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Passenger Terminal Performance as Maritime Transportation Infrastructure in Supporting Port Area Development

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ABSTRACT

Passenger terminals are not only service facilities for maritime travelers but also transport nodes that shape accessibility, mobility, and the functional relationship between ports and their surrounding areas. This study evaluates passenger-terminal facility performance and translates service-improvement priorities into implications for port-area development. A mixed survey and field-evaluation design was applied at Tanjung Perak Surabaya, Tanjung Emas Semarang, Benoa Bali, and Lembar Lombok. Four hundred passengers (100 at each port) assessed 41 service attributes grouped into safety, security and order, reliability and regularity, comfort, convenience and accessibility, and equality. Customer Satisfaction Index (CSI), Importance-Performance Analysis (IPA), and Quality Function Deployment (QFD) were integrated to identify overall satisfaction and priority interventions. The overall mean CSI across the four terminals was 84.8%, indicating very high satisfaction, with port-level averages of 85.8% at Tanjung Perak, 81.8% at Tanjung Emas, 84.7% at Benoa, and 86.8% at Lembar. Despite these high scores, IPA and QFD revealed localized deficiencies in emergency and health facilities, security, flood handling, waiting-room comfort, toilets, thermal control, boarding and debarkation access, schedule information, public transport connections, terminal layout, and inclusive facilities. The novelty of this article is the translation of user-based terminal performance priorities into an urban-planning interpretation for the port-city interface. Port-area development is therefore treated as a planning implication rather than a directly measured dependent variable. The results suggest that terminal investment should combine internal service quality with multimodal access, inclusive public space, climate resilience, and adaptive information systems.

Keywords: passenger terminal, maritime transportation, port area development, Customer Satisfaction Index, importance-performance analysis, quality function deployment, urban planning.

INTRODUCTION

Passenger terminals are strategic components of maritime transportation because they organize the transition between sea and land modes, concentrate passenger flows, and provide the public-facing interface of a port. In port cities and coastal regions, the quality of terminal infrastructure can therefore influence more than the immediate travel experience. Passenger ports can become starting points for urban development, tourism activity, and infrastructure upgrading [1], while Indonesian evidence also shows that port development can mediate wider coastal-area development processes [2]. From a transport-geography perspective, terminals are nodes where flows, networks, land use, and accessibility are spatially connected [3]. Recent port-city studies accordingly argue that passenger and freight flows should be incorporated into transport and spatial planning rather than treated as isolated port operations [4]. Sustainable urban mobility planning in port areas further emphasizes coordination between port access, local mobility, environmental objectives, and urban development [5], while collaborative port-city planning requires institutional coordination between port authorities, local governments, users, and other stakeholders [6].

The operational quality of a passenger terminal remains the foundation of this broader role. Port-service studies consistently show that service quality and user satisfaction are important indicators

of port competitiveness and management performance. Le et al. found a direct relationship between logistics service quality and customer satisfaction in a developing-country port context [7]. Mwendapole and Jin reported that reliability and responsiveness were especially important in explaining seaport-user satisfaction [8]. Nguyen et al. demonstrated the usefulness of Importance-Performance Analysis (IPA) for allocating limited improvement resources to service attributes that users consider important [9]. In Indonesia, Wicaksono and Djakfar combined Customer Satisfaction Index (CSI), IPA, and Quality Function Deployment (QFD) to evaluate container-terminal services and translate customer requirements into technical actions [10]. Digital adoption and service quality have also been linked to strategic collaboration and business sustainability at Indonesian port terminals [11]. For passenger facilities specifically, studies at Ulee Lheue and Tengkayu I show that safety, security, reliability, comfort, convenience, equality, schedule information, emergency facilities, and health services are recurring determinants of perceived terminal performance [12], [13].

Urban and regional planning literature provides a complementary perspective. Port-city sustainability is shaped by interactions between economic activity, infrastructure, land use, environmental quality, and governance [14]. Access bottlenecks can weaken the port-city relationship and create congestion and environmental externalities [15]. The port-city interface itself has long been recognized as a spatial and institutional zone in which port and urban interests overlap [16]-[18]. More recent planning work shows that physical and institutional boundaries between port and city can be actively reshaped through planning and stakeholder engagement [19]. Likewise, port-hinterland accessibility is related to urban economic strength, but infrastructure expansion needs to be coordinated with environmental and spatial objectives [20]. These studies imply that a passenger terminal should not be evaluated only as an internal service building; its performance also matters for circulation, accessibility, safety, public-space quality, resilience, and the overall usability of the port area.

However, two analytical streams are still often separated. Service-quality research usually measures user satisfaction and identifies operational priorities, whereas port-city and urban-planning research focuses on accessibility, spatial development, governance, and sustainability. There is limited empirical work that translates passenger-terminal service priorities directly into planning implications for port-area development, particularly across several Indonesian ports with different roles and contexts. This creates a practical gap for decision makers: a terminal may obtain a high aggregate satisfaction score while still containing specific weaknesses that constrain safe circulation, inclusive access, public-transport integration, or resilience at the port-city interface.

This article addresses that gap by integrating CSI, IPA, and QFD to evaluate passenger-terminal performance at four Indonesian public ports and then interpreting the resulting priorities from a transport and urban-planning perspective. The study has three objectives: (1) to compare passenger satisfaction across six service dimensions; (2) to identify port-specific priority improvements using IPA and QFD; and (3) to synthesize those priorities into planning implications for port-area development. The research position is deliberately cautious: the study does not statistically estimate land-use change, property values, employment growth, or other direct measures of area development. Instead, it examines how terminal performance can support area development through the functional quality of a transport node, its accessibility, safety, inclusivity, resilience, and interface with surrounding urban systems. This framing allows the service-performance evidence to be used for infrastructure and spatial planning without making causal claims that are not supported by the data.

RESEARCH METHODS

Research design and study area

The study used a mixed field-evaluation design combining passenger surveys, direct observation, interviews, documentation, and focus-group discussions. The empirical survey was conducted from January to September 2024 at four public passenger terminals: Tanjung Perak Surabaya, Tanjung Emas Semarang, Benoa Bali, and Lembar Lombok. These ports represent different maritime and urban contexts, from a major metropolitan gateway and inter-island hub to tourism-oriented and regional passenger gateways. The selection is consistent with the parent research design, which

sought to compare terminal-facility performance across different categories of Indonesian public ports.

Table 1. Study locations, 2023 passenger population, and survey sample

Port	Functional context	2023 passengers	Sample
Tanjung Perak, Surabaya	Major passenger gateway serving East Java and eastern Indonesia	373,136	100
Tanjung Emas, Semarang	Urban maritime gateway serving Central Java	208,321	100
Benoa, Bali	Passenger/cruise gateway with strong tourism function	77,523	100
Lembar, Lombok	Regional gateway connecting Lombok and Bali	224,980	100
Total	-	883,960	400

The 2023 passenger volumes were used as the population reference. The parent study applied non-probability passenger sampling and used the Slovin formula with a 10% error tolerance as a practical basis for sample sizing. The resulting values were rounded to 100 respondents per terminal, giving 400 respondents in total. Accordingly, the sample should be interpreted as a comparative terminal-user survey rather than a probability sample intended for precise national population inference.

Service dimensions and instrument

The assessment framework followed Indonesian passenger-service standards, particularly the Minister of Transportation Regulation PM 37/2015 on sea-transport passenger service standards and PM 39/2015 on ferry passenger service standards [21], [22]. The survey instrument contained 41 attributes grouped into six dimensions. Each attribute was assessed on a five-point Likert scale for passenger satisfaction/performance, while importance scores were used for CSI weighting and IPA positioning. Field checklists were used to verify the presence and condition of facilities.

Table 2. Passenger-terminal performance dimensions and planning relevance

Dimension	No. of attributes	Representative attributes	Planning relevance
Safety	9	Fire protection, evacuation, emergency contact, health staff, first aid, wheelchair, stretcher, tidal-flood handling	Risk reduction and climate resilience
Security and order	8	CCTV, barriers, officers, complaint information, metal detector, parking, baggage control	Safe public realm and controlled circulation
Reliability / regularity	3	Punctuality, ticket service, departure/arrival information	Network reliability and travel certainty
Comfort	9	Waiting room, toilet, prayer room, lighting, thermal control, organized passenger lanes, health room	Quality of terminal public space
Convenience/ accessibility	9	Passenger information, disruption information, onward transport,	Multimodal access and wayfinding

Dimension	No. of attributes	Representative attributes	Planning relevance
		complaint desk, trolley/porter, public transport, layout, Wi-Fi	
Equality	3	Facilities for disabled passengers, nursing room, ticket affordability	Inclusive and equitable access

Instrument validity was evaluated by comparing item correlations with r-table = 0.1966 for n = 100 at the 5% significance level. All reported Pearson correlations exceeded the threshold and had significance values below 0.05. Reliability was evaluated using Cronbach's alpha. Across the four ports, alpha coefficients for the six dimensions ranged from 0.62 to 0.95, all above the 0.60 criterion adopted in the parent study. This supports the internal consistency of the instrument for comparative service evaluation.

CSI, IPA, and QFD analysis

CSI was used to summarize the level of passenger satisfaction by weighting perceived performance with the relative importance of each attribute. The calculation followed the conventional sequence of mean importance score (MIS), mean satisfaction/performance score (MSS), weighting factor (WF), weighted score (WS), and the final index. With a five-point scale, the calculation can be expressed as:

$$MIS_i = \frac{\sum Y_{ij}}{n}$$

$$MSS_i = \frac{\sum X_{ij}}{n}$$

$$WF_i = \frac{MIS_i}{\sum MIS_i}$$

$$WS_i = MSS_i \times WF_i$$

$$CSI = \frac{\sum WS_i}{5} \times 100\%$$

The CSI interpretation used five categories:

- CSI < 35% = dissatisfied;
- 35% ≤ CSI < 51% = less satisfied;
- 51% ≤ CSI < 66% = moderately satisfied;
- 66% ≤ CSI < 81% = satisfied; and
- 81% ≤ CSI ≤ 100% = very satisfied.

IPA compared perceived performance and importance for each attribute and positioned the attributes in a Cartesian matrix. The quadrant requiring primary managerial attention contains attributes with high importance but relatively lower performance. QFD was then used to translate identified passenger needs into improvement requirements and to rank improvement priorities. The use of CSI, IPA, and QFD in combination is consistent with previous port-service research that first measures overall satisfaction, then isolates priority gaps, and finally converts those gaps into actionable service or infrastructure responses [9], [10], [13].

Planning interpretation for port-area development

A final interpretive step was added for this article. The priority attributes obtained from IPA and QFD were grouped into four planning dimensions: (1) safety and climate resilience; (2) comfort, inclusivity, and terminal public space; (3) multimodal accessibility, circulation, and wayfinding; and

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(4) information, digital support, and adaptive management. These dimensions were compared with recent port-city and urban-mobility literature [2], [4]-[6], [14]-[20]. This step does not create a new statistical variable for 'port-area development'. Instead, it provides a transparent planning interpretation of how facility priorities can strengthen the terminal as a transport node and as part of the port-city interface.

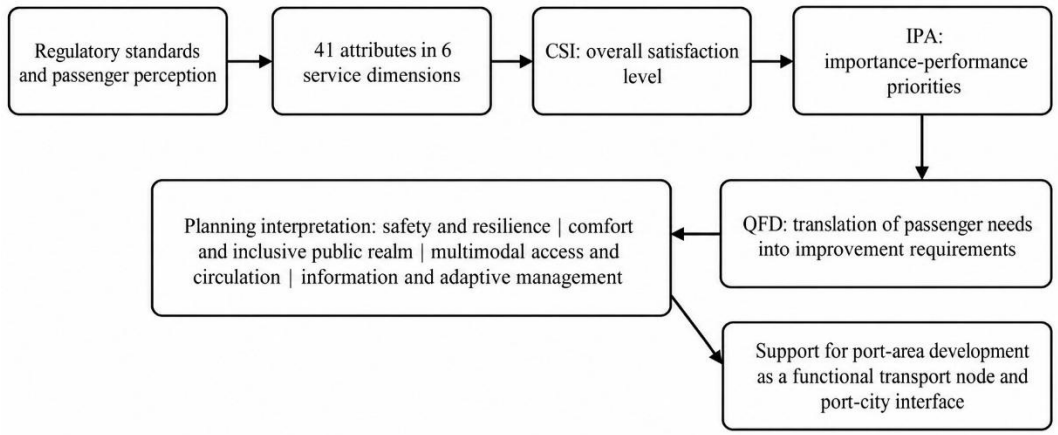


Figure 1. Analytical framework linking passenger-terminal performance to port-area development implications

RESULT AND DISCUSSION

Passenger satisfaction and cross-port performance

The CSI results show a generally high level of satisfaction at all four passenger terminals. The average of the six service dimensions was 85.8% at Tanjung Perak, 81.8% at Tanjung Emas, 84.7% at Benoa, and 86.8% at Lembar. Across all 24 port-dimension combinations, the mean was 84.8%, which falls within the 'very satisfied' category. These results indicate that most facilities already provide a positive passenger experience, but the differences among dimensions are important because aggregate satisfaction can conceal localized weaknesses.

Table 3. Customer Satisfaction Index by service dimension and port

Service dimension	Tanjung Perak (%)	Tanjung Emas (%)	Benoa (%)	Lembar (%)
Safety	85	81	83	86
Security and order	87	80	85	87
Reliability / regularity	85	83	86	88
Comfort	86	82	85	87
Convenience / accessibility	86	82	84	86
Equality	86	83	85	87
Port mean	85.8	81.8	84.7	86.8

Tanjung Perak had consistently high values between 85% and 87%, with security and order as the highest dimension. Tanjung Emas recorded the lowest port average; its security and order dimension reached 80%, which is categorized as 'satisfied' rather than 'very satisfied'. Benoa showed a relatively balanced profile, while Lembar recorded the highest values, including 88% for reliability and regularity. The pattern is consistent with prior evidence that service quality is multidimensional and that reliability, responsiveness, safety, and physical facilities may influence satisfaction differently

[7]-[9]. The finding also supports Indonesian passenger-terminal studies in which facilities may be broadly acceptable even though specific safety, information, or comfort attributes remain below expected standards [12], [13].

A practical implication is that CSI should not be used as a stand-alone investment rule. A high average score can produce a false sense that improvement is unnecessary. Passenger terminals are complex public facilities: an emergency stretcher, a flooded access route, an unavailable wheelchair, poor lighting, or unclear onward-transport information may affect a small part of the passenger journey but still represent a critical service failure. IPA and QFD are therefore essential complements because they reveal which attributes deserve priority even when aggregate satisfaction is high.

Priority gaps from IPA and QFD

The combined IPA-QFD results reveal different local improvement profiles. Tanjung Perak requires attention to a mix of operational, comfort, and information issues; Tanjung Emas has a more concentrated set of security and access priorities; Benoa combines health, flood, accessibility, and passenger-comfort needs; and Lembar requires stronger health, resilience, public-transport, wayfinding, and information facilities. Table 4 summarizes the priorities used in the planning synthesis.

Table 4. Main IPA and QFD improvement priorities by passenger terminal

Port	Main IPA priorities	Main QFD priority clusters
Tanjung Perak	Security/health personnel, stretcher, ship-schedule information, prayer-room condition, lighting, thermal control, complaint desk, ticket price	Evacuation and emergency information; flood pump; CCTV/security and metal detector; baggage control; punctuality/ticketing; waiting room, toilet and health room; disruption information; public transport; terminal layout
Tanjung Emas	CCTV and parking condition	Covered embarkation/debarkation access and passenger movement to/from the ship
Benoa	Health staff, wheelchair, tidal-flood handling, baggage control, punctuality, toilet condition	Evacuation/emergency facilities; security equipment; waiting room/toilet; thermal comfort; passenger amenities; disruption and onward-transport information; trolley/porter; disability facilities; ticket affordability
Lembar	Health staff, first aid, wheelchair, tidal-flood handling and pump, punctuality/ticketing, health room, complaint desk, public transport, terminal layout, Wi-Fi	Evacuation/emergency facilities; security equipment; baggage control; waiting room/toilet; thermal comfort and amenities; disruption/onward information; porter; disability facilities; ticket affordability

Several patterns cut across the four terminals. First, safety and health facilities repeatedly appear as priorities. Stretcher availability, health staff, first-aid equipment, wheelchairs, emergency information, evacuation guidance, and flood-response facilities are not merely service amenities; they determine whether the terminal can function safely during disruptions. This is especially important in coastal areas where tidal flooding and extreme-weather exposure may affect access and operations. Second, comfort attributes such as waiting rooms, toilets, lighting, ventilation or air conditioning, prayer facilities, and organized passenger lanes remain important even when their CSI values are high. Passenger ports serve as public spaces where users may spend substantial waiting

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time, so the quality of the internal environment is part of the infrastructure function, not an optional hospitality feature.

Third, information and movement are central. Ship punctuality, departure and arrival information, travel-disruption information, terminal layout, public-transport connections, parking, and covered embarkation/debarkation access affect the continuity of the passenger journey. This matches the planning argument that a port terminal must be integrated with the urban transport system and that transport planning should coordinate port and city mobility [4], [5]. Road and access bottlenecks can weaken port-city performance even when port operations themselves are technically efficient [15]. For passenger terminals, the equivalent issue is the continuity of movement from urban access modes through ticketing, security, waiting, boarding, debarkation, baggage handling, and onward transport.

Implications for maritime transportation and port-area development

The results support a broader interpretation of passenger-terminal performance as infrastructure for port-area development. This relationship should be understood functionally rather than as a direct causal estimate of urban growth. A well-performing terminal increases the usability of the port as a transport node, improves the quality of passenger movement, reduces friction at the land-sea interface, and can strengthen the attractiveness of the surrounding area for tourism, commerce, and public activity. Krile et al. similarly describe passenger ports as catalysts for urban infrastructure and regional attractiveness [1], while Syafiq et al. identify port development as an important element in coastal-area development in Indonesia [2].

From an urban-planning perspective, the port-city interface is shaped by spatial, institutional, and mobility relationships [16]-[19]. Therefore, improvement decisions should not stop at the terminal wall. For example, a complaint about public-transport availability is simultaneously a terminal-service issue and an urban-mobility issue. Poor parking configuration or unclear terminal layout may generate circulation conflicts at the port boundary. A lack of accessible facilities can exclude users and weaken the public character of the infrastructure. Flood handling and drainage influence operational continuity and the resilience of the surrounding port district. Schedule information and digital feedback affect how passengers plan their arrival, waiting, and onward movement. These relationships are summarized in Table 5.

Table 5. Translation of terminal-performance priorities into port-area planning implications

Planning dimension	Evidence from terminal priorities	Implication for port-area development
Safety and climate resilience	Health staff, first aid, stretcher, evacuation, emergency contact, tidal-flood handling, pumps, lighting	Design resilient access and emergency systems; maintain continuity of terminal and surrounding-area operations during hazards
Comfort and inclusive public realm	Waiting rooms, toilets, thermal control, prayer facilities, nursing rooms, disability facilities, seating	Treat terminal interiors and forecourts as inclusive public spaces that support long dwell times and diverse users
Multimodal accessibility and circulation	Parking, public transport, terminal layout, boarding/deboarding access, baggage flow, passenger lanes	Integrate port access with urban transport, separate conflicting flows, improve pedestrian continuity and last-mile connections
Information and adaptive management	Schedule information, disruption information, complaint service, Wi-Fi and user feedback	Provide real-time information and continuous performance

Planning dimension	Evidence from terminal priorities	Implication for port-area development
		monitoring to support adaptive operations and planning
Local activity and gateway function	Ticket affordability, food/retail amenities, tourism-oriented passenger flows	Strengthen the terminal as an accessible gateway that can support surrounding commercial and tourism activity without compromising transport function

The planning synthesis is consistent with sustainable port-city research. Zheng et al. emphasize that port-city sustainability requires coordination across economic, environmental, and social dimensions [14]. Maslaric et al. show that mobility planning in port areas can convert sustainability objectives into operational transport measures [5]. Ettorre et al. argue for co-planning approaches that combine spatial information and stakeholder collaboration [6]. Russo and Musolino further note that passenger and freight flows can be incorporated into transport-system models for port-city planning [4]. The current results add a service-performance layer to that literature: passenger perception can identify where the infrastructure interface is weakest and can help sequence investments before large spatial projects are undertaken.

The distinction between high satisfaction and persistent priority gaps is especially relevant for planning. Lembar, for example, had the highest mean CSI, yet IPA still identified public transport, terminal layout, health facilities, flood response, and Wi-Fi as priorities. This demonstrates that satisfaction is relative to current experience, while planning must also consider importance, risk, inclusivity, and future demand. Conversely, Tanjung Emas had a lower average CSI and a specific security concern, indicating a need for targeted investment rather than broad reconstruction. The CSI-IPA-QFD combination therefore supports differentiated planning: some terminals require system-wide upgrades, while others require precise interventions at critical interfaces.

Management and monitoring implications

For port managers, the findings suggest a cyclical performance-management approach. CSI can be used as a periodic dashboard of passenger satisfaction, IPA can identify which attributes have become urgent, and QFD can translate those priorities into technical or managerial actions. The parent research also developed a web-based evaluation concept for real-time data collection. In the context of this article, such digital monitoring is relevant because port-area planning benefits from continuous evidence rather than one-time surveys. This is compatible with evidence from Indonesian ports showing that digital adoption and service quality can strengthen strategic collaboration and business sustainability [11].

For local governments and spatial planners, the main implication is the need to connect terminal evaluation with mobility and area-development programs. A terminal improvement plan should be reviewed alongside access roads, public-transport routes, pedestrian paths, flood-control systems, tourism nodes, commercial activities, and land-use plans. Port and city agencies often have different mandates, which can create fragmented decisions at the interface [16], [17]. A shared set of performance indicators can provide a practical basis for coordination because it turns passenger experience into specific, observable infrastructure priorities.

CONCLUSION

This study evaluated passenger-terminal performance at four Indonesian public ports and translated the resulting service priorities into implications for maritime transportation and port-area development. The combined mean CSI was 84.8%, indicating a very high overall level of passenger satisfaction. Port-level means were 85.8% at Tanjung Perak Surabaya, 81.8% at Tanjung Emas Semarang, 84.7% at Benoa Bali, and 86.8% at Lembar Lombok. Nevertheless, aggregate satisfaction

did not eliminate the need for targeted improvements. IPA and QFD identified recurring priorities involving health and emergency facilities, security equipment, tidal-flood handling, waiting-room and toilet conditions, thermal comfort, boarding and debarkation access, schedule and disruption information, public-transport connections, terminal layout, disability facilities, and passenger-support services. The main contribution of the article is a planning interpretation of these service priorities. Passenger-terminal performance is positioned as a component of the port-city interface: safety and resilience support operational continuity; comfort and inclusive facilities improve the quality of terminal public space; multimodal access and circulation connect maritime travel with the urban transport system; and information systems support adaptive management. In this sense, terminal improvement can support port-area development by strengthening the functionality and accessibility of the transport node rather than by directly causing spatial or economic growth. The CSI-IPA-QFD sequence is useful because it combines an aggregate satisfaction indicator with attribute-level prioritization and a mechanism for translating passenger needs into actions. The study has limitations. The survey was cross-sectional, used non-probability passenger sampling, and did not directly measure land-use change, accessibility indices outside the terminal, local economic impacts, environmental externalities, or property-market effects. Consequently, claims about port-area development are interpretive and planning-oriented. Future research should integrate terminal-service indicators with GIS-based accessibility, public-transport connectivity, pedestrian-network quality, land-use change, flood-risk mapping, and longitudinal economic indicators. Before-and-after evaluation of terminal upgrades would also help determine whether improvements in service performance generate measurable benefits for the surrounding port district. For practice, port authorities and local governments should institutionalize periodic CSI-IPA-QFD monitoring and use the results as a shared evidence base for coordinated transport, infrastructure, and spatial-planning decisions.

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