-RESEARCH ARTICLE-

PASSENGER SATISFACTION AND DIGITAL SERVICE INNOVATION IN FERRY TRANSPORT: EVIDENCE FROM INDONESIA

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─**Abstract**─

Passengers represent a critical resource for ferry service providers, making it essential to identify determinants that strengthen passenger loyalty. Accordingly, this study investigated the influence of e-ticketing, real-time tracking, and digital payment systems on passenger loyalty, with passenger satisfaction examined as a mediating mechanism. Data were collected from ferry passengers in Indonesia using a simple random sampling approach. Structural equation modelling was conducted using Smart PLS to analyse the relationships among the variables. The results indicate that e-ticketing, real-time tracking, and digital payment significantly enhance passenger satisfaction. Furthermore, passenger satisfaction was found to positively influence passenger loyalty and to mediate the relationship between digital service features and loyalty outcomes. This research contributes to the limited body of literature emphasising the role of digital service innovations in fostering passenger satisfaction and loyalty within the ferry transport sector.

Keywords: E-Ticketing, Real Time Tracking, Digital Payment, Passenger Satisfaction, Passenger Loyalty

INTRODUCTION

Public transportation constitutes a fundamental component of contemporary mobility systems, as it contributes to economic efficiency and environmental sustainability (Abdelwahed et al., 2023). It is widely recognised as a core transport mode due to its affordability and its potential to reduce environmental externalities. The effectiveness

of public transportation largely depends on the ability to anticipate service disruptions and deliver dependable services, ensuring that passengers receive timely and accurate information (Fahim et al., 2024). Public transportation encompasses various modes, including trams, metro systems, railways, buses, ferry services, and cable cars (Krishnamoorthy & Venugopal, 2025).

Indonesia exhibits distinctive geographical conditions as an archipelagic country, which necessitate a dependable and adaptable inter-island maritime transport network, particularly ferry services (Riyadi, 2024). Given the large number of islands and extensive routes connecting major and remote regions, ferries serve as a critical mechanism for regional integration, cargo movement, and passenger transportation. Despite their essential role, ferry services continue to encounter operational challenges, including slow service delivery, comfort-related issues, limitations in real-time tracking, inefficient ticketing processes, and insufficient terminal infrastructure (Eddrgash, 2022). These constraints directly influence passenger satisfaction and loyalty, which are key concerns for transport operators and policymakers.

The expansion of globalisation and international trade has increased the relevance of global logistics and international collaboration. The current era is characterised by the fourth industrial revolution, commonly referred to as digital transformation, which focuses on developing innovative technological solutions and applications (Salawu & Ghadiri, 2022). The advancement of digital technologies, such as real-time tracking, digital payment systems, and electronic ticketing, has created opportunities to improve user experience, service transparency, operational performance, and satisfaction levels (Subramanya et al., 2022). Several countries have implemented digital solutions in maritime logistics to reduce costs, enhance real-time monitoring, improve data transparency, and enable paperless documentation (Zeng et al., 2025). Prior studies indicate that passenger satisfaction and loyalty are negatively affected by slow services, limited comfort, inadequate real-time communication, inefficient ticketing systems, and poor terminal facilities.

Customer satisfaction is a crucial determinant of the sustainability and performance of transportation systems. Within the transport context, satisfaction reflects passengers' evaluations of service punctuality, cost, comfort, safety, and reliability (Hermawati et al., 2026). When transport services meet or exceed user expectations, satisfaction increases, which subsequently strengthens loyalty. Higher satisfaction also generates positive word of mouth and facilitates acceptance of new transport policies and innovations. Satisfied users are more inclined to support long-term infrastructure initiatives, provide valuable feedback, and comply with regulatory requirements (Irshad et al., 2024). Therefore, customer satisfaction is a key indicator for investment decisions, service enhancement strategies, and policy formulation. Improving satisfaction is essential to mitigate congestion, encourage sustainable mobility, and

enhance overall transport system quality (Mrad & Mraihi, 2023).

Scheduling represents a significant determinant of customer satisfaction in transportation systems. Scheduled departure and arrival times are communicated by service providers and are expected to align with actual service delivery (Teklay et al., 2023). However, transport services frequently experience delays due to unpredictable external and operational factors that must be addressed by transit authorities. The prediction and analysis of ferry delays remain a major challenge influencing passenger satisfaction (González et al., 2025). Ferry travel times often fluctuate due to environmental and operational conditions. Prior research has demonstrated that the provision of real-time information reduces perceived waiting time and enhances user satisfaction (Das & Budhkar, 2023). Similarly, García-Rodríguez et al. (2023) reported that online information systems improve accessibility and clarity of information for users. Accurate delay prediction is critical for passengers to plan their journeys effectively (Sarhani et al., 2025).

Transportation systems worldwide are undergoing significant technological transformation, including ferry services (Bodrožić & Adler, 2025). As customer expectations evolve, digital transformation has become imperative, leading ferry operators to adopt advanced ticketing solutions. Mobile ticketing and contactless payment systems provide convenience, enhance safety, and improve operational efficiency (Baharum et al., 2024). In recent years, speed and hygiene have also emerged as important determinants of passenger satisfaction (Avasthi et al., 2025). Digital ticketing has transitioned from being an optional convenience to a fundamental element of modern transport systems, offering contactless, secure, and efficient service access. Furthermore, online ticket sales are expanding in both passenger and freight transport sectors (Kaczerska et al., 2023).

Digital payment systems have experienced rapid development globally due to technological progress and evolving consumer preferences (Chaturvedi & Ranjan, 2025). These systems have contributed to financial inclusion, particularly in developing economies, by increasing access to banking services and supporting economic growth. Contactless payment technologies and mobile platforms have transformed transaction practices, with mobile wallets becoming increasingly prevalent (Bhuiyan et al., 2025). Digital payments are reshaping the transportation sector by improving convenience and operational efficiency. Nevertheless, disparities in digital access persist across social groups, which may limit the benefits of technological advancement (Wani et al., 2025). Addressing these challenges is necessary to maximise the advantages of digital payment systems in developing contexts (Purnawan et al., 2025). In public transportation, digital payment mechanisms have fundamentally transformed system operations, enabling authorities to deliver enhanced user experiences through advanced technological solutions (Mogaji & Nguyen, 2024).

The purpose of this study was to investigate the impact of e-ticketing, real-time tracking, and digital payment systems on passenger loyalty, with passenger satisfaction examined as a mediating variable.

LITERATURE REVIEW

Digital Service Innovation

Digital service innovation has been conceptualised as a form of organisational change driven by technological advancements, where users increasingly rely on digital and information technologies to influence multiple organisational functions (Vărzaru & Bocean, 2024). Prior research indicates that digital innovation focuses on restructuring business operations through digital and internet-based tools to improve customer reach and engagement. In addition, conducting transactions through digital platforms is considered cost-efficient because it reduces the need for manual intervention in operational processes (Jiao et al., 2025). Consequently, digital transaction systems contribute to time and cost savings for all stakeholders involved in service delivery and operational activities.

Passenger Satisfaction

Passenger satisfaction has been conceptualised as a multidimensional construct that reflects passengers' evaluations of service quality and the extent to which service expectations are fulfilled. In transportation research, satisfaction is influenced by several service attributes, including reliability, perceived value, information availability, safety and security, responsiveness, and tangible service elements (Velastegui-Hernández et al., 2024). Passenger satisfaction is shaped by a combination of tangible service quality characteristics and behavioural and psychological determinants. Traditional service quality frameworks, which emphasise dimensions such as safety, facility conditions, and accessibility, play a significant role in forming passengers' satisfaction perceptions (Mahpour et al., 2025). Passenger satisfaction determinants differ across transportation modes, such as rail, bus, and ferry systems, due to variations in operational and service characteristics. Ferry travel is often associated with heterogeneity in vessel standards, baggage handling procedures, exposure to outdoor waiting areas influenced by weather conditions, and docking operations, which collectively affect passenger experiences (krile & Maiorov, 2020). Prior studies indicate that both pre-boarding information and onboard facilities are critical factors in shaping passenger satisfaction within ferry transportation contexts.

Real-Time Tracking

Real-time tracking has been described as the continuous monitoring and updating of the status and geographical position of consignments, assets, personnel, and vehicles within

service systems (Husak et al., 2021). In ferry transportation, queuing is an inherent operational characteristic because vessels must depart and arrive at scheduled intervals, requiring trucks and private vehicles to wait until the next boarding opportunity (Yang, 2022). When service capacity is lower than passenger or vehicle demand, some users are transported while others are required to wait, which creates challenges in managing customer expectations and ensuring transparency regarding boarding times. Scholars have suggested that the perceived cost of travel is generally lower than the perceived cost of waiting, particularly when waiting times are uncertain or unexplained. Empirical evidence further indicates that uncertain waiting periods impose disproportionately high perceived costs on passengers. Providing real-time information has been shown to improve the perceived quality of the waiting experience by reducing ambiguity and increasing informational clarity (González et al., 2025).

Research conducted in bus and rail transport contexts demonstrates that accurate and reliable real-time information increases user retention and satisfaction by reducing perceived waiting time (Owusu-Agyemang et al., 2024). Real-time tracking contributes significantly to passenger satisfaction by facilitating travel planning, decreasing uncertainty, and enhancing transparency, which collectively improve travel experiences and perceived service quality (Henríquez-Jara et al., 2019). Studies on transit systems further reveal that real-time arrival information reduces stress and anxiety associated with waiting, leading to higher satisfaction levels among passengers (Brakewood & Watkins, 2019). Additionally, real-time data provision supports repeated service usage and strengthens trust, thereby fostering passenger loyalty. The positive association between real-time tracking and passenger satisfaction has been consistently reported across multiple empirical investigations (Souassi & Hnaka, 2025).

E-Ticketing

The concept of an e-ticket has been defined as a digital mechanism that records travel transactions electronically without issuing physical tickets (Cost, 2020). E-ticketing represents an advanced approach for managing and documenting travel purchases, where transaction details are stored in electronic databases rather than in traditional paper-based formats (Nzakizwanimana, 2021). In conventional airline ticketing, passengers often receive printed itinerary receipts, which may create ambiguity regarding the actual ticket, as the authoritative record is maintained digitally. Through e-ticketing platforms, users can search, reserve, pay for, and print travel-related documents online from any location worldwide. This system reduces administrative burdens associated with passenger accounting, usage monitoring, sales documentation, and manual paperwork (Nwafor, 2025). The transportation sector has undergone substantial transformation with the adoption of digital ticketing systems, as many passengers increasingly utilise contactless payment technologies, mobile applications, and smart cards instead of traditional paper tickets (Avasthi et al., 2025). These

technological advancements have enabled paperless and cashless travel, significantly enhancing user experience and convenience (Chourasia, 2024). From an operational perspective, digital ticketing assists transport operators in minimising human errors inherent in manual systems, reducing administrative expenditures, and improving fare collection processes (Luhur et al., 2021).

Beyond facilitating payment processes, e-ticketing systems contribute to service delivery through the integration of features such as intuitive user interfaces, data security mechanisms, and electronic reservation capabilities, all of which support improvements in transport system performance (Anwer et al., 2024). These systems enable the management of large passenger volumes, thereby enhancing regulatory compliance, usability, and efficiency within transportation networks (Scărișoreanu, 2020). Additionally, e-ticketing offers substantial convenience by allowing passengers to purchase tickets remotely from any geographical location (Wandile et al., 2024). Prior studies in bus and rail transport contexts indicate that the availability of e-ticketing significantly influences passenger retention and satisfaction by increasing perceived service reliability and reducing waiting times (Gamage, 2024). E-ticketing has been shown to positively affect customer satisfaction and loyalty by improving service quality, increasing convenience, and streamlining the ticket purchasing process (Pratama and Nusraningrum, 2025). Empirical evidence further suggests that system reliability, data security, and user-friendly interfaces are key determinants of positive user perceptions of e-ticketing systems (Sizan & Rahman, 2025). Enhanced satisfaction subsequently strengthens customer loyalty, encourages repeat usage, and fosters trust in digital travel platforms (Qteishat et al., 2014).

Digital Payments

Digital payments, also referred to as electronic payments, are defined as financial transactions in which funds are transferred from the payer to the payee through digital channels, such as card terminals, websites, and mobile applications, without the use of physical cash (Sahayaselvi, 2017). These platforms provide virtual accounts, digital wallets, and bank transfer services to accelerate transaction processes and reduce reliance on cash-based payments (Alam et al., 2021). Such objectives align with broader digitalisation initiatives aimed at improving service quality, transparency, and operational efficiency within public service and transportation systems (Kulkarni et al., 2021). Upon successful payment, electronic tickets are automatically generated through QR code systems and delivered via mobile applications or email platforms. These QR codes can be scanned at terminals, thereby enhancing the accuracy and speed of ticket validation processes (Han Jie & Nayef Abdulwahab Mohammed, 2023).

Contactless technology has emerged as a critical component of modern transportation systems due to its potential to enhance operational efficiency and user convenience

(Manimuthu et al., 2021). It addresses scalability challenges by supporting interoperability and seamless usage across regional transport networks. Contactless payment solutions are widely adopted in transit fare systems in major urban areas and are commonly integrated with identity cards, transport cards, and banking cards to ensure secure, rapid, and convenient transactions (Mogaji & Nguyen, 2024). Additionally, innovative contactless systems promote data security, user comfort, hygienic payment practices, and rapid transaction processing, making them more advantageous than traditional cash-based methods (Geni & Husein, 2025). The technological infrastructure underpinning contactless payment systems includes mobile wallets, radio frequency identification (RFID), and near field communication (NFC) technologies, such as Samsung Pay, Google Wallet, and Apple Pay (Rachapudi, 2022). NFC facilitates secure short-range data exchange between devices, while RFID supports fast, reliable, and automated payment processing and identification functions (Kartika & Asrofillah, 2025).

Digital payment systems enhance passenger satisfaction and contribute to customer loyalty by providing secure, fast, and convenient transactions and reducing friction during travel processes (Islam, 2024). Empirical studies report that passengers who use digital payment options experience higher satisfaction due to seamless service delivery and ease of use (Shiwakoti et al., 2022). Increased satisfaction fosters positive attitudes, strengthens trust, and enhances the likelihood of future usage, thereby reinforcing loyalty towards transportation services (Purnawan et al., 2025). Prior research also indicates that user-friendly and secure online payment systems significantly influence user satisfaction levels. Based on the above literature, the following hypotheses are developed.

H1: *Passenger satisfaction has positive effect on passenger loyalty.*
H2: *Digital payment has positive effect on passenger satisfaction.*
H3: *Real time tracking has positive effect on passenger satisfaction.*
H4: *E-ticketing has positive effect on passenger satisfaction.*
H5: Passenger satisfaction mediates between digital payment and passenger loyalty.
H6: Passenger satisfaction mediates between real time tracking and passenger loyalty.
H7: *Passenger satisfaction mediates between e-ticketing and passenger loyalty.*
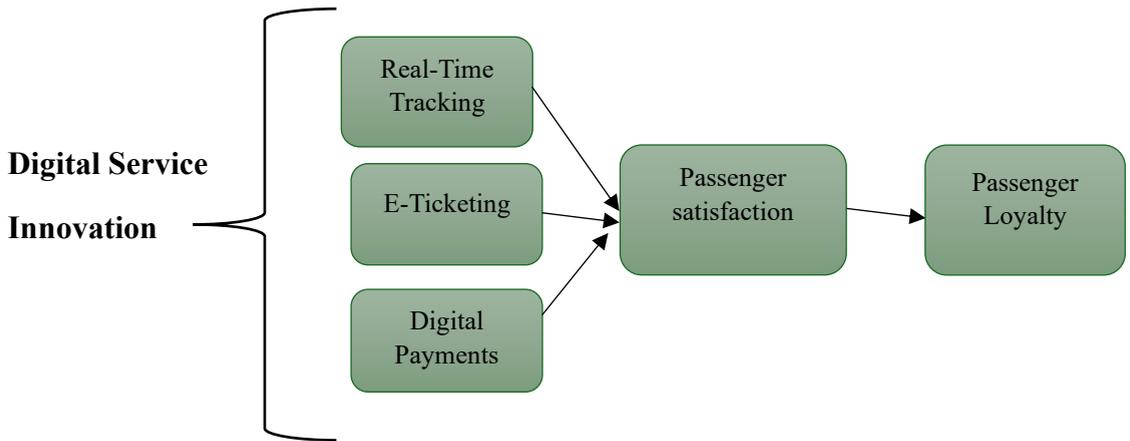
Figure 1: Framework

METHODOLOGY

To examine passenger satisfaction and loyalty in the Indonesian ferry context, this study adopted a quantitative research design. Data were collected using a structured questionnaire administered to ferry passengers. A six-point Likert scale was utilised to measure the study constructs, and measurement items were adapted from established studies. Specifically, the digital payment scale was adopted from Al-Qudah et al. (2024), the e-ticketing items were adapted from Islam (2023), the real-time tracking scale was sourced from (Gumasing et al., 2025), and the scales for passenger satisfaction and passenger loyalty were adapted from (Ha et al., 2019). The questionnaire was distributed to 300 ferry passengers using a simple random sampling technique. A total of 191 valid responses were obtained and included in the final analysis. Smart PLS 4 was employed to test the proposed hypotheses and conduct data analysis. This study utilised PLS-SEM for several reasons. First, PLS-SEM is appropriate for prediction-oriented research objectives. Second, it is suitable for models that include multiple constructs, numerous measurement items, and complex structural relationships. The conceptual model of this study includes independent variables, a mediating variable, and a dependent variable, which indicates a high level of model complexity. Finally, PLS-SEM is appropriate for studies with relatively large sample sizes, and the sample size in this research met this criterion.

RESULTS

The Smart PLS procedure was implemented following the two-stage approach proposed by (Ringle et al., 2015). The first stage focused on evaluating the measurement model, including the assessment of construct validity and reliability. The second stage involved testing the structural model to examine the proposed hypotheses. In the initial stage, the

factor loadings of the measurement items were analysed. Previous methodological guidelines suggest that item loadings should exceed the threshold value of 0.70 to justify item retention within the model (Hair Jr et al., 2017). As presented in Table 1, all measurement items demonstrated loadings equal to or greater than 0.70, indicating acceptable indicator reliability.

Table 1: Loading

	DP	ET	PL	PS	RTT
DP1	0.848				
DP2	0.873				
DP3	0.881				
ET1		0.870			
ET2		0.842			
ET3		0.854			
PL1			0.854		
PL2			0.826		
PL3			0.827		
PL4			0.720		
PS1				0.841	
PS2				0.843	
PS3				0.863	
PS4				0.867	
RTT1					0.773
RTT2					0.857
RTT3					0.815
RTT4					0.868
RTT5					0.863

Additionally, composite reliability (CR) and average variance extracted (AVE) were assessed to evaluate the validity and reliability of the study constructs. As shown in Table 2, all CR values exceed 0.70, and AVE values are above 0.50, satisfying the recommended threshold criteria. These results confirm that the measurement model demonstrates adequate reliability and convergent validity.

Table 2: CR and AVE

	rho_c	AVE
DP	0.902	0.753
ET	0.891	0.731
PL	0.882	0.653
PS	0.915	0.728
RTT	0.920	0.699

Discriminant validity in this study was assessed using the heterotrait–monotrait ratio of correlations (HTMT), which is recognised as a more robust and preferred method.

Methodological guidelines recommend that HTMT values should remain below 0.85 to establish discriminant validity (Yusoff et al., 2020). As presented in Table 3, all HTMT values fall below the 0.85 threshold, indicating that the constructs are empirically distinct. These findings confirm that discriminant validity has been satisfactorily achieved.

Table 3: Discriminant Validity

	DP	ET	PL	PS	RTT
DP					
ET	0.744				
PL	0.792	0.742			
PS	0.836	0.845	0.845		
RTT	0.710	0.704	0.657	0.774	

The study further assessed the coefficient of determination (R^2) to evaluate the extent to which the independent variables explain variations in the dependent constructs. R^2 provides an indication of the explanatory power of the predictor variables. As reported in Table 4, the proposed predictors account for 67.8% of the variance in passenger satisfaction (PS) and 53.1% of the variance in passenger loyalty (PL), demonstrating substantial explanatory capability of the model.

Table 4: R-Square

	R-Square
PL	0.531
PS	0.678

With the completion of the first stage of analysis, the second stage was carried out using the bootstrapping procedure with 5,000 subsamples. Hypothesis significance was evaluated based on the obtained t-values. Given that the proposed hypotheses are one-tailed, t-values exceeding 1.645 were considered statistically significant. The findings presented in Table 5 indicate that PS exerts a positive influence on PL, with a path coefficient (B) of 0.330 and a t-value of 6.023.

Table 5: Direct Findings

	B	SD	T	P Values
DP -> PS	0.330	0.055	6.023	0.000
ET -> PS	0.354	0.054	6.568	0.000
PS -> PL	0.728	0.032	22.736	0.000
RTT -> PS	0.270	0.059	4.545	0.000

E-ticketing (ET) also positively affects PS (B = 0.354, t = 6.568), while real-time tracking (RTT) demonstrates a significant positive effect on PS (B = 0.270, t = 4.545). Furthermore, PS shows a strong positive impact on passenger loyalty (PLS) with B = 0.728 and t = 22.736.

Mediating effects are reported in Table 6. The results confirm that PS mediates the relationships between digital payment (DP), ET, RTT, and PL, with t-values of 5.584, 6.624, and 4.438, respectively.

Table 6: Mediation Results

	B	SD	T	P Values
RTT -> PS -> PL	0.197	0.044	4.438	0.000
DP -> PS -> PL	0.241	0.043	5.584	0.000
ET -> PS -> PL	0.258	0.039	6.624	0.000

These findings indicate that all hypothesised relationships in the proposed model are supported.
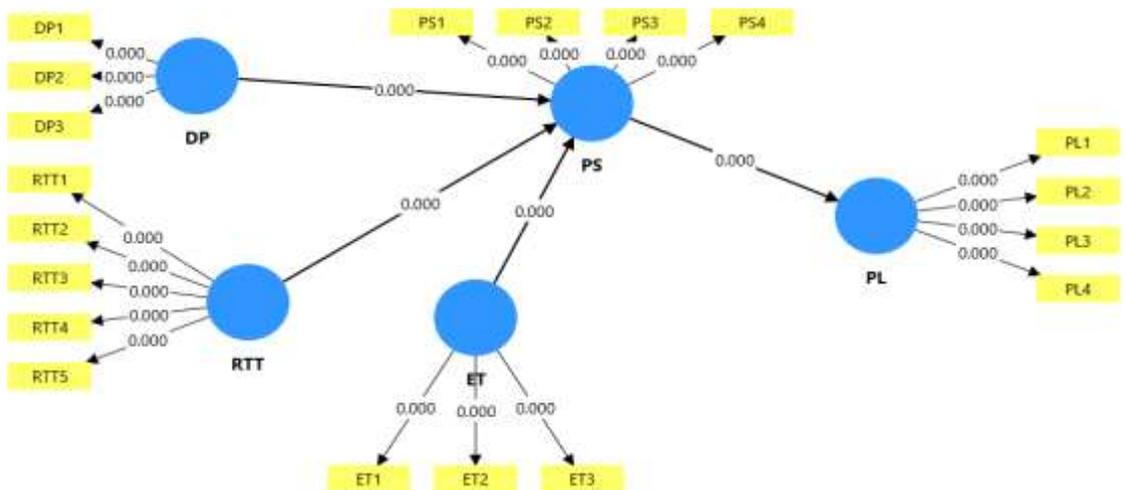

Figure 2: Structural Model

DISCUSSION AND CONCLUSION

Transportation systems are critical for the economic development of nations, and ferry services hold particular significance within the Indonesian context. This study investigated the impact of passenger satisfaction, e-ticketing, real-time tracking, and digital payment systems on passenger loyalty. The results indicate that passenger satisfaction exerts a positive effect on loyalty. When satisfaction is enhanced through reliability, safety, comfort, and overall service quality, passengers are more likely to remain committed to the service provider. Increased satisfaction fosters higher

perceived value, emotional attachment, and trust, which collectively strengthen loyalty. Satisfied passengers are also more inclined to reuse services, share positive word of mouth, and demonstrate repeated engagement, highlighting passenger satisfaction as a key determinant of sustained loyalty. Transport operators prioritising passenger satisfaction can therefore enhance service sustainability and secure long-term loyalty. These findings are consistent with the results reported by KRILE and MAIOROV (2020).

The analysis further reveals that e-ticketing positively influences passenger satisfaction, aligning with prior findings (Qteishat et al., 2014). These results underscore the significance of digital service innovation in transportation. The availability of e-tickets reduces physical contact, shortens waiting times, and simplifies the booking process, thereby improving passenger satisfaction. Efficient e-ticketing systems enhance accuracy, transparency, and convenience in transactions, while allowing passengers to manage reservations, avoid errors, and access travel information with ease. By improving convenience and speed, e-ticketing emerges as a crucial driver of satisfaction, and transport providers that implement reliable digital ticketing solutions are better positioned to strengthen passenger experiences. The findings also confirm a positive effect of digital payments on passenger satisfaction (Purnawan et al., 2025). Digital payment systems reshape how passengers interact with transport services, improving perceived operational efficiency, reducing transaction-related stress, and minimizing reliance on cash. The speed and flexibility offered by these systems allow passengers greater control over their journeys and contribute to a smoother travel experience, thereby enhancing satisfaction. In addition, digital payments provide greater security and transparency, building passenger confidence in the service provider. These results highlight the importance of technology-driven solutions for contemporary passengers, indicating that integrating digital payment mechanisms is essential for improving satisfaction.

Moreover, real-time tracking demonstrates a positive influence on passenger satisfaction, consistent with previous research (Souassi & Hnaka, 2025). A likely explanation is that uncertainty associated with travel is reduced. Access to real-time tracking enables ferry passengers to monitor delays, arrival times, and vessel locations, supporting more informed planning and decision-making. This access enhances passengers' perceptions of reliability and control, thereby increasing satisfaction. Additionally, timely updates provided through real-time tracking help manage expectations and reduce travel-related anxiety. In today's technology-oriented environment, real-time tracking serves as a value-added service that directly contributes to passenger satisfaction.

LIMITATIONS

This section outlines several limitations of the study and provides directions for future

research. The current framework was applied specifically to ferry services in Indonesia. It is recommended that the same model be tested in the context of other public transport modes, such as bus and train systems within Indonesia. From a geographical perspective, future studies could extend the framework to ferry services in other countries, for example, Malaysia, to examine the generalisability of the findings. The present model includes a single mediating variable, passenger satisfaction. Future research could consider incorporating moderating variables to explore conditional effects within the framework. Additionally, while passenger satisfaction was employed as a mediator in this study, transportation image could also serve as an alternative or complementary mediating construct in subsequent investigations to provide further insights into factors influencing passenger loyalty.

CONTRIBUTION

The present study offers both theoretical and managerial contributions. From a theoretical perspective, it emphasises the critical role of passenger satisfaction in fostering passenger loyalty. Additionally, it addresses a gap in the literature by examining the influence of real-time tracking on passenger satisfaction, an area that has received limited attention in prior research. The study also underscores the significance of digital payment systems in generating positive passenger experiences and emotional engagement. From a managerial standpoint, the findings provide actionable insights for ferry service operators in Indonesia. The results offer guidance for designing strategies aimed at enhancing passenger satisfaction and loyalty, thereby supporting the development of effective retention initiatives and improving overall service quality.

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