



Research Article

**The impact of competing port management paradigms on consumer satisfaction:
The case of truck drivers**

Mukhlis^{1,2,*}, Renni Anggraini³, Muttaqin³ and Muhammad Isya³

¹*Department of Civil Engineering, Faculty of Engineering, Universitas Malikussaleh, Lhokseumawe 24355, Indonesia*

²*Doctoral Student, Postgraduate Program, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia*

³*Department of Civil Engineering, Faculty of Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia*

**Corresponding author's e-mail address: mukhlis@unimal.ac.id*

Article information	Abstract
Received: January 29, 2026 Revision: May 8, 2026 Accepted: May 15, 2026	This study aims to examine the influence of competing port management paradigms- customer-oriented, stakeholder-oriented, and technology-oriented paradigms- on customer satisfaction. Operational outcomes, corporate image, and perceived port digitalization represent these paradigms. The empirical focus of this study is on truck drivers, the direct users of landside port services, at two major ports in Aceh Province. Based on a partial least squares-structural equation modeling (PLS-SEM) analysis of 150 respondents, two principal results can be formulated. First, operational outcomes have been proven to be the most significant determinant of customer satisfaction. Second, image (corporate responsibility) and perceived port digitalization (technology-driven port management) did not show a significant direct effect on customer satisfaction. Furthermore, these two variables actually had a significant negative effect on operational outcomes, which in turn had an indirect negative impact on customer satisfaction. The study highlights a contextual misalignment between techno-social and stakeholder- oriented port management strategies and the practical expectations of downstream logistics users.
Keywords Aceh; Corporate responsibility; Customer satisfaction; Digitalization; Operational efficiency; Port management paradigms; Truck drivers	

1. Introduction

The development of cargo ports globally demonstrates increasing competition, placing service quality as a key factor in competitiveness (Roh et al., 2025). Although the transformation towards smart ports and e-transformation has been shown to improve customer satisfaction and loyalty, its success is highly dependent on consistent core service quality and comprehensive customer orientation (Zhou & Suh, 2025). Therefore, various approaches, such as benchmarking, Quality Function Deployment, and the Kano model, have been developed to identify service gaps and prioritize quality-improvement investments, thereby enhancing customer satisfaction and strengthening port competitiveness in the global market (Gonzalez & Quesada, 2024).

At the conceptual level, a significant paradigm shift has occurred in port management, moving from traditional approaches to a more complex and multi-layered framework. The initial paradigm, rooted in the service quality (SERVQUAL) perspective, positioned customer satisfaction as a direct result of service efficiency, speed, reliability, and low cost through direct interaction between service providers and users without the mediation of technology or other actors (Campomori & Casula, 2022; Ingsih et al., 2024). As stakeholder theory evolved, the focus of port management expanded from consumers alone to a range of other actors, such as local communities, governments, workers, and

the environment, giving rise to the stakeholder paradigm, which emphasizes social and environmental responsibility as a source of value creation (Satta et al., 2025). However, this paradigm remains one-way and may burden service provider organizations (Reed et al., 2024).

More recently, the techno-social paradigm has emerged to address these limitations by emphasizing the inseparability of human actors, digital resources, and interaction patterns in shaping organizational outcomes. Under this paradigm, organizational performance is understood as the result of (1) individual and group capabilities and motivations, (2) digital infrastructures that enable transformation, and (3) the collective interaction between human and technological components (Iden & Bygstad, 2025). Unlike stakeholder-oriented or technology-centric approaches, the techno-social paradigm conceptualizes technology not merely as a supporting tool but as an integral element embedded within social practices and decision-making processes (Herterich et al., 2023). This distinction implies that contemporary studies of port customer satisfaction can no longer rely solely on efficiency- or responsibility-based paradigms but must also account for customer service quality, stakeholder responsibility, and technology-mediated interactions.

Empirical studies increasingly support this integrative perspective. Research conducted in Vietnam and other developing countries demonstrates that SERVQUAL-derived dimensions, such as reliability, responsiveness, assurance, empathy, and tangibles, including technology adoption and terminal physical conditions, remain significant predictors of container port satisfaction (Dewa, 2023; Nguyen et al., 2022). Furthermore, structural factors such as intermodal network accessibility, service route diversity, and nonlinear port-selection attributes have been shown to influence user satisfaction in the Kano model and in configurative approaches (Roh et al., 2025). Thus, the development of modern logistics systems demonstrates that user satisfaction is increasingly shaped by service digitalization, interaction personalization, service accessibility, intermodal integration, and human resource knowledge and competency, which have been shown to improve efficiency, transparency, flexibility, and the quality of the user experience (Siregar et al., 2022; Veloso & Sousa, 2022).

In the Indonesian context, prior studies have shown that port user satisfaction in Aceh is strongly associated with service optimization, infrastructure quality, and human resource performance, with Malahayati Port serving as the region's primary container hub (Taharuddin et al., 2025). However, operational evaluations indicate that, despite relatively high user satisfaction, service performance still exhibits low to moderate variation across several Aceh ports (Nurazizah et al., 2023). This is reinforced by the finding that the lean service approach places customer value and satisfaction at the heart of efforts to increase container port productivity (Amri et al., 2024).

Based on the above description, this study proposes a model that examines the influence of service quality variables as determinants of user satisfaction in freight port transportation, by integrating the traditional customer paradigm, stakeholder paradigm, and techno-social paradigm. Operational variables- operational efficiency, corporate responsibility, and technology-driven port management- are positioned as determinants of port customer satisfaction. This study aims to contribute theoretically by advancing integrated models of port service quality and, practically, by offering strategic insights for port managers seeking to enhance service quality and user satisfaction in a sustainable and context-sensitive manner.

2. Literature review

Container port service quality may be defined as the overall quality of port facilities and the port's ability to offer differentiated services compared to its competitors (Baştuğ et al., 2022). It is a measure of how well a service meets customer needs, as seen from the comparison between customer expectations and the actual service received (Veloso & Sousa, 2022). Service quality occurs through a process and represents an intensive performance presentation (Kuzu, 2024).

This study uses three independent variables to represent the three currently evolving port management paradigms: consumer-oriented, stakeholder-based, and technology-oriented. The

consumer-oriented variable is operational outcomes, the stakeholder paradigm is image (from corporate social responsibility), and the technology paradigm is digitalization.

Operational outcomes reflect the final quality of the service provided. Uniform and standardized services, guaranteed cargo safety, accurate shipping documents, and a diversity of service types are also indicators in this dimension. A grounded theory study by Fahri (2022) identified aspects of public satisfaction relevant to service operational outcomes (outputs). Because output is part of reliability and assurance, it also significantly influences satisfaction with the use of sea logistics routes.

Hypothesis 1 = External factors have a positive and significant effect on customer satisfaction.

Beyond operational aspects, a port's image and reputation are also crucial for service quality. This image is shaped by social responsibility, which focuses on how the port operates safely and is environmentally friendly. Furthermore, fulfilling social responsibility towards the surrounding community is an important indicator in assessing the sustainability of port services. Research (Vasheghani & Abtahi, 2023) on multimodal strategic planning highlights the importance of port reputation in driving satisfaction with maritime logistics routes.

Hypothesis 2 = Image factors have a positive and significant influence on customer satisfaction.

Digitalization is an effort to eliminate the inconvenience caused by manual processes. (Lin et al., 2025). When digitalization is implemented in services, consumers perceive that this inconvenience is reduced, or even eliminated, thus encouraging them to consume (Chen & Huang, 2025). Based on this, digitalization can increase consumer satisfaction. (Brunner et al., 2025). This type of digitalization represents a key characteristic of future ports and is a central objective of technological development in the transportation sector (Pagano et al., 2022). Digital technologies will increase port efficiency in various ways, such as reducing idle time, enhancing security, ensuring efficient cargo handling, creating accurate port schedules and plans, and reducing the number of operations required to move containers (Kine et al., 2022). A study by Siregar et al. (2022) on the electronic system showed the effect of perceived digitalization on satisfaction in sea logistics routes. Therefore, perceived port digitalization has a significant impact on satisfaction with sea logistics.

Hypothesis 3 = The perceived port digitalization has a positive and significant effect on customer satisfaction.

Furthermore, because operational outcomes in port management are part of performance, performance is also influenced by image and perceived variables related to port digitalization. Image and digitalization variables, in turn, indirectly influence operational outcomes, increasing satisfaction with sea logistics. Therefore, the following hypothesis is proposed:

Hypothesis 4 = Image has a positive and significant influence on operational outcomes.

Hypothesis 5 = Perceived port digitalization has a positive and significant effect on operational outcomes.

Hypothesis 6 = Image has a positive and significant influence on customer satisfaction indirectly through operational outcomes.

Hypothesis 7 = Perceived port digitalization has a positive and significant effect on customer satisfaction, indirectly through operational outcomes.

3. Methodology

The image variable and the perceived port digitalization variable are measured using a scale developed from the literature (Pagano et al., 2022). The image indicators from corporate social responsibility (CSR) are denoted CSR1-CSR7, indicating that seven items are used to measure image. There are four perceived port digitalization (DG) indicators, covering DG1-DG4. The operational outcomes (OC) variable comprises six indicators, OC1-OC6. These indicators were developed from questionnaires created by Vrhovac et al. (2024) and Lopes et al. (2025). Finally, the customer satisfaction (CS) indicator comprises five items, labeled CS1-CS5. The indicators for this variable

are adapted from Alsalfitti and Notteboom (2025). All indicators are measured on a five-point Likert scale, where 1 indicates Strongly Disagree, and 5 indicates Strongly Agree. All constructs in this study are measured using consistent reflective indicators, and no distinction is made in measurement between direct and indirect effects. The differences among hypotheses lie solely in the structural relationships tested.

Two ports were used as research locations in this study: Malahayati (75 respondents) and Lhokseumawe (75 respondents). Both ports are the largest in Aceh province, Indonesia. The statistical parameters for both ports are shown in **Table 1**. Pelindo Multi Terminal, a state-owned port company, manages both ports. Pelindo Multi Terminal manages 36 ports in Indonesia, some of which are under subsidiaries such as Indonesia Kendaraan Terminal and Tanjung Priok Port. **Figure 1** shows the location of this study, along with the locations of other Pelindo ports on Sumatra Island.

Table 1 Location description.

	Malahayati	Lhokseumawe
Size	Pier: 380 m Depth: -9 to -16 m	Pier: 761 m Depth: -9 to -13 m
Location	5.598°N, 95.523°E	5.167°N, 97.150°E
Ship visits	379 units (1,681,382 Gross tonnage) (2024)	300 - 450 units (2.5 - 3.2 million Gross tonnage)
Container yard size	20,000 m ²	25,000 m ²
Technological features	Cashless payment, 1 unit reachstacker, 1 unit harbor mobile crane, 2 unit mobile crane, and a digital logistics monitoring system	Cashless payment, 1 unit mobile crane, 3 units forklift, 2 units terminal trucks, and a digital logistics monitoring system
Throughput capacity	250,000 TEUs/year (installed capacity) Containers: 12,307 TEUs (2024 realization) Non-containers: 289,449 Tons (2024 realization)	4.5 million tons (installed capacity) 1.2 million tons (2023 realization)

Source: Pelindo Multi Terminal (2025)

In the context of this research, both ports are currently focusing on digitizing their logistics flows to reduce extortion, shorten dwell times, and improve data transparency. This digitalization is transforming the way truck drivers work from a manual/paper-based system to an app- and card-based system. This digitalization makes queues more predictable with a booking system, cashless payments, digital documents with QR codes, and the location of goods displayed in the system/app.

However, this study conceptualizes digitalization at the perceptual level rather than as an objective infrastructural construct. Therefore, digitalization is modeled as a reflective construct, in which observed indicators represent users' overall evaluation of the port's digital service capabilities. Such an approach is consistent with prior research in information systems that treats user perceptions of technology as reflective latent variables. Hence, this study does not measure what the port has, but how the user experiences it.

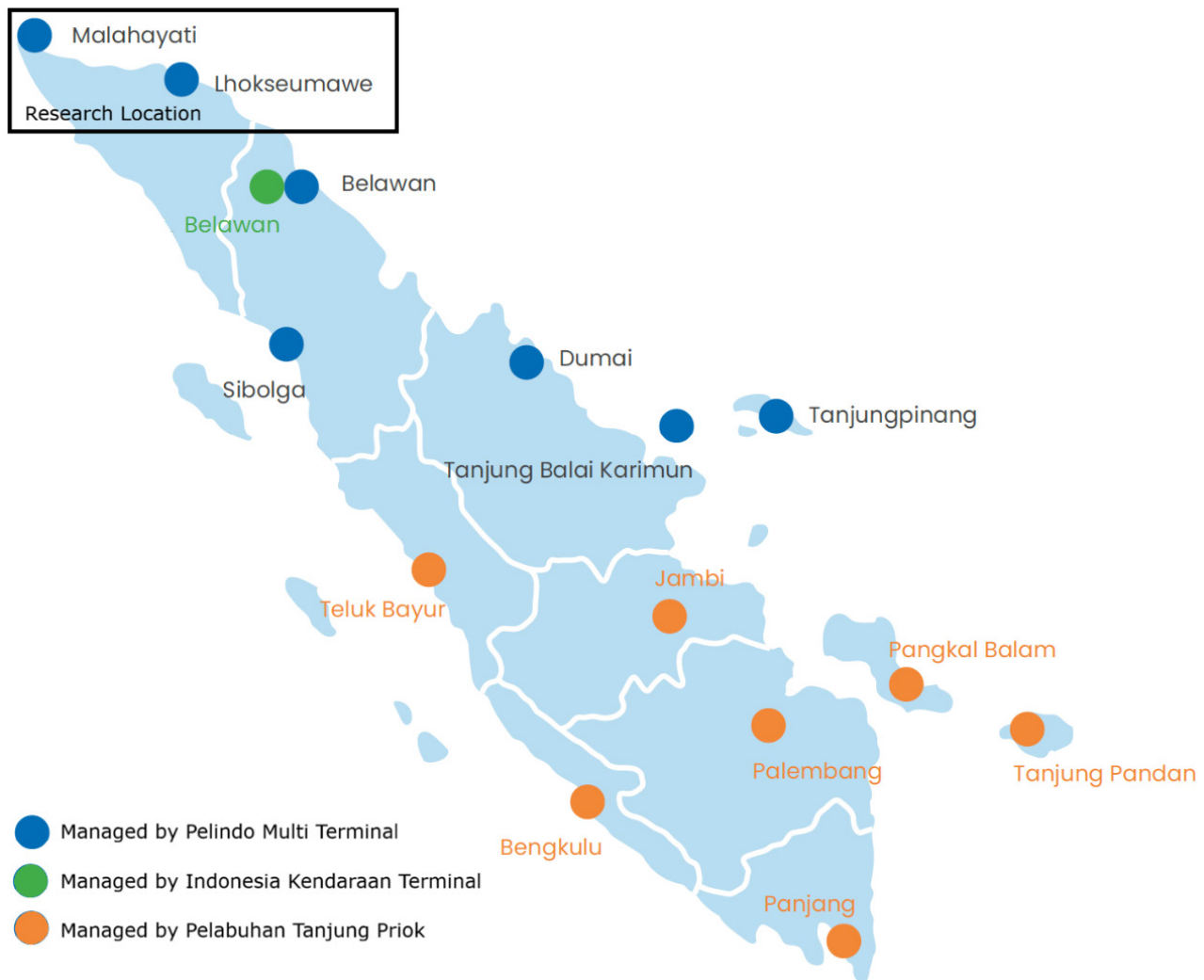


Figure 1 Research location.
 Source: Pelindo Multi Terminal (2025)

The respondents in this research are truck drivers. Questionnaires were distributed to truck drivers waiting at the ports. Truck drivers' opinions are extremely important to port performance because their perceptions reflect the actual and operational quality of port services. They are the actors most negatively affected by port disruptions, as they are a vital link between ports and end consumers (Jaya & Kaisar, 2024). Communication failures between terminals and truck drivers can result in long container waiting times, high empty runs, and increased freight costs (Karam et al., 2023). In the context of digitalization, truck drivers are key nodes in the digital shipping ecosystem (Gao et al., 2023). Furthermore, studies by Bottalico and Nowak (2024), Eaton (2024), and Rattanakunuprakarn et al. (2024) show that work pressure, fatigue, safety issues, and the quality of working conditions for truck drivers significantly impact the resilience of logistics and port systems by causing congestion, reduced throughput, and increased operational uncertainty. Therefore, truck drivers are an indirect and significant source of port revenue and are key players in the maritime economy (Hammed et al., 2025). Port governance models must take truck drivers into account to ensure successful and effective transformation (Andersen et al., 2023).

The selection of truck drivers as the focal respondents in this study is theoretically grounded in their role as front-line operational users and critical intermediaries in the port logistics chain. In port systems, different stakeholders prioritize different value drivers, and these preferences are often highly context-specific (Pallis & Vitsounis, 2016). Truck drivers, as landside operators, directly

experience port service performance in terms of turnaround time, congestion, coordination, and system reliability.

Prior studies emphasize that truck drivers are not only frequent users of port facilities but also key informants on service quality and operational efficiency, as their perceptions are shaped by repeated interactions with port processes (Vaggelas, 2019; Cele, 2018). Moreover, in the intermodal supply chain, port drayage drivers occupy a structurally disadvantaged yet critical position, often facing delays, inefficiencies, and coordination failures that reflect broader systemic issues (Jaffee & Rowley, 2009; Jiang et al., 2017).

From a methodological perspective, focusing on truck drivers enables the study to capture operational-level articulation of user demand, which is often underrepresented in port policy and management research. Their perspectives provide valuable insights into the practical effectiveness of port management paradigms, particularly regarding real-time service delivery and workflow integration.

This study used SmartPLS3 to analyze the data using partial least squares structural equation modeling (PLS-SEM). PLS-SEM is suitable for estimating complex equations with a limited number of participants and for handling non-normal data. The inclusion of both direct and indirect paths enables testing of partial mediation, providing a more comprehensive understanding of how digitalization and image influence satisfaction.

The analysis was carried out in two steps. The first step was confirmatory factor analysis (CFA) to analyze the validity and reliability of the model using the average variance extracted (AVE), composite reliability (CR), and heterotrait monotrait (HTMT) parameters. Items were removed if the parameter threshold was not met. In the next stage, a structural analysis was conducted using the bootstrapping method with 5,000 resamplings to obtain the significance level of individual relationships in the model. A hypothesis will be accepted if the significance level of the relationship between the two hypothesized variables reaches a threshold of 0.05 ($p\text{-value} < 0.05$) and the sign (positive or negative) of the path coefficient is in the hypothesized direction.

4. Results

The demographic details of the respondents in this study are listed in **Table 2**. The largest group of respondents was aged 30 - 39 years (20.3 percent), used class III trucks (72.7 percent), had only been operating at the studied port for 1 - 5 years (65.3 percent), and transported cement (35.3 percent). These statistics indicate that the study respondents were dominated by active, medium-scale operational actors, with relatively early to intermediate levels of experience, who routinely interact directly with core port services, so that their perceptions reflect their actual operational experiences with service quality and port performance.

Several CFAs were conducted to correct items whose loading factors, AVE, CR, or HTMT were outside the established threshold. The CFA revealed that, of 22 items, seven had to be eliminated to obtain values that met the criteria of $AVE > 0.5$, $CR > 0.7$, and $HTMT < 0.9$. These deleted items include CSR1, CSR2, CSR4, OC3, OC4, DG3, and CS3. The remaining 15 items were retained to represent four latent variables. As shown in **Table 3**, the AVE for each latent variable exceeded 0.5, and the CR exceeded 0.7, indicating satisfactory levels of convergent validity and composite reliability. Although the loading factor was very low (DG4), this item was retained because it did not affect the AVE and CR values. Discriminant validity, as shown in **Table 4**, was calculated using HTMT. Overall, these results showed no ratios above 0.9, confirming that discriminant validity was not violated.

The research model was then tested using the bootstrapping procedure with 5,000 resamples, as shown in **Figure 2**. All paths involving outcome variables were highly significant, as indicated by $p\text{-values}$ of 0.009 for image to outcome, 0.000 for perceived port digitalization to outcome, and 0.000 for outcome to customer satisfaction. All were within the value limit below 0.01, indicating a highly significant relationship. Meanwhile, the direct effects of image and perceived port digitalization on

customer satisfaction were insignificant because the p-values for the image-to-customer satisfaction and perceived port digitalization-to-customer satisfaction paths were both greater than 0.05, namely, 0.113 and 0.357 (**Table 5**).

Table 2 Respondent demographic details.

Variables	(n = 150)	%
Age group		
20 - 29	32	21.3
30 - 39	44	29.3
40 - 49	42	28.0
50 - 59	23	15.3
60 and above	9	6.0
Truck		
Class III (2-axle trucks)	109	72.7
Class IV (3 axle trucks)	7	4.7
Class V (Trucks $\geq$ 4 axles)	34	22.7
Length of time using the port		
1 - 5 years	98	65.3
6 - 10 years	30	20.0
11 - 15 years	13	8.7
16 - 20 years	8	5.3
21- 25 years old	1	0.7
Items that are usually carried		
Bulk asphalt	8	5.3
Palm kernel shells	15	10.0
Crude palm oil	25	16.7
Logistics	47	31.3
Cement	53	35.3
Flour	2	1.3
Frequency		
1 - 5 times	13	8.7
6 - 10 times	49	32.7
11 - 15 times	53	35.3
16 - 20 times	19	12.7
21 - 25 times	14	9.3
26 - 30 times	2	1.3

Table 3 Convergent validity and composite reliability.

Items	Wordings	Loadings
Image from Corporate Social Responsibility (CSR) (CR = 0.828; AVE = 0.549)		
CSR1, CSR2, and CSR4 failed to converge		
CSR3	The port I use always emphasizes safety in operations and work.	0.649
CSR5	The port I use demonstrates strong social responsibility towards employees and other stakeholders.	0.749
CSR6	The port I use always emphasizes environmentally friendly operations.	0.856
CSR7	The port I use has an environmental management system in place.	0.695
Operational Outcomes (OC) (CR = 0.803; AVE = 0.504)		
OC3 and OC4 failed to converge		
OC1	The workforce at this port has high experience and professionalism.	0.740
OC2	The port I use always provides reliable service.	0.682
OC5	The port I use always offers competitive service prices.	0.693
OC6	The costs and service processes at this port are communicated transparently.	0.725
Perceived Port Digitalization (DG) (CR = 0.780; AVE = 0.560)		
DG3 failed to converge		
DG1	I can make orders and track shipments digitally at this port.	0.778
DG2	The digital-based container management system at this port is very reliable.	0.932
DG4	The level of application of information and communication technology (ICT) in customer service at the port I use is very good.	0.453
Customer Satisfaction (CS) (CR = 0.875; AVE = 0.645)		
CS3 failed to converge		
CS1	Overall, I am satisfied with the facilities, equipment, and infrastructure at the port I used.	0.881
CS2	Overall, I am satisfied with the management and employees of the port I use.	0.887
CS4	I will recommend this port service to my business partners.	0.522
CS5	I will continue to use the port services I currently use.	0.863

Table 4 Discriminant validity using HTMT.

Constructs	CS	DG	CSR	OC
Customer satisfaction (CS)				
Perceived Port Digitalization (DG)	0.281			
Image (CSR)	0.325	0.389		
Outcome (OC)	0.741	0.472	0.343	

Table 5 Structural analysis results.

	β	Mean	Standard deviation	t values	p-values	Conclusion
<i>Direct Effects</i>						
Outcome -> Customer Satisfaction	0.650	0.653	0.061	10.66	0.000	H1 Accepted
Image -> Customer Satisfaction	-0.109	-0.110	0.067	1.62	0.113	H2 Rejected
Perceived Port Digitalization -> Customer Satisfaction	0.088	0.075	0.097	0.91	0.357	H3 Rejected
Image -> Outcome	-0.170	-0.186	0.065	2.63	0.009	H4 Rejected
Perceived Port Digitalization -> Outcome	-0.377	-0.392	0.092	4.09	0.000	H5 Rejected
<i>Indirect Effects</i>						
Perceived Port Digitalization -> Outcome -> Customer Satisfaction	-0.245	-0.257	0.067	3.65	0.000	H6 Accepted
Image -> Outcome -> Customer Satisfaction	-0.110	-0.122	0.044	2.49	0.013	H7 Accepted

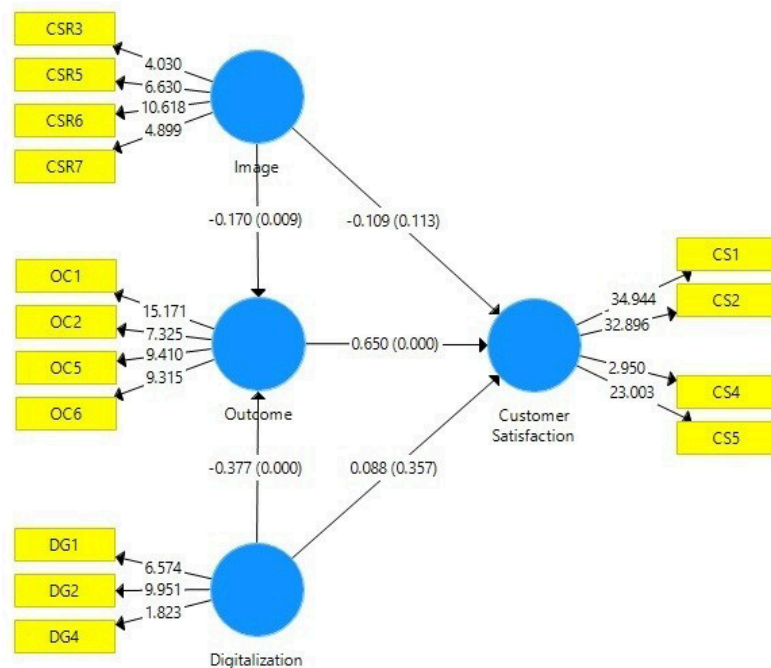


Figure 2 Model of the influence of port service quality variables on satisfaction.

The coefficients of determination were 0.412 for customer satisfaction and 0.175 for operational outcomes. These results indicate that operational outcomes, image, and perceived port digitalization account for 41.2 percent of the variance in customer satisfaction, while image and perceived port digitalization account for 17.5 percent of the variance in operational outcomes. Other unexplained variance may be caused by polynomial or interactive relationships between variables in the model, observed variables that have been removed from the model, transcendent aspects of quality or results that cannot be measured and are subjective, and other variables not measured in this study.

A surprising finding is that both perceived port digitalization and image negatively impact operational outcomes. Meanwhile, the effect of operational outcomes on customer satisfaction is positive. This means that perceived port digitalization and image reduce the impact of operational outcomes needed to improve customer satisfaction.

This finding contradicts a substantial body of prior research that generally reports positive effects of digitalization and CSR on operational and service performance in port and logistics contexts. For instance, Almeida and Okon (2024) demonstrate that smart port technologies enhance user satisfaction and operational efficiency, while Zhou and Suh (2025) find that CSR initiatives positively influence service-related outcomes in container terminals. Against this prevailing narrative, and building on this study's contribution, particularly its focus on competing port management paradigms and the often-overlooked perspective of truck drivers, the following section provides a detailed discussion that further elaborates and substantiates these insights.

5. Discussion

This study deliberately adopts the perspective of truck drivers to capture operational-level evaluations of port performance, which are often overlooked in port governance studies. Using PLS-SEM, this study found a significant positive relationship between operational outcome and CS, and a significant negative relationship between image and perceived port digitalization and CS. This finding suggests that, for the study respondents, who were predominantly truck drivers, institutional image and digital transformation initiatives were not yet perceived as direct sources of value that increased satisfaction. This is in line with the view that the benefits of CSR and perceived port digitalization are often indirect, long-term, or felt more by other strategic actors, such as cargo owners, regulators, or terminal operators, rather than by day-to-day operational users.

Interestingly, the results of the study actually show that image and perceived port digitalization have a negative and significant effect on operational outcomes. This finding contradicts previous research. The literature shows that smart technologies can improve user satisfaction among truck drivers (Almeida & Okon, 2024). This research is also not in line with findings at container terminals in South Korea; that CSR influences aspects of user satisfaction (Zhou & Suh, 2025).

One possible explanation for this discrepancy lies in differences in respondent profiles: prior studies often capture managerial or system-level perspectives. In contrast, this study reflects the experiences of operational users. This conflicting result indicates that, in the empirical context of this study, increased image and perceived port digitalization initiatives are correlated with decreased perceived operational performance. This finding supports the critical literature on perceived port digitalization and CSR in the port sector, which emphasizes trade-offs and implementation burdens, particularly in the early stages of adoption. Barbieri and Capoani (2025) emphasized that digitalization and automation also carry social risks, such as labor substitution, which can reduce social acceptance and perceptions of fairness within the port community. In practice, when digitalization is high, it can trigger negative impacts, such as reduced job opportunities and increased energy consumption (Cardinali & de Giovanni, 2022). A study by Almeida and Okon (2024) also emphasized that developing smart ports without comprehensive evaluation benchmarks can lead to unanticipated negative social and economic impacts. Karam et al. (2023) show that digitalization can reduce operational efficiency in trucking if digital systems are not synchronized with drivers' work practices and do not support disruption management. Current research shows that digitalization does not reduce the burden that prevents truck drivers from experiencing satisfaction, as observed by Wide et al. (2023). Instead, it increases administrative complexity (Wide et al., 2023).

Consequently, this research, from a sociotechnical perspective, confirms the assumption that organizations are networks of individuals and resources working together to achieve goals (Iden & Bygstad, 2025). Whenever an organization overemphasizes one aspect (technology), and neglects the other (human resources), technology will have an undesirable effect. A study by Acheampong et al. (2025) at the Port of Tema, Ghana, on independent truckers found that the adoption of technologies such as the Truck Appointment System (TAS) is highly dependent on truck drivers' education, training, and self-efficacy. Like Ghana, the ports of Malahayati and Lhokseumawe in Indonesia are also in the context of developing countries that are still new to implementing digitalization. In this situation, digitalization has not yet reached an optimal stage that can satisfy all stakeholders.

This shortcoming in developed countries is illustrated by a study by Karlsson et al. (2023). This study shows that digitalization is often geared toward employee needs because ports, especially smaller ones, are more likely to satisfy the interests of their internal stakeholders. In contrast, at an ultra-modern port like Tuas, digitalization integrates the needs of both internal and external stakeholders (Roh et al., 2025).

Although digitalization is modeled as a unified latent construct, additional insight can be gained by examining the descriptive statistics of its individual indicators. The results reveal a nuanced pattern across different aspects of perceived digitalization. The ability to perform digital ordering and shipment tracking (DG1) shows the highest mean score ($M = 3.71$; $SD = 0.845$), suggesting that core transactional functionalities are relatively well established. However, the perceived reliability of the container management system (DG2) shows moderate scores with high variability ($M = 3.31$; $SD = 0.864$), indicating inconsistent user experiences among respondents. Most notably, the ICT-based customer service dimension (DG4) records the lowest mean and relatively low variance ($M = 2.99$; $SD = 0.548$), suggesting a consistently weaker evaluation across users. This implies that, while basic digital functionalities are available, the integration of ICT into customer-facing services remains underdeveloped.

These findings suggest that dissatisfaction with port digitalization is primarily driven by uneven system reliability and insufficient integration of digital services. In practical terms, this may relate to issues such as system responsiveness, service interface quality, or communication inefficiencies rather than purely infrastructural components. Therefore, even within a reflective measurement framework, analyzing individual indicators provides important diagnostic insights into which aspects of digitalization require improvement. This indicator-level interpretation helps address concerns that reflective modeling may obscure specific problem areas by demonstrating that meaningful operational insights can still be derived from item-level analysis.

A CSR program in a maritime company can be seen as creating an image that is more “concerned with stakeholders’ interests, including government, customers, society, the environment, and employees” (Zhai, 2023). This quote suggests that truck drivers are not yet viewed as distinct stakeholders targeted by CSR. Furthermore, truck drivers themselves have an interest in carrying out their duties while remaining focused on operational outcomes. The present study argues that this orientation, along with the lack of CSR-driven impact on truck driver satisfaction, may explain why this study revealed no positive impact on driver satisfaction.

To further interpret these findings, this study draws on the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2012) to explain why digitalization may not lead to higher satisfaction in this context. According to TAM, technology adoption is primarily driven by perceived usefulness and perceived ease of use. However, empirical evidence from Banda Aceh and Jambi shows that perceived usefulness and attitude toward use may not significantly influence digital transformation, while ease of use and social influence play a more critical role (Wildhani et al., 2024). This suggests that digital systems may be implemented without necessarily being perceived as beneficial by users.

In this study, the negative relationship between perceived port digitalization and satisfaction may indicate that digital systems are not sufficiently aligned with truck drivers’ operational needs. From a UTAUT perspective, this can be explained by weak facilitating conditions and high effort expectancy, where users experience technological systems as complex, unreliable, or poorly integrated into their workflows. Studies in Aceh further confirm that facilitating conditions and performance expectancy are key determinants of technology use, whereas other factors, such as social influence, often have a limited impact (Afrah et al., 2025).

This misalignment is particularly relevant in developing regions such as Aceh, where infrastructural limitations, inconsistent system interfaces, and varying levels of digital literacy often constrain digital adoption. Prior research in rural Indonesia highlights that barriers such as system usability issues, limited infrastructure, and low digital literacy significantly hinder effective

technology adoption (Yusuf et al., 2026). As a result, digitalization may increase the perceived burden on operational users rather than reduce it.

Furthermore, studies in Aceh indicate that technology adoption is highly context-dependent and often influenced by economic and capability constraints. For example, research on smart farming technology adoption in Aceh shows that limited user capability and high implementation costs significantly hinder adoption, despite generally positive attitudes toward technology (Agussabti et al., 2022). Similar patterns are observed in fintech and digital payment adoption, where facilitating conditions and user readiness play a more decisive role than perceived benefits alone. These findings suggest that the unfavorable perception of digitalization observed in this study is not necessarily a rejection of technology itself, but rather a reflection of incomplete adoption conditions, where technological systems are introduced without sufficient support, training, or alignment with user practices. This study, therefore, suggests that digitalization in port contexts should be evaluated in terms of user acceptance conditions, as emphasized by TAM and UTAUT frameworks.

From a practical perspective, these findings challenge the prevailing assumption that digitalization and CSR initiatives will automatically enhance operational performance and user satisfaction. Instead, port managers should recognize that poorly aligned digital transformation efforts may impose unintended operational burdens, particularly on frontline users such as truck drivers. Furthermore, these findings suggest that port digitalization should be implemented as a gradual and inclusive transformation process. Given that truck drivers represent operational users with varying levels of digital literacy, a fully digital system may unintentionally increase their cognitive and administrative burden. Therefore, port authorities should consider hybrid and transitional solutions to bridge the digital divide. For instance, the use of short messaging services (SMS)-based services or simplified mobile interfaces can provide accessible alternatives for users who are less familiar with complex digital platforms. In addition, deploying field officers or on-site digital assistants can help truck drivers navigate digital systems, particularly during the early stages of implementation.

Furthermore, improving facilitating conditions, such as system reliability, interface usability, and real-time support, is critical to ensuring that digitalization reduces, rather than increases, operational friction. Training programs tailored to truck drivers' needs and work routines may also enhance their perceived ease of use and, ultimately, improve acceptance, as suggested by the TAM and UTAUT frameworks. These measures highlight that successful port digitalization is also a human-centered adaptation process. This study, therefore, emphasizes that the success of digitalization should be evaluated by the extent to which these technologies are usable, accessible, and meaningful for all user categories. Furthermore, port digitalization strategies should shift from a technology-centric approach toward a user-centered implementation model that prioritizes usability, inclusiveness, and operational compatibility.

It is important to note that these findings are contextually bounded by the sample, which consists of 150 truck drivers as direct operational users. They are an important, yet relatively small, segment of the broader port stakeholder population. Other actors, such as cargo owners, freight forwarders, shipping agents, and port authorities, may interact with digital systems differently, and potentially derive greater strategic or informational benefits; therefore, the findings may not fully capture their potentially more favorable perceptions. As a result, the negative relationship observed between perceived port digitalization and customer satisfaction should be interpreted as stakeholder-specific rather than universal, reflecting operational exposure, system usability, and day-to-day work constraints.

This reliance on a single stakeholder perspective also implies a partial assessment of customer satisfaction within a complex, multi-actor port environment. These limitations are particularly important in interpreting the study's counterintuitive findings, as the negative perceptions of digitalization and CSR may reflect stakeholder-specific biases rather than system-wide performance outcomes. Accordingly, future research is encouraged to adopt a multi-stakeholder approach to better understand how digitalization generates differentiated value across user groups.

6. Conclusions

This study contributes to the literature by demonstrating that port management paradigms do not operate universally and linearly towards customer satisfaction. The integration of efficiency, social responsibility, and techno-social paradigms needs to be tested simultaneously and contextually. These findings enrich the literature on port service quality by confirming that perceived port digitalization and corporate responsibility do not always serve as value drivers; rather, they can become value inhibitors if they are not aligned with the operational needs of primary users.

Practically, the results of this study imply that port managers in developing regions like Aceh need to prioritize improving operational outcomes, such as reduced waiting times, reliable gate and loading/unloading processes, and service transparency, before or simultaneously with the implementation of digitalization and social responsibility agendas. Digitalization and CSR need to be designed to be more user-centered, simple, and support the smooth operation of truck drivers as key actors in port connectivity. With this approach, port transformation toward a more sustainable and technology-based direction can truly improve user satisfaction, not reduce it.

Furthermore, this study confirms that port customer satisfaction results from a complex interaction between management paradigms and user characteristics; thus, port policies and strategies need to consider the different roles, experiences, and needs of actors within the logistics ecosystem in a more inclusive, contextual manner. This study highlights that digitalization may not create uniform value across stakeholders, but instead produces asymmetrical benefits and burdens, particularly between strategic and operational actors.

Acknowledgements

The authors would like to acknowledge the editors and the anonymous reviewers for their valuable comments that improved the quality of the manuscript. The authors acknowledge the use of ChatGPT (OpenAI) and Grammarly for assistance with structuring and refining the manuscript's grammar.

Declaration of generative AI in scientific writing

The authors used ChatGPT (OpenAI) and Grammarly for assistance in conceptualization and grammar refinement of the manuscript. With or without AI applications, the authors are fully accountable for every process of the work and manuscript writing. All final edits, interpretations, and conclusions are the sole responsibility of the authors. The authors academically and ethically confirmed that the stated AI statements are true, and the authors are ultimately responsible and accountable for the contents of the published work, including the correctness of the references in the reference list.

CRedit author statement

Mukhlis: Conceptualization; Methodology; Investigation; Supervision; Project Administration; Writing - Original Draft; Visualization. **Renni Anggraini:** Conceptualization; Methodology; Supervision; Funding acquisition; Writing - Review & Editing. **Muttaqin:** Supervision; Resources; Data Curation; Writing - Review & Editing. **Muhammad Isya:** Supervision; Data Curation; Writing - Review & Editing.

References

- Afrah, Z., Mahmud, T., Rahmawati, & Taj, S. (2025). Usage of financial technology: A study on the Lhokseumawe community based on the UTAUT model. *Jurnal Ilmu Perbankan dan Keuangan Syariah*, 7(1), 170-186. <https://doi.org/10.24239/jipsya.v7i1.319.170-186>
- Agussabti, A., Rahmaddiansyah, R., Hamid, A. H., Zakaria, Z., Munawar, A. A., & Abu Bakar, B. (2022). Farmers' perspectives on the adoption of smart farming technology to support food

- farming in Aceh Province, Indonesia. *Open Agriculture*, 7(1), 857-870.
<https://doi.org/10.1515/opag-2022-0145>
- Ali, C., Wildhani, A. M., & Purwaningsih, T. (2024). Analyzing the factors influencing the digital transformation of public services in Banda Aceh and Jambi. *Jurnal Sosioteknologi*, 23(1), 1-15. <https://doi.org/10.5614/sostek.itbj.2024.23.1.5>
- Almeida, F., & Okon, E. (2024). Achieving sustainable development goals through digitalization in ports. *Business Strategy and the Environment*, 33(7), 6737-6747.
<https://doi.org/10.1002/bse.3842>
- Alsalfiti, A., & Notteboom, T. (2025). The impact of port service quality on customer satisfaction: The case of clearing and forwarding agents in Kuwait Shuwaikh Port. *Maritime Business Review*, 10(1), 76-103. <https://doi.org/10.1108/MABR-04-2024-0030>
- Amri, A., Jalil, S., Akmal, S., Zakaria, M., & Taiwo, O. S. (2024). *Waste analysis in the container unloading process using a lean service approach*. In Proceedings of the 1st Malikussaleh International Conference on Education Social Humanities and Innovation. University of Al-Muslim at Bireun, Aceh, Indonesia.
<https://proceedings.unimal.ac.id/miceshi/article/view/494>
- Andersen, T., Aryee, J., Acheampong, G., & Hansen, A. S. (2023). The continuous search for new port governance models: Experiences from a developing country. *Journal of Shipping and Trade*, 8(1), 10. <https://doi.org/10.1186/s41072-023-00139-8>
- Barbieri, E., & Capoani, L. (2025). Renewable energy, resilience, digitalization, and industrial policies in seaborne transport. *Energies*, 18(5), 1089. <https://doi.org/10.3390/en18051089>
- Baştuğ, S., Haralambides, H., Esmer, S., & Eminoğlu, E. (2022). Port competitiveness: Do container terminal operators and liner shipping companies see eye to eye? *Marine Policy*, 135, 104866. <https://doi.org/10.1016/j.marpol.2021.104866>
- Bottalico, A., & Nowak, J. (2024). Employment conditions, conflicts, and new challenges along the transport-logistics chain. *Sociologia del Lavoro*, 169, 9-23. <https://doi.org/10.3280/SL2024-169001>
- Brunner, M., Tripathi, S., Gundolf, K., Bachmann, N., Thienemann, A. K., Tüzün, A., Pöchtrager, S., & Jodlbauer, H. (2025). Enhancing customer satisfaction through digitalization: Past, present, and possible future approaches. *Procedia Computer Science*, 253, 2929-2940.
<https://doi.org/10.1016/j.procs.2025.02.017>
- Campomori, F., & Casula, M. (2022). Institutionalizing innovation in welfare local services through co-production: Toward a Neo-Weberian State? *Italian Political Science Review/Rivista Italiana di Scienza Politica*, 52(3), 313-327. <https://doi.org/10.1017/ipo.2021.43>
- Cardinali, P. G., & De Giovanni, P. (2022). Responsible digitalization through digital technologies and green practices. *Corporate Social Responsibility and Environmental Management*, 29(4), 984-995. <https://doi.org/10.1002/csr.2249>
- Cele, N. (2018). *Customer perceptions of service delivery: A case study at Transnet Port Terminal, Pier 2* (Master's thesis). Durban University of Technology, South Africa.
<https://doi.org/10.51415/10321/3137>
- Chen, W., & Huang, M. (2025). Improvement of transportation infrastructure, payment digitalization, and tourism consumption expenditure: Analysis based on CHFS data. *Finance Research Letters*, 76, 107000. <https://doi.org/10.1016/j.frl.2025.107000>
- Dewa, A. L. (2023). Empirical analysis of service quality on consumer satisfaction in maritime transportation. *Research Horizons*, 3(5), 531-540.
<http://www.journal.lifescifi.com/index.php/RH/article/view/166>
- Eaton, L. E. (2024). *Strategies impacting sustainable performance in an intermodal trucking company: A qualitative study* (Doctoral dissertation). National University.
<https://www.proquest.com/openview/a2fd41b2e0d239795d40b15520ca73a5>

- Fahri, J. (2022). Exploring citizens' satisfaction with the infrastructure of services at a local seaport in Ternate, North Maluku. *Journal of Indonesian Economy and Business*, 37(2), 103-135. <https://doi.org/10.22146/jieb.v37i2.3449>
- Gao, X., Kong, Y., & Cheng, L. (2023). Strategies and mechanisms for building digital resilience of container shipping platforms in crisis situations: A network orchestration perspective. *Ocean & Coastal Management*, 246, 106887. <https://doi.org/10.1016/j.ocecoaman.2023.106887>
- González, M., & Quesada, G. (2024). Port productivity: Benchmarking analysis of strategic ports. *International Journal of Productivity and Performance Management*, 73(2), 456-475. <https://doi.org/10.1108/IJPPM-09-2022-0453>
- Hammed, O. G., Abdul-Azeez, I. F., & Akewushola, R. O. (2025). Stakeholders' management and economic sustainability of freight transport firms in Lagos State. *Transportation Research Procedia*, 89, 638-649. <https://doi.org/10.1016/j.trpro.2025.05.087>
- Herterich, M. M., Dremel, C., Wulf, J., & vom Brocke, J. (2023). The emergence of smart service ecosystems: The role of socio-technical antecedents and affordances. *Information Systems Journal*, 33(3), 524-566. <https://doi.org/10.1111/isj.12412>
- Iden, J., & Bygstad, B. (2025). Sociotechnical micro-foundations for digital transformation. *European Journal of Information Systems*, 34(2), 367-382. <https://doi.org/10.1080/0960085X.2024.2347950>
- Ingsih, K., Astuti, S. D., & Riyanto, F. (2024). The role of digital competence in improving service quality and employee performance. *SA Journal of Human Resource Management*, 22, 2689. <https://doi.org/10.4102/sajhrm.v22i0.2689>
- Jaffee, D., & Rowley, A. (2009). *Hauling containers: Port drayage drivers in the logistics supply chain*. SSRN Electronic Journal. Retrieved from <https://doi.org/10.2139/ssrn.1617348>
- Jaya, J. D., & Kaisar, E. I. (2024). *Improving the efficiency of traffic outside intermodal facilities: A proof of concept of operations* (pp. 23-36). In Proceedings of the International Conference on Transportation and Development 2024. <https://doi.org/10.1061/9780784485521.003>
- Jiang, C., Lu, L., & Lu, J. J. (2017). Socioeconomic factors affecting the job satisfaction levels of self-employed container truck drivers: A case study from Shanghai Port. *Maritime Policy & Management*, 44(5), 641-656. <https://doi.org/10.1080/03088839.2017.1326182>
- Karam, A., Jensen, A. J. K., & Hussein, M. (2023). Analysis of the barriers to multimodal freight transport and their mitigation strategies. *European Transport Research Review*, 15(1), 43. <https://doi.org/10.1186/s12544-023-00614-0>
- Karlsson, M., Sandberg, J., & Lind, M. (2023). *Digitalization drivers, barriers, and effects in maritime ports*. In Proceedings of the Americas Conference on Information Systems 2023. Americas Conference on Information Systems. https://aisel.aisnet.org/amcis2023/sig_green/sig_green/16
- Kine, H. Z., Gebresenbet, G., Tavasszy, L., & Ljungberg, D. (2022). Digitalization and automation in intermodal freight transport and their potential application for low-income countries. *Future Transportation*, 2(1), 41-54. <https://doi.org/10.3390/futuretransp2010003>
- Kuzu, A. (2024). *The key for sustainable companies: Difficulties in measuring service quality and an evaluation of the SERVQUAL scale* (pp. 41-54). In Sharma, R., Bhardwaj, I., Grima, S., Sachdeva, T., Sood, K., & Özen, E. (Eds.). Contemporary studies in economic and financial analysis. Emerald. <https://doi.org/10.1108/S1569-37592024000113A003>
- Lin, C. C., Yang, Z., & Chang, C. H. (2025). Facilitating the adoption of virtual communities through emotional connections in the global logistics industry. *International Journal of Logistics Research and Applications*, 28(2), 191-209. <https://doi.org/10.1080/13675567.2022.2153815>
- Lopes, L. S., Nabais, J. L., Pinto, C., Caldeirinha, V., & Pinho, T. (2025). Essential competencies in maritime and port logistics: A study on the current needs of the sector. *Sustainability*, 17(6), 2378. <https://doi.org/10.3390/su17062378>

- McCalla, R. J., Slack, B., Pallis, A. A., & Vitsounis, T. K. (2016). Key interactions and value drivers towards port users' satisfaction (pp. 119-136). In Hall, P. (Ed.). *Integrating seaports and trade corridors* (1st ed.). Routledge. <https://doi.org/10.4324/9781315589039>
- Nguyen, T. Q., Ngo, L. T. T., Huynh, N., Quoc, T., & Hoang, L. V. (2022). Assessing port service quality: An application of the extension of fuzzy AHP and importance-performance analysis. *Plos One*, 17(2), e0264590. <https://doi.org/10.1371/journal.pone.0264590>
- Nurazizah, K., Suherman, A., & Fitri, A. (2023). Evaluation of the performance improvement of the Muara Angke Nusantara Fishing Port (NFP), Jakarta. *Journal of Fisheries, Gadjah Mada University*, 25(1), 67-76. <https://doi.org/10.22146/jfs.79115>
- Pagano, P., Antonelli, S., & Tardo, A. (2022). C-Ports: A proposal for a comprehensive standardization and implementation plan of digital services offered by the "Port of the Future". *Computers in Industry*, 134, 103556. <https://doi.org/10.1016/j.compind.2021.103556>
- Pelindo Multi Terminal. (2025). *Annual report 2024: Enhancing port integration and expansion*. Pelindo Multi Terminal. Retrieved from <https://pelindomultiterminal.co.id/pages/annualrep>
- Rattanakunuprakarn, S., Jin, M., Camur, M. C., & Li, X. (2024). *Assessing the effects of container handling strategies on enhancing freight throughput* (pp. 170-181). In Proceedings of the 2024 Winter Simulation Conference. IEEE. <https://doi.org/10.1109/wsc63780.2024.10838632>
- Reed, M. S., Merkle, B. G., Cook, E. J., Hafferty, C., Hejnowicz, A. P., Holliman, R., Marder, I. D., Pool, U., Raymond, C. M., Wallen, K. E., Whyte, D., Ballesteros, M., Bhanbhro, S., Borota, S., Brennan, M. L., Carmen, E., Conway, E. A., Everett, R., Armstrong-Gibbs, F., ... Stroobant, M. (2024). Reimagining the language of engagement in a post-stakeholder world. *Sustainability Science*, 19(4), 1481-1490. <https://doi.org/10.1007/s11625-024-01496-4>
- Roh, S., Haddoud, M. Y., Emmanuel Onjewu, A. K., Jang, H., & Thai, V. (2025). Revisiting the impact of container port service quality on customer satisfaction: A configuration approach. *Transport Policy*, 162, 221-231. <https://doi.org/10.1016/j.tranpol.2024.12.008>
- Satta, G., Vitellaro, F., Njikatoufon, A. G., & Risitano, M. (2025). Green strategies in ports: A stakeholder management perspective. *Maritime Economics & Logistics*, 27(1), 96-122. <https://doi.org/10.1057/s41278-024-00294-0>
- Siregar, B. R., Sonny, I., & Widodo, W. (2022). How does e-service affect the satisfaction of shipping companies through trust? *East African Scholars Journal of Economics, Business and Management*, 5(8), 228-235. <https://doi.org/10.36349/easjebm.2022.v05i08.005>
- Taharuddin, Fitri, I., Badaruddin, & Lubis, S. N. (2025). Factors influencing the opening of regional shipping routes in the Aceh region to enhance regional development and global connectivity. *IOP Conference Series: Earth and Environmental Science*, 1452(1), 012046. <https://doi.org/10.1088/1755-1315/1452/1/012046>
- Vaggelas, G. K. (2019). Measurement of port performance from the users' perspective. *Maritime Business Review*, 4(2), 130-150. <https://doi.org/10.1108/MABR-08-2018-0024>
- Vasheghani, M., & Abtahi, M. (2023). Strategic planning for multimodal transportation in ports. *Maritime Policy & Management*, 50(7), 957-979. <https://doi.org/10.1080/03088839.2022.2061060>
- Veloso, C. M., & Sousa, B. B. (2022). Drivers of customer behavioral intentions and the relationship with service quality in specific industry contexts. *The International Review of Retail, Distribution and Consumer Research*, 32(1), 43-58. <https://doi.org/10.1080/09593969.2021.2007977>
- Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36(1), 157-178. <https://doi.org/10.2307/41410412>

- Vrhovac, V., Dakić, D., Milisavljević, S., Ćelić, Đ., Stefanović, D., & Janković, M. (2024). Factors influencing user satisfaction in last-mile delivery: A structural equation modeling approach. *Mathematics*, 12(12), 1857. <https://doi.org/10.3390/math12121857>
- Wide, P., Kalahasthi, L., & Roso, V. (2023). Efficiency effects of information on operational disruption management in port hinterland freight transport: Simulation of a Swedish dry port case. *International Journal of Logistics Research and Applications*, 26(5), 524-547. <https://doi.org/10.1080/13675567.2022.2100333>
- Yusuf, F. (2026). A Mixed-methods design for analyzing telemedicine adoption: An information systems approach integrating TAM–ISS, digital literacy, and usability. *Journal of Applied Data Sciences*, 7(1), 303-325. <https://doi.org/10.47738/jads.v7i1.1084>
- Zhai, Z. (2023). *Research on the ways and effects of corporate social responsibility: Based on COSCO shipping* (pp. 344-352). In Proceedings of the 3rd International Conference on Public Management and Intelligent Society. Atlantis Press. https://doi.org/10.2991/978-94-6463-200-2_36
- Zhou, L., & Suh, W. (2025). A study on port service quality, customer satisfaction, customer loyalty, and referral intention: Focusing on Korean container terminals amid smart port development. *Systems*, 13(6), 486. <https://doi.org/10.3390/systems13060486>