily accessible from all directions, by pedestrians, private drivers, and public transportation users. Its location adjacent to the Nol Kilometer water shelter allows for a transfer in less than a three-minute walk via a designated pedestrian path.

Figure 2. Nol Kilometer Shelter Location

Strategic Function of Shelters in the Intermodal System

The Nol Kilometer Shelter is designed as the main integration node between modes in Banjarmasin City with its main function as a transit point connecting land and river transportation systems. The existence of this bus stop plays an important role in the city's mobility system because it connects public transportation corridors, especially the Trans Banjarmasin BRT corridor and the Banjarbakula BTS which serve both inner-city and regional routes (between cities/districts), provides connectivity to river transportation modes especially for tourist destinations such as the Floating Market, Kampung Ketupat, and Lok Baintan, as well as being a point of integration of technology-based services through an electronic payment system and digital schedule information that can be accessed through the BTSGO and Land Partner applications.

The facilities available at the Nol Kilometer Shelter are designed to support user comfort and efficiency, including a covered waiting area that is disability-friendly, toilets and a prayer room, an MSME area and canteen, bicycle parking and a drop-off zone, digital information boards and CCTV, as well as a Transportation Agency post that provides information services and direct supervision.

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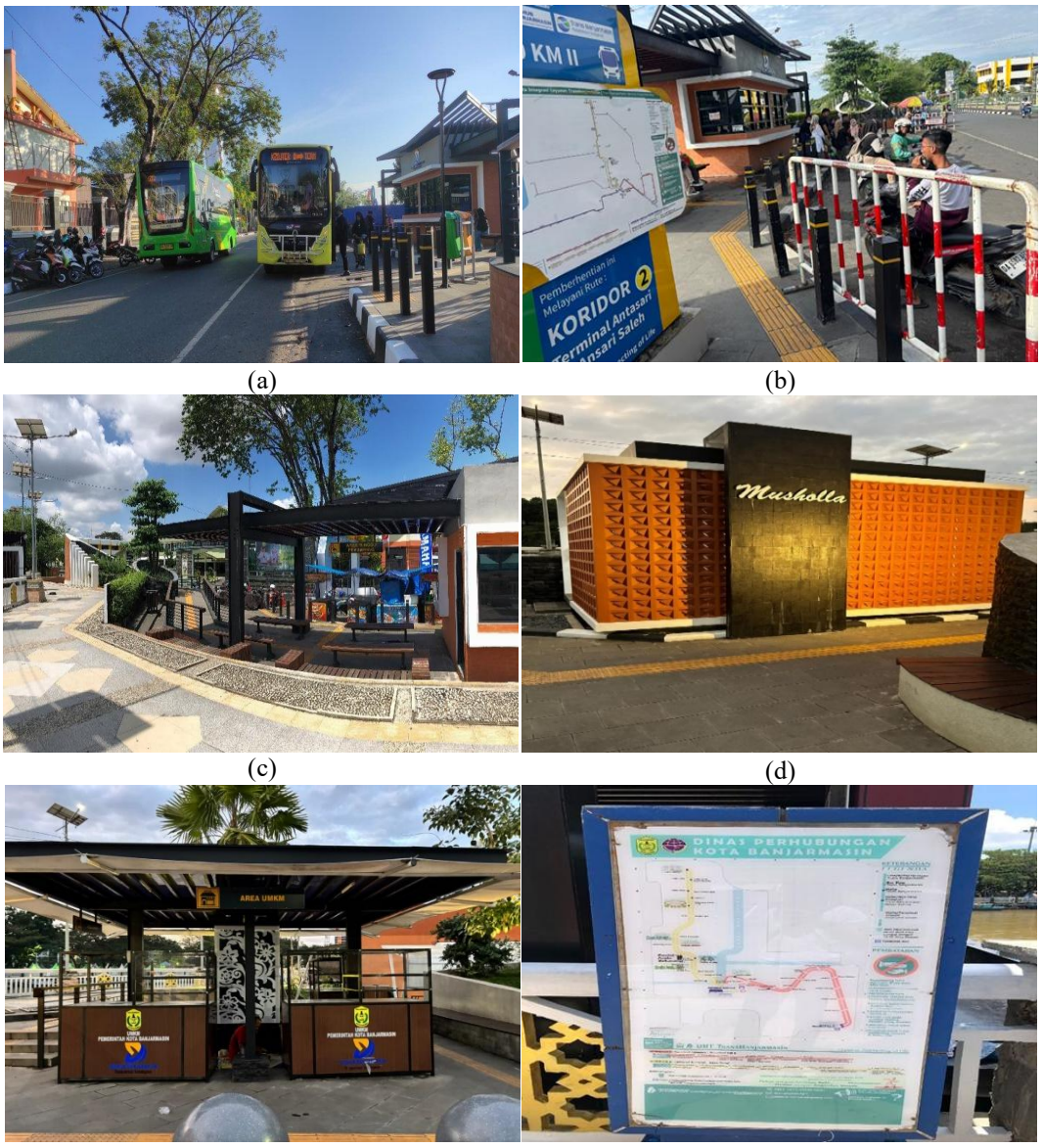

(a) (b)

(c) (d)

(e) (f)

Figure 3. Conditions and Facilities of Nol Kilometer Shelter: (a) BRT & BTS Meeting Point; (b) Condition of Sidewalks Boundary of Integration Shelter; (c) Connecting Road of Integration Shelter and Water Shelter; (d) Prayer Room Facilities; (e) MSME Facilities; (f) Trans Banjarmasin BRT Route Board.

Land Transportation Around the Nol Kilo Shelter

To support the location analysis, secondary data from the Banjarmasin City Transportation Agency was used as a reference in understanding the profile and characteristics of the modes involved. Land transportation around the Nol Kilometer Shelter is dominated by the Trans Banjarmasin Bus Rapid Transit (BRT) and Trans Banjarbakula Bus (BTS) services. The following is a list of these services:

Table 1. Land Transportation Around the Nol Kilo Shelter

Fashion	Fleet Size	Active Corridor	Average Travel Time	Waiting Pause	Supporting Applications
Trans Banjarmasin BRT	17 units	4 corridors	28–34 minutes	15 minutes	QRIS, BTSGO
BTS Banjarbakula	80 units	4 corridors (1A, 1B, 3, 4)	52–147 minutes	30–40 minutes	Land Partners, Bus Friends

BRT and BTS use modern fleets with air conditioning, priority seating, and a cashless system. However, schedule synchronization between corridors and with water transportation is not yet fully implemented.

(a) (b)

Figure 4. Land Transportation Modes Around the Nol Kilo Shelter: (a) BRT Transbanjarmasin (b) BRT Trans Banjarbakula

Water transportation in Banjarmasin involves traditional and semi-modern vessels such as kelotok (motorized boats) and jukung (motorized boats). Based on Transportation Agency data and field observations, there are:

- 88 tourist kelotok units operate at 3 large bases
- 12 active water shelter points
- The operational system is divided into:
  - Regular: waiting for quota of 18–23 passengers
  - Charter: flexible rates, depending on distance and agreement

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Figure 5. Kelotok Water Transportation Mode

Figure 5 shows a tourist kelotok operating on the Martapura River in Banjarmasin. This mode of transportation is used by local residents and tourists as a means of river transportation, connecting the Nol Kilometer Shelter to various water tourism destinations. Kelotok serves as a traditional mode of transportation that is still active and plays a vital role in the city's land-water intermodal integration system.

Table 2. Service Routes and Utilization Profile of River Transportation from the Nol Kilometer Shelter

Route	Traveling time	Information
Nol Kilometer water shelter – View Tower	5 minutes	A short and popular route for local tourists, often used on weekends.
Nol Kilometer water shelter – Kampung Ketupat	8 minutes	Traversing local culinary and craft areas, perfect for a short cultural tour.
Nol Kilometer Water Shelter – Muara Kelayan	14 minutes	A medium route that passes through residential areas and local docks.
Nol Kilometer Water Shelter – City Hall	23 minutes	Access to government areas, usually used during visits by agencies or regional guests.
Nol Kilometer Water Shelter – Basirih Dome	48 minutes	Pilgrimage route to the tombs of famous scholars, active on weekends and religious commemorations.
Nol Kilometer Water Shelter – Alalak	1 hour 47 minutes	Long route to the suburbs, rarely used except for special tours.
Nol Kilometer Water Shelter – Cemara	1 hour 21 minutes	The route to the water and educational tourism area is suitable for group tours.
Nol Kilometer Water Shelter – Lulut River	55 minutes	The medium route to the city border area is used on a limited basis.
Nol Kilometer Water Shelter – Jingah River	35 Minutes	Access to residential areas and local markets, occasionally used by local residents.

Respondent Data

The characteristics of the respondents in this study reflect the social profile and behavior of public transportation users, particularly in the context of the integration of land and river transportation modes in the Banjarmasin Nol Kilometer Shelter area. A total of 100 respondents were recruited through a field survey using a questionnaire, with data collection taking into account diversity in age, gender, education level, and transportation mode usage patterns. Understanding these characteristics is crucial for assessing the potential acceptance of an intelligent intermodal transportation system as a whole.

Table 1. Distribution of Respondents by Age

Age Category	Number of Respondents
11–20	13
21–30	28
31–40	22
41–50	32
51–60	5

Table 4. Distribution of Respondents by Gender

Gender	Number of Respondents
Man	64
Woman	36

Table 5. Distribution of Respondents Based on Education Level

Level of education	Number of Respondents
Elementary/Middle School	13
High School/Vocational School	34
Diploma	32
Bachelor degree)	19
Postgraduate	2

Discussion

This discussion aims to elaborate on the field findings through quantitative and qualitative approaches, linking them to theoretical frameworks and previous studies, and examining the extent to which the research findings contribute to the development of an intelligent intermodal transportation system in Banjarmasin City. This discussion is structured thematically into three main sections: interpretation of the findings, theoretical and empirical comparisons, and narrative elaboration of the research questions.

This study found that the efficiency of the intermodal transportation system at the Banjarmasin Nol Kilometer Shelter still faces several fundamental issues. Quantitative findings from the questionnaire indicate that waiting times for transfers between modes, both from land to river transportation and vice versa, mostly exceed 20 minutes. Most respondents also felt that travel times did not match their expectations as users. This indicates that coordination between transportation operators has not been systematically established, particularly regarding service scheduling.

However, comfort and safety aspects performed relatively well. Most respondents felt comfortable with the facilities available at the shelter, such as seating, lighting, and a clean waiting area. Perceptions of safety were also high, indicating that users felt safe from potential disruptions, both technical and social. However, observations and interviews revealed limited access for people with disabilities, inadequate sidewalk conditions, and the absence of dedicated lanes that support inclusive intermodal connectivity.

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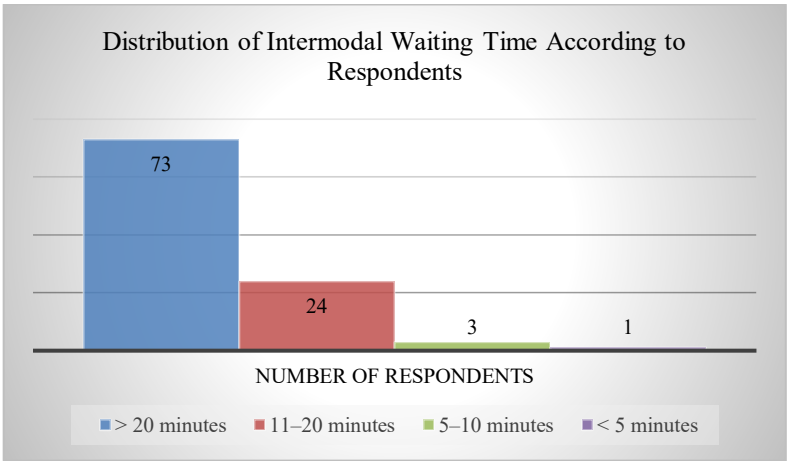

Figure 6. Distribution of Waiting Time Between Modes According to Respondents

The adoption of smart transportation technology has also not been evenly distributed. Land transportation modes such as BTS and BRT have begun adopting digital information systems like the BTSGO app and QRIS-based electronic payment systems. In contrast, river transportation modes like kelotok (motorized boat) still use conventional systems, without digital signage, time tracking systems, or cashless payment schemes. Qualitative findings from interviews with the Transportation Agency and water transportation operators indicate that there remains resistance to digitalization and limited institutional capacity to develop cross-modal technology integration.

Focus Group Discussion with Stakeholders

The research findings indicate that the integration of multimodal transportation in Banjarmasin has advanced, especially in the establishment of physical infrastructure such as land bus stations and river shelters, however the execution remains suboptimal. Muhammad Rizki Ansyari, A.Md.Tra, a staff member in the Road Transportation Network Data Management Division of the Banjarmasin City Transportation Agency, asserts that the primary challenge is the lack of comprehensive integration in infrastructure connectivity regarding accessibility and design. The problem is intensified by the lack of a real-time information system, which renders intermodal transfers less efficient.

From the operator's viewpoint, Maulana Ibrahim, proprietor of MG Berkah Usaha, and Hermansyah, owner of MG Doa Ibu, indicated that transfers from buses to kelotoks remain protracted due to the lack of synchronization between kelotok schedules and other transportation modes. According to Defy Arisanti, STr., MT., Head of the UPTD Terminal, public interest in utilizing public transportation remains minimal, particularly with water transportation, which is predominantly viewed as an alternate or tourist option rather than a primary form of transit. Dwi Harianto, an employee at Adaro Logistics, corroborates this perspective, observing that the public favors private vehicles for pragmatic reasons.

The interviews disclosed numerous significant issues, including inadequate physical connectivity, facilities requiring maintenance, restricted accessibility for individuals with disabilities, unsynchronized schedules, protracted mode transfers, the absence of a cohesive real-time tracking system, the lack of an integrated ticketing system, and insufficient coordination among operators and agencies. From a technology standpoint, transportation applications like BTSgo and Mitra Darat, along with cashless payment methods, were deemed beneficial for delivering fleet arrival schedule information and mitigating illegitimate charges. Nonetheless, its execution persists in encountering technical malfunctions and has a deficiency in cross-modal integration.

Most interviewees highlighted the necessity of enhancing infrastructures, including river shelters, bus stops, mooring ladders for kelotoks, and waiting areas, while ensuring the availability of sufficient toilets and covered waiting spaces to shield users from inclement weather, with particular consideration for the elderly and individuals with disabilities. Agency coordination was deemed

insufficient, as each mode functions autonomously without synchronized schedules, leading to prolonged wait times and inefficiency.

The respondents concurred that policy harmonization and the enhancement of institutional capacity are vital for the attainment of an integrated transportation management system. Nonetheless, many projects have been executed, encompassing the creation of transportation information applications, the enhancement of bus stop comfort, and the fortification of human resources within the public transportation sector by the Transportation Agency. Private operators, such Hermansyah and Maulana, indicated their preparedness to conform to the integrated system, albeit they need adequate policy assistance and resources.

SWOT Analysis of the Intermodal Transportation System in Banjarmasin City

A SWOT analysis is a strategic evaluation method for the strengths, weaknesses, opportunities, and threats faced by the intermodal transportation system in Banjarmasin City. This approach helps understand the current situation from multiple perspectives, primarily through data triangulation from observations, field surveys, and in-depth interviews with stakeholders involved in the management and development of the transportation system in the area.

Table 6. SWOT Analysis of Intermodal Transportation in Banjarmasin

Aspect	Information
Strength	Developing infrastructure; early adopter enthusiasm; geographic location supports river transport development
Weakness	Schedules are not synchronized; facilities are not optimal; coordination between operators is minimal; there is no specific regional regulation on intermodal integration.
Opportunity	Smart city policy support; economic and tourism potential; improved quality of life through transportation efficiency
Threat	Limited development budget; resistance to change from the community and operators; water transportation is not yet available as official mass transportation

A SWOT analysis was used to formulate a strategy for developing the intermodal transportation system in Banjarmasin, taking into account existing strengths, weaknesses, opportunities, and threats. Based on observations and interviews, the strategy was structured into four main categories: SO, WO, ST, and WT. The goal is to optimize internal and external potential and address transportation integration challenges adaptively and sustainably.

Table 7. Development Strategy Based on SWOT Analysis

A. SO Strategy (Strength - Opportunity) Maximizing internal strengths to seize external opportunities		
No	**Strategic Focus**	**Explanation**
1	Utilization of Infrastructure for Smart Mobility	Optimizing the use of existing bus stops and shelters as land and river transportation connectivity points through integration with smart transport applications such as BTS Go and Mitra Darat, in line with the Smart City vision.
2	River-Based Tourism Corridor Development	Develop intermodal transportation routes (land–river) in tourist areas (Floating Market, Kampung Kuin, etc.) to support the tourism sector with existing physical infrastructure.
3	Digitalization of Transportation Service Information	Improve the digital information system (real-time) regarding schedules, positions, capacities, and fares of modes that can be accessed through a single platform.
B. WO Strategy (Weakness - Opportunity) Overcoming internal weaknesses by taking advantage of external opportunities		

No	Strategic Focus	Explanation
1	Intermodal Schedule Adjustment and Synchronization	Develop a digital-based scheduling system that allows for synchronization of arrival/departure times between modes. This can be implemented with the support of smart city policies.
2	Revitalization of Passenger Facilities	Optimizing support opportunities from central/regional governments to improve the comfort of bus stop facilities, water shelters, pedestrian paths, and disability facilities at integration points.
3	Public Education and Socialization	Conduct digital and physical campaigns on the benefits of integrated intermodal modes to encourage changes in people's behavior.

C. ST Strategy (Strength - Threat)
Using internal strengths to face external threats

No	Strategic Focus	Explanation
1	Utilizing Technology for Budget Efficiency	With the initial investment of existing digital systems and infrastructure, operational costs and the development of new systems can be reduced. For example, by using sensors and applications to monitor service performance.
2	Preparation of Cross-Agency Proposals	Leveraging the power of local government networks and user enthusiasm to develop joint funding proposals (e.g. Special Allocation Funds, CSR, private partnerships).
3	Efficient Route Design Based on Strategic Points	Using the strength of strategic locations of bus stops/shelters to design main routes that minimize the need for private modes, thereby reducing community resistance.

D. WT Strategy (Weakness - Threat)
Minimize internal weaknesses to avoid external threats

No	Strategic Focus	Explanation
1	Formulation of Special Regulations for Intermodal Integration	Proposing a Regional Regulation (Perda) specifically for mode integration that regulates scheduling, fares, minimum service standards, and operator incentives. This could reduce coordination barriers and operator resistance.
2	Operator Collaboration and User Needs Mapping	Initiate a collaborative forum between the Transportation Agency, bus and kelotok operators, and the user community to develop a service model that meets needs.
3	Optimizing Transportation Data Usage	Conduct regular surveys, travel time monitoring, and user feedback to continuously improve the system, despite limited budgets.

This SWOT analysis and strategy development demonstrate that intermodal transportation development in Banjarmasin has a strong foundation, particularly in terms of infrastructure and technological initiatives. However, several fundamental weaknesses, such as unsynchronized schedules, non-inclusive facilities, and weak coordination, need to be addressed through a cross-sectoral approach. The significant potential of the tourism sector and the support of smart city policies can act as levers to realize a sustainable, efficient, and inclusive transportation system. Strategy development requires continuous evaluation through a participatory approach involving the government, operators, and users.

Comparison with Previous Theories and Research

The findings of this study are in line with the concept of intermodal integration proposed by [8], which states that ideal integration includes physical dimensions, fares, schedules, information, and

institutions. In the context of Banjarmasin, only some of these dimensions have begun to be implemented, while the rest still require strengthening. This is reinforced by the findings of [15] which show that the lack of integration of transportation services in Surabaya is largely influenced by minimal schedule integration and network dominance by a single operator, a situation also observed in Banjarmasin.

In addition, the concept of smart transportation or smart mobility as explained by [16] and [17] emphasizes the importance of using information technology to support an efficient, safe, and sustainable transportation system. This study shows that land transportation in Banjarmasin has moved in this direction, but river transportation is still lagging behind in terms of digitalization. The lack of real-time information and electronic ticketing systems on kelotok is a serious obstacle in realizing integrated smart transportation.

Research [18] on the integration of Suroboyo Bus and feeder transportation in Surabaya also shows similar challenges, such as long waiting times and limited facilities for people with disabilities. Rahman's suggestion regarding the importance of developing digital facilities and inclusive networks is highly relevant for implementation in Banjarmasin, especially for river transportation which still does not have a similar support system.

Meanwhile, best practices from developed countries, such as intermodal systems in Japan and the European Union that integrate ports, high-speed rail, and local modes with the support of digitalization and multistakeholder policies, provide important comparisons. In Banjarmasin, successful integration remains hampered by a lack of institutional coordination, sub-inclusive supporting infrastructure, and limited fiscal and technological capacity.

CONCLUSION

The study concludes that the intermodal river and land transportation system in Banjarmasin is still not optimally integrated within the framework of smart mobility. While land transportation has shown significant progress, river transportation remains constrained by limited accessibility, low comfort and safety standards, unsynchronized schedules, and the absence of integrated ticketing and digital services. To address these challenges, development efforts should prioritize the digitization of kelotok services, the establishment of physical intermodal connections, and the provision of real-time information systems and accessible facilities. The success of these strategies will depend on strong institutional coordination, policy support, and active community engagement to encourage the wider adoption of smart intermodal transportation.

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