

The Influence of Service Quality, Work Efficiency, and Innovation on Loyalty through Satisfaction

Service Quality,
Work Efficiency, and
Innovation

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ABSTRACT

The shipyard industry in Batam plays a vital role in supporting Indonesia's maritime economy. PT Biro Klasifikasi Indonesia (BKI) Batam Branch, as a national classification body, faces challenges in new ship supervision, including inefficient work areas and limited surveyor resources. This study aims to analyze the influence of service quality, work area efficiency, and service innovation on service loyalty through shipyard satisfaction. A quantitative method using PLS-SEM was employed, involving 129 shipyard respondents. Results show that all three independent variables significantly and positively affect satisfaction, which in turn mediates their influence on service loyalty. The results of the study indicate that service quality, work area efficiency, and service innovation significantly contribute positively to shipyard satisfaction levels, which in turn substantially influence loyalty to the service. Customer satisfaction has been proven to play a significant mediating role in bridging the influence of these three variables on loyalty. These findings support the validity of the Disconfirmation of Expectations theory and underscore the urgency of digital innovation as a strategic approach to enhancing competitive advantage. Therefore, this study recommends improving operational efficiency, conducting continuous technical training, and accelerating digital transformation as priority policies to strengthen the service performance of PT BKI Batam Branch.

Keywords: Digital Innovation, Service Innovation, Service Loyalty, Service Quality, Shipyard Satisfaction, Work Area Efficiency.

ABSTRAK

Industri galangan kapal di Batam memiliki peran penting dalam mendukung pertumbuhan ekonomi maritim nasional. PT Biro Klasifikasi Indonesia (BKI) Cabang Batam, sebagai lembaga klasifikasi nasional, menghadapi tantangan dalam pengawasan bangunan kapal baru seperti ketidakefisienan area kerja dan keterbatasan jumlah surveyor. Penelitian ini bertujuan untuk menganalisis pengaruh kualitas layanan, efisiensi area kerja, dan inovasi layanan terhadap loyalitas layanan melalui kepuasan galangan kapal. Metode penelitian menggunakan pendekatan kuantitatif dengan teknik PLS-SEM dan melibatkan 129 responden dari galangan kapal. Hasil menunjukkan bahwa ketiga variabel bebas berpengaruh positif dan signifikan terhadap kepuasan,

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dan kepuasan terbukti memediasi hubungan dengan loyalitas layanan. Hasil penelitian menunjukkan bahwa kualitas layanan, efisiensi area kerja, dan inovasi layanan secara signifikan memberikan kontribusi positif terhadap tingkat kepuasan galangan kapal, yang pada gilirannya memengaruhi loyalitas terhadap layanan secara substansial. Kepuasan pelanggan terbukti memainkan peran mediatif yang signifikan dalam menjembatani pengaruh ketiga variabel tersebut terhadap loyalitas. Temuan ini mendukung validitas teori *Disconfirmation of Expectations* serta menegaskan urgensi inovasi digital sebagai pendekatan strategis untuk meningkatkan keunggulan kompetitif. Oleh karena itu, studi ini merekomendasikan peningkatan efisiensi operasional, penyelenggaraan pelatihan teknis yang berkelanjutan, dan percepatan transformasi digital sebagai kebijakan prioritas untuk memperkuat kinerja layanan PT BKI Cabang Batam.

Kata kunci: Inovasi Digital, Inovasi Layanan, Loyalitas Layanan, Kualitas Layanan, Kepuasan Galangan Kapal, Efisiensi Wilayah Kerja.

INTRODUCTION

Organizational performance reflects how effectively an entity achieves its goals and standards (Wardhana & Si, 2024), while companies act as economic drivers by providing goods, creating jobs, and sustaining growth (Sugiantari et al., 2023). This is crucial in Indonesia's shipping industry, which supports the maritime economy of an archipelagic nation (Amalia et al., 2023). Shipbuilding supervision ensures quality and compliance with international safety rules, where service quality strongly influences shipyard satisfaction. Employee engagement and communication further enhance collaboration and task completion (Surya et al., 2023; Sugiantari et al., 2023). Customer satisfaction, shaped by quality, efficiency, and responsiveness, is central to loyalty and mediates the link between service quality and loyalty (Zhou et al., 2021; Gazi et al., 2025). In shipyards, satisfaction improves through effective supervision, innovation, and efficiency, making these aspects strategic for strengthening organizational performance in the shipping sector (Nguyen et al., 2018).

Batam is Indonesia's largest maritime hub, hosting over 100 active shipyards that build and repair vessels for domestic and export markets. Each year, hundreds of new ships require inspection and certification by the Indonesian Classification Bureau (*Biro Klasifikasi Indonesia*/BKI). The high project volume and shipyard locations spread across Tanjung Uncang, Sekupang, Kabil/Punggur, and Batu Ampar create long travel distances and heighten the risk of delays. With only 15 surveyors and 7 assistants, the Batam Branch faces a heavy workload in overseeing hundreds of projects annually, which limits supervision effectiveness. As the only national ship classification body since 1964, BKI plays a vital role in ensuring vessels meet national and international standards. Despite its strategic position in Batam, operational challenges, such as uneven labor distribution and inspection travel times that exceed working hours, slow down certification and disrupt shipyard operations, causing losses for owners. Competition from global classification societies, including Lloyd's Register (LR), Bureau Veritas (BV), and the American Bureau of Shipping (ABS), further pressures BKI to enhance efficiency, service quality, and competitiveness to sustain its role in Indonesia's maritime economy.

PT BKI Main Branch Batam Class has a major role in supervising shipbuilding in various shipyards in the Batam area, but faces challenges in maintaining service user satisfaction. Complaints that often arise are the absence of BKI surveyors according to a predetermined schedule, due to the long distance between work areas and the high volume of work. BKI surveyors play an important role in the follow-up inspection after the initial supervision by the shipyard's internal quality control team, to ensure the quality and feasibility of the ship. Table 1 displays data on BKI Batam's new shipbuilding projects during 2021-2024.

BKI data shows a sharp rise in newbuilding projects from 2021–2024, with Tanjung Uncang and Sagulung leading at 547 projects in 2024. However, Batam's shipyard distribution is uneven: Tanjung Uncang and Sagulung host 50 shipyards, Kabil and

Punggur 14, Sekupang and Tanjung Riau 10, and Batu Ampar only 2. With just 15 surveyors handling hundreds of projects, BKI Batam struggles with logistical constraints, risking inspection quality and client trust. Although PT BKI's 2023 Customer Satisfaction Index (CSI) reached 89.51 nationally and 83.97 at Batam (excellent), surveyor shortages cause delays that reduce satisfaction and loyalty. To address this, clustering four surveillance areas is seen as a way to cut travel time and improve service (Gazi et al., 2025). Service loyalty is shaped by quality, efficiency, and innovation, which foster satisfaction and long-term partnerships (Dwivedi, 2024). Thus, continuous improvement through efficiency, innovation, and digital transformation is crucial. Digital tools for recording inspections enhance transparency, accuracy, and speed, strengthening trust and satisfaction. Such innovation boosts loyalty by improving quality, responsiveness, and tailored solutions (Chaudhary et al., 2025), with satisfaction as the main mediator (Kosasih et al., 2024). Customer needs and operational software since 2006 as shown in Figure 1.

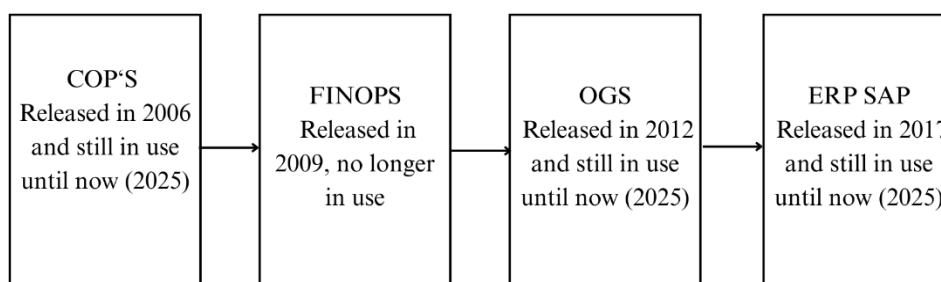


Figure 1. Mapping the use of BKI Operational Software

The Classification Operating System (COP'S) launched in 2006 modernized BKI's operations, followed by the Finance Operating System (FINOP'S) in 2009, later replaced by SAP ERP in 2017. The One Gate System (OGS), introduced in 2012, aimed to boost efficiency. However, Batam's shipbuilding industry still struggles with limited surveyors, vast work areas, and uneven workloads, causing delays in inspection and certification (Zhou et al., 2021) and lowering customer satisfaction (Ram et al., 2024). This study applies PLS-SEM and IPMA (Ketchen, 2013), extending Chaudhary et al. (2025) and Gazi et al. (2025).

This study aims to analyze the influence of service quality, work area efficiency, and service innovation on the satisfaction of shipyards in Batam, and its impact on BKI Batam service loyalty. In addition, this study also examines the mediating role of shipyard satisfaction in the relationship between service quality, work area efficiency, and service innovation on service loyalty.

LITERATURE REVIEW & HYPOTHESIS DEVELOPMENT

Operations Management

Operations management is a critical strategic function that focuses on transforming inputs into efficient and effective outputs to create value for organizations and their customers. In the context of shipyards, operations management encompasses key decisions such as process design, quality management, capacity planning, and resource allocation, all of which are vital for optimizing performance (Slack et al., 2010). For PT Biro Klasifikasi Indonesia (BKI) Batam Branch, effective operations management is essential to address challenges like limited surveyor resources and vast work areas, which often lead to delays in ship supervision and certification. By optimizing work area efficiency through strategic layout designs and streamlined workflows, BKI can reduce lead times and operational costs, directly enhancing shipyard satisfaction (Ummah et al., 2017). Moreover, integrating digital tools, such as real-time inspection tracking systems, aligns with modern operations management principles, improving transparency and

responsiveness, which are critical for fostering customer trust and loyalty (Heizer et al., 2020; Zhou et al., 2021).

Service innovation within operations management further strengthens BKI's ability to meet evolving industry demands. Innovations like digitized reporting systems and automated scheduling not only improve operational efficiency but also enhance service quality by ensuring consistency and accuracy in supervision processes (Fitzsimmons & Fitzsimmons, 2001). According to the Resource-Based View theory, such innovations provide a competitive advantage by creating unique value that competitors struggle to replicate (Barney et al., 2021). For instance, adopting advanced technologies, such as digital dashboards for real-time monitoring, can reduce errors and accelerate certification, directly impacting shipyard satisfaction and loyalty (Kowalkowski et al., 2024). Additionally, lean service strategies, which emphasize waste reduction and process optimization, can address BKI's resource constraints by maximizing surveyor productivity and minimizing idle time (Jebbor et al., 2023). By embedding innovation and efficiency into its operations management framework, BKI can strengthen its service delivery, ensuring sustained client satisfaction and loyalty in Batam's competitive maritime industry.

Determinants of Customer Satisfaction and Service Loyalty

The quality of technical services, such as those of BKI Surveyors, is strongly influenced by the effectiveness of supervision (Slack et al., 2010; Usman et al., 2023). The servqual model from Parasuraman et al. (2008) assesses quality through five main dimensions: tangibles, reliability, responsiveness, assurance, and empathy, which have been shown to correlate with customer satisfaction and loyalty (Jahmani et al., 2020). In the context of shipyards, supervision becomes a process control tool, influences value perception, drives loyalty through satisfaction, and determines long-term loyalty more than service innovation (Slack et al., 2010; Ummah et al., 2017; Kiumarsi et al., 2020; Kosasih et al., 2024; Prasetyo et al., 2025).

Efficiency in operational management is an important indicator for maximizing output with minimal resources, and greatly affects performance and customer satisfaction in the shipyard industry (Jebbor et al., 2023). Efficiency includes optimization of time, labor, and facilities, and can be achieved through layout design, information technology, and monitoring systems. Strategies such as yield management and lean service are also important (Fitzsimmons & Fitzsimmons, 2001; Slack et al., 2010; Ummah et al., 2017). Efficiency affects satisfaction and loyalty through response time, resource utilization, process simplicity, and operational smoothness (Rasheed & Rashid, 2024; Gazi et al., 2025).

Service innovation involves creating new value through process, technology, and customer interaction changes, which in shipyards enhances efficiency and reliability (Fitzsimmons & Fitzsimmons, 2001). Through digital media, it also expands promotional reach and strengthens brand awareness (Riswandi et al., 2024). According to Resource-Based View theory (Barney et al., 2021), innovation is a key source of competitive advantage and sustainable value (Ummah et al., 2017). In this study, innovation by BKI Surveyors includes service development, process improvement, and technology adaptation (Kowalkowski et al., 2024; Moreira et al., 2024), which has a direct impact on loyalty if it is solutive and efficient (Kiumarsi et al., 2020; Kosasih et al., 2024; Chaudhary et al., 2025).

H1: Service quality has a positive and significant effect on customer satisfaction.

H2: Work area efficiency has a positive and significant effect on customer satisfaction.

H3: Service innovation has a positive significant effect on customer satisfaction.

H4: Customer satisfaction has a positive and significant effect on service loyalty.

Customer Satisfaction as Mediator Variable

Customer satisfaction is a psychological response when a service meets or exceeds expectations and is an indicator of successful supervision of new buildings by BKI Surveyors (Arora & Banerji, 2024). Based on Disconfirmation of Expectations Theory and Cognitive Motivational Relational (CMR) Theory, satisfaction arises from performance and emotional responses to service (Jahmani et al., 2020; Arora & Banerji, 2024). In this context, shipyard satisfaction is assessed from reliability, timeliness, professionalism, and responsiveness, and mediated by work efficiency, quality, and digital innovation to loyalty (Parasuraman et al., 2008; Nguyen et al., 2018; Setiawan et al., 2020; Kiumarsi et al., 2020; Jahmani et al., 2020; Prasetio et al., 2025; Chaudhary et al., 2025).

Service quality is important for smooth operations through effective supervision, such as performance monitoring, constructive feedback, and consistent enforcement of work procedures. High-quality service has been shown to increase customer satisfaction, particularly in the service and manufacturing sectors (Chaudhary et al., 2025). Supervisors who are competent in identifying problems and providing quick solutions also strengthen the perception of service quality (Kiumarsi et al., 2020).

Service quality plays an important role in ensuring standardized operations and increasing customer satisfaction through effective supervision (Kiumarsi et al., 2020; Chaudhary et al., 2025). Work area efficiency, through space and resource optimization, accelerates services and reinforces positive perceptions of the organization (Luhulima et al., 2022; Fitriadi & Ayob, 2023; Rasheed & Rashid, 2024). Service innovations such as technology and personalization increase service value and loyalty (Kosasih et al., 2024; Zhang, 2024). Satisfaction as a third outcome is an important mediator of loyalty formation (Nguyen et al., 2018; Zhou et al., 2021; Rane et al., 2023; Gazi et al., 2025).

H5: Service quality has a positive effect on service loyalty mediated by customer satisfaction.

H6: Work area efficiency has a positive effect on service loyalty mediated by customer satisfaction.

H7: Service innovation has a positive effect on service loyalty mediated by customer satisfaction.

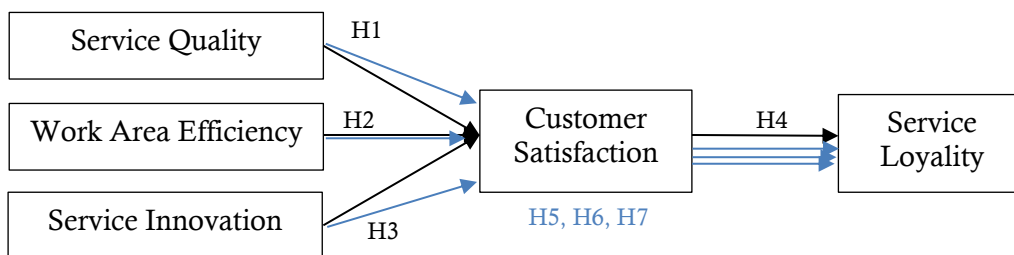


Figure 2. Research Framework

Figure 2 shows the research framework in this study. This research consists of independent variables in the form of service quality, work area efficiency, and service innovation, mediation variables in the form of customer satisfaction, and bound variables in the form of service loyalty. This study aims to examine the influence of service quality, work area efficiency, and service innovation on customer satisfaction (H1, H2, H3). In addition, it also aims to determine the influence of customer satisfaction as a mediating variable on service loyalty (H4). Finally, this study seeks to determine the role of customer satisfaction in mediating the influence of service quality, work area efficiency, and service innovation on loyalty service (H5, H6, H7).

RESEARCH METHODS

This study employs a quantitative explanatory research design to test the causal relationships between service quality, work area efficiency, and service innovation on service loyalty, with shipyard satisfaction as the mediating variable. The research was conducted in the shipyard industry of Batam, Indonesia, where the maritime sector plays a vital role in supporting the national economy and the operations of PT Biro Klasifikasi Indonesia (BKI). The population in this study consists of shipyard companies operating in Batam that are clients of BKI. The sampling technique used was purposive sampling, as respondents were selected based on their knowledge and involvement in service interactions with BKI. A total of 129 valid responses were collected, which is considered adequate for Partial Least Squares Structural Equation Modeling (PLS-SEM), as this method is robust for complex models and small to medium sample sizes.

Data collection was carried out through structured questionnaires distributed both online and offline during the period of January to March 2025. To ensure the reliability of the responses, anonymity and voluntary participation were emphasized, with informed consent obtained from all participants. The questionnaire items were developed based on established literature, covering variables of service quality, work area efficiency, service innovation, shipyard satisfaction, and service loyalty. Each construct was measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to distribution, the instrument was reviewed by academic experts to ensure content validity.

Data analysis was conducted using SmartPLS 4.1 software. The evaluation of the measurement model (outer model) included testing for convergent validity, discriminant validity, and construct reliability. The structural model (inner model) was then assessed through path coefficient analysis, coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and bootstrapping procedures to test hypotheses and mediation effects. The use of PLS-SEM was justified because it allows simultaneous testing of multiple relationships, is less sensitive to data normality issues, and is suitable for predictive research in applied contexts.

Ethical considerations were also addressed by ensuring that respondents' data remained confidential and used solely for academic purposes. This approach provides methodological rigor and ensures that the study's findings can be interpreted with validity and reliability in the context of Indonesia's shipyard industry.

RESULTS

This research methodology highlights the supervision of new buildings by BKI Surveyors in the past two years, with respondents from the Quality Control (QC), Engineering, and engineering staff divisions purposively selected for their direct involvement in supervision, work area efficiency, and service innovation. Data was collected via a Google Form questionnaire on June 9-12, 2025, with 201 questionnaires distributed and 152 returned (Table 1).

A total of 201 questionnaires were distributed to QC personnel, Engineering, and technical staff at the shipyard. Respondents were given four days, from June 9 to 12, 2025, to complete the questionnaire. During this period, 152 questionnaires were returned to the researchers. Of these, 3 questionnaires were incomplete and could not be used in the further data analysis process. Thus, the total data that could be validly analyzed was 149 questionnaires, reflecting a response rate of 74.1%. It indicates excellent respondent participation and meets the survey feasibility standards. The number of samples obtained is considered adequate for multivariate statistical analysis, especially Partial Least Squares Structural Equation Modeling (PLS-SEM). Based on Hair et al. (2022), the minimum sample size in PLS-SEM is determined through the 10-times rule, which is at least ten times the number of arrows to the dependent construct. With 149 valid samples, this condition is met. Sekaran and Bougie (2010) also state that a sample size of 30-500 is appropriate for quantitative research, including regression and structural modeling.

This study involved 149 respondents of QC personnel at shipyards who had used the new building supervision service from BKI Surveyors, with data collected through

questionnaires on June 9-12, 2025. The majority of respondents were male (93.3%) and aged 21-30 years (47.7%), reflecting the dominance of a young workforce. Most had a bachelor's degree (78.5%) and served as QC (49%), followed by Engineering Staff (23.5%), Supervisor (12.8%), Manager (9.4%), and Engineer (5.4%). The length of service was mostly 1-3 years (43%), and 63.1% came from shipyards that have been BKI clients for more than 3 years, reflecting a stable and ongoing working relationship

Table 1. Total Returned Questionnaires from Shipyards

No	Shipyards Name	Total Questionnaires Returned
1	PT Bahtera Bahari Shipyards	13
2	PT Bandar Abadi	8
3	PT Bandar Victory Shipyards	10
4	PT Bintang Inti Persada Shipyards	3
5	PT Buana Cipta mandala	2
6	PT Karya Teknik Utama	18
7	PT Merah Putih Shipyards	5
8	PT Pasifik Karyasindo Perkasa	3
9	PT Patria Maritim Perkasa	8
10	PT Amnor Shipyards	2
11	PT ASL Shipyards	5
12	PT Batam Marina Shipyards	2
13	PT. Batamitra Sejahtera	3
14	PT. Boston Oriental Shipbuilding	1
15	PT Cahaya Samudra Shipyards	1
16	PT CIH Indonesia	3
17	PT Citra Shipyards	9
18	PT Gahara Samudra Berlian	2
19	PT Galaksi Indo Marine	5
20	Karyasindo Samudra Biru	5
21	PT Lestari Osean Indonesia	11
22	PT Mandiri Berjaya Shhipbuilding	3
23	PT Marindo Jaya Samudera	1
24	PT Pacific Atlantic Shipyards	3
25	PT Pan Batam Island Shipyards	1
26	PT Vesinter Indonesia	1
27	PT Blue Ocean Shipyards	1
28	PT Delta Shipyards	2
29	Labroy Shipbuilding & Engineering	3
30	PT Marcopolo Shipyards	3
31	PT Maritim Indo Lestari	1
32	PT Sumber Samudra Makmur	1
33	PT Synergy Kalista Yasa	5
34	PT Tiger Trans International	1
35	PT Usda Seroja Jaya	1
36	PT Wira Bahari Shipyards	1
37	PT Lautan Lestari Shipyards	1
38	PT Sumber Marine Shipyards	1
39	Incomplete data	3
Total		152

Source: Author's Processed Data (2025)

Table 2 shows the descriptive analysis that was carried out to determine the characteristics of the data distribution of each indicator on the research variables. Descriptive statistics displayed include mean, standard deviation, excess kurtosis, and

skewness. This analysis aims to provide an overview of the distribution of respondents' perceptions of each indicator used in the study.

Table 2. Respondent Characteristics

Category	Description	Number
Gender	Male	139
	Female	10
Age	21 - 30 Years	71
	31 - 40 Years	28
	41 - 50 Years	42
	51 - 60 Years	8
Education	High School	32
	Bachelor	117
Position	Manager	14
	Supervisor	19
	Engineering Staff	35
	Quality Control	73
	Engineer	8
Length of Service	< 1 Year	26
	1 - 3 Years	64
	> 3 Years	59
Length of time as a BKI client	< 1 Year	8
	1 - 3 Years	47
	> 3 Years	94

The descriptive statistics show that the indicators of service quality generally received high ratings, with mean values ranging from 4.215 (SQ9) to 4.57 (SQ11). The standard deviations were relatively low (around 0.69–0.86), indicating consistent responses across participants. Several items, such as SQ11 (M = 4.57, SD = 0.717, kurtosis = 7.654, skewness = –2.351) and SQ12 (M = 4.51, SD = 0.711, kurtosis = 7.09, skewness = –2.133), exhibited high excess kurtosis and negative skewness, suggesting responses were strongly clustered toward the higher end of the scale. For work area efficiency, the indicators also demonstrated high mean scores, ranging from 4.362 (EF2) to 4.456 (EF3), with standard deviations between 0.728 and 0.762. The kurtosis values (4.762–6.367) and skewness (–1.735 to –2.008) reflect a concentration of responses in agreement with the statements, reinforcing the positive perception of efficiency in work areas. The indicators of service innovation showed slightly lower means compared to service quality and efficiency, ranging between 4.275 (SI1) and 4.336 (SI2), but still above the midpoint of the scale. Standard deviations were around 0.77–0.84, with negative skewness values (–1.597 to –1.65), indicating a tendency toward agreement.

Regarding shipyard satisfaction, all four indicators reported very high mean scores, between 4.463 (CS3) and 4.53 (CS4), with relatively low standard deviations (0.681–0.728). The kurtosis values (4.921–8.157) and strong negative skewness (–1.692 to –2.239) further highlight that responses were clustered at the “agree” to “strongly agree” end of the scale. Finally, the indicators of service loyalty varied slightly more, with mean scores ranging from 4.221 (SL2) to 4.49 (SL4). Most items showed negative skewness, except SL2 (skewness = –0.671, kurtosis = –0.242), which was closer to a normal distribution compared to other indicators. Nonetheless, the overall results suggest respondents generally reported high levels of loyalty, aligning with the consistently positive perceptions across other constructs.

The results of the descriptive analysis in Table 2 show that the average value of all indicators ranges from 4.215 to 4.57, indicating the tendency of respondents to agree to strongly agree with the questionnaire statements on a Likert scale of 1-5. The highest value is found in indicator SQ11 (4.57) of the Service Quality variable, and the lowest in SI1 (4.275) of Service Innovation. Standard deviations ranged from 0.691-0.855, indicating low to moderate variation in responses, signaling consistency of responses. The mostly positive excess kurtosis values indicate a leptokurtic distribution, such as in indicators

SQ11 (7.654) and CS2 (7.333), which means respondents answered relatively uniformly (Hair et al., 2022). Meanwhile, negative *skewness* values indicate a skew to the left, with indicators such as SQ11 (-2.351), CS3 (-2.239), and SL4 (-2.087), reflecting that respondents' perceptions tend to be high. These skewness and kurtosis values, although some exceed ± 2 , are still acceptable for PLS-SEM (Sekaran & Bougie, 2019).

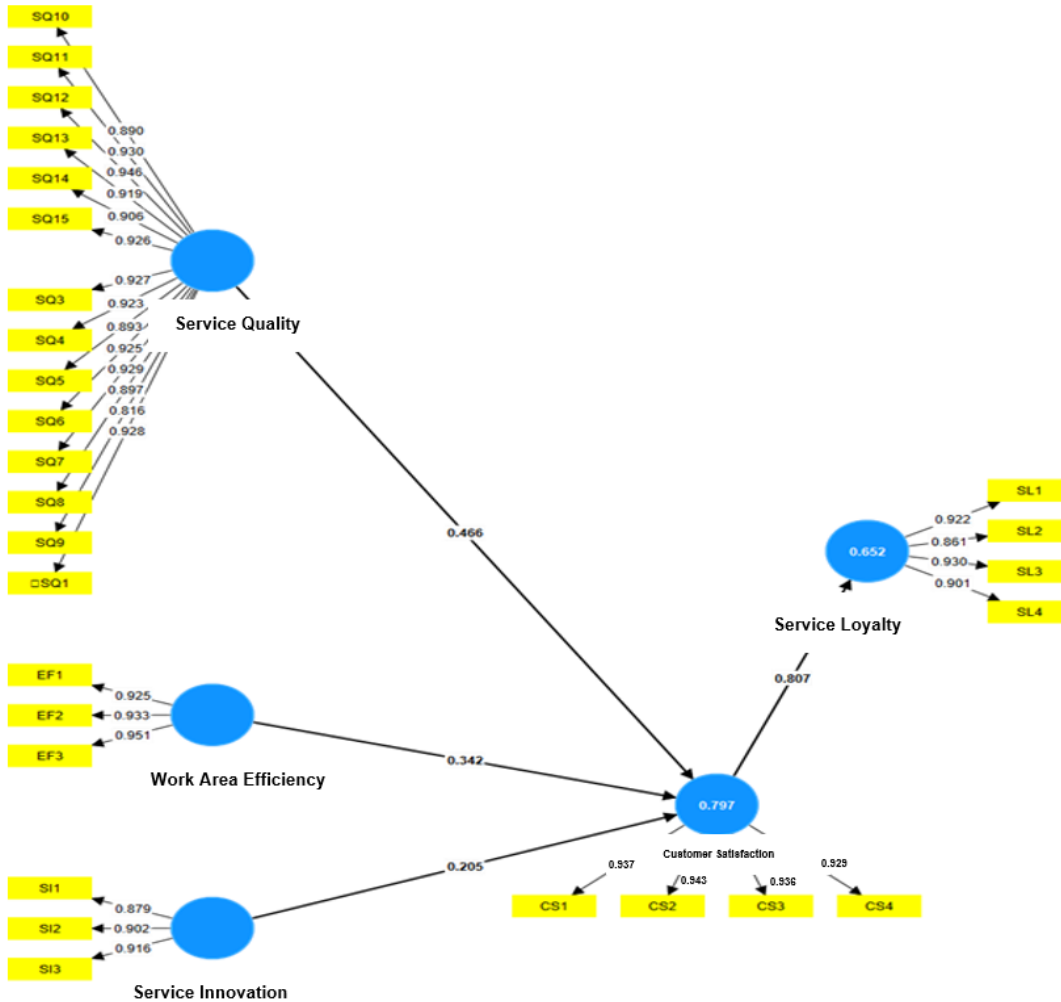


Figure 3. Outer Model

Figure 3 shows the visualization of the outer model in the PLS-SEM analysis, which illustrates the relationship between the latent constructs of Service Quality, Work Area Efficiency, Service Innovation, Shipyard Satisfaction, and Service Loyalty and their measuring indicators. Blue circles represent the latent constructs, while indicators are shown in yellow boxes connected by lines with outer loading values, mostly above 0.70, signifying strong and significant contributions.

Convergent validity in evaluating the outer model of PLS-SEM aims to measure the extent to which indicators in one construct are correlated with each other. The test is carried out through the outer loading value, where the indicator is declared valid if it has a loading > 0.70 (Ketchen, 2013).

According to Ketchen (2013), indicators are considered convergently valid if they have an outer loading value above 0.70. Based on Table 3, most indicators of the five main constructs of Service Quality, Work Area Efficiency, Service Innovation, Shipyard Satisfaction, and Service Loyalty have met this criterion with values between 0.648 to 0.951. However, one indicator, SQ2, from the Service Quality construct was declared invalid because it had a loading value of 0.648. The Service Quality construct has 15

indicators, with the highest value in SQ12 (0.946), and only SQ2 is invalid. The Work Area Efficiency construct consists of EF1-EF3 with values between 0.925 to 0.951. Service Innovation (SI1-SI3) showed values above 0.91. The Shipyard Satisfaction construct (CS1-CS4) has a value of 0.929 to 0.943. While Service Loyalty (SL1-SL2) shows a value between 0.861 to 0.922. Thus, all indicators are declared convergently valid, except SQ2, so that the constructs in the model have been measured accurately and consistently.

Table 3. Convergent Validity (a)

Variable	Indicators	Outer Loadings	Description
Service Quality	SQ1	0.93	Valid
	SQ2	0.648	Not Valid
	SQ3	0.925	Valid
	SQ4	0.921	Valid
	SQ5	0.893	Valid
	SQ6	0.927	Valid
	SQ7	0.929	Valid
	SQ8	0.895	Valid
	SQ9	0.815	Valid
	SQ10	0.89	Valid
	SQ11	0.928	Valid
	SQ12	0.946	Valid
	SQ13	0.916	Valid
	SQ14	0.902	Valid
	SQ15	0.927	Valid
Work Area Efficiency	EF1	0.925	Valid
	EF2	0.933	Valid
	EF3	0.951	Valid
Service Innovation	SI1	0.913	Valid
	SI2	0.928	Valid
	SI3	0.928	Valid
Shipyard Satisfaction	CS1	0.937	Valid
	CS2	0.943	Valid
	CS3	0.936	Valid
	CS4	0.929	Valid
Service Loyalty	SL1	0.922	Valid
	SL2	0.861	Valid
	SL3	0.93	Valid
	SL4	0.901	Valid

In this study, all constructs in the model have AVE values > 0.50, such as Service Quality (0.802), Work Area Efficiency and Shipyard Satisfaction (0.876), Service Innovation (0.808), and Service Loyalty (0.817), indicating high internal consistency and fulfilled convergent validity.

Cross-loading is a method for testing discriminant validity in the PLS-SEM model, which ensures that each construct is unique and indicators only measure their own constructs. According to Ketchen (2013), Discriminant validity is achieved if the loading value of the indicator on the original construct is higher than the loading value on other constructs in the model.

All indicators in this study meet the criteria for discriminant validity through cross loading analysis, indicated by the highest loading values that consistently appear in their original constructs, such as the CS2 indicator on Shipyard Satisfaction (0.943), EF3 on Work Area Efficiency (0.951), SI2 on Service Innovation (0.902), SL3 on Service Loyalty (0.930), and SQ1-SQ15 which show the highest loading value on Service Quality. The results of this analysis indicate that each indicator is able to measure its construct precisely without mixing meanings between constructs, thus supporting the validity and accuracy of the measurement model. In addition to cross-loading analysis, discriminant validity was also tested using the Fornell-Larcker Criterion, a method in the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach that assesses discriminant validity

by comparing the square root of the Average Variance Extracted (AVE) with the correlation between constructs. Discriminant validity is considered achieved if the AVE value is greater than the correlation between constructs, indicating that the indicator is more related to its own construct (Ketchen, 2013).

Table 4. Fornell-Larcker and HTMT Result

Variable	Work Area Efficiency	Service Innovation	Shipyards Satisfaction	Service Quality	Service Loyalty	Description
Fornell Larcker						
Work Area Efficiency	0.936					Valid
Service Innovation	0.587	0.899				Valid
Shipyards Satisfaction	0.786	0.693	0.936			Valid
Service Quality	0.695	0.617	0.83	0.912		Valid
Service Loyalty	0.652	0.632	0.807	0.681	0.904	Valid
HTMT Result						
Work Area Efficiency						Valid
Service Innovation	0.644					Valid
Shipyards Satisfaction	0.834	0.747				Valid
Service Quality	0.726	0.654	0.857			Valid
Service Loyalty	0.695	0.686	0.852	0.705		Valid

Based on Table 4, all constructs in the model have met the criteria for discriminant validity through the Fornell-Larcker approach. This can be seen from the $\sqrt{\text{AVE}}$ value of each construct, which is higher than the correlation between constructs, such as Work Area Efficiency ($\sqrt{\text{AVE}} 0.936 > \text{correlation } 0.587\text{-}0.786$), Shipyards Satisfaction ($\sqrt{\text{AVE}} 0.936$), Service Quality ($\sqrt{\text{AVE}} 0.912 > \text{correlation } 0.695\text{-}0.830$), and Service Loyalty ($\sqrt{\text{AVE}} 0.904$).

In addition, discriminant validity was also tested with the Heterotrait-Monotrait Ratio (HTMT), a more sensitive approach in PLS-SEM measurement. According to (Henseler, Ringle, & Sarstedt, 2015), discriminant validity is considered met if the HTMT value between constructs is <0.90 ; values exceeding this limit indicate a lack of empirical differences between constructs.

Based on Table 4, all HTMT values between constructs are below the 0.90 threshold, such as between Work Area Efficiency and Service Innovation (0.644), Shipyards Satisfaction and Service Loyalty (0.852), and Service Quality and Service Loyalty (0.705). This indicates that each construct meets discriminant validity based on the HTMT approach and is sufficiently conceptually and empirically distinct. Thus, there is no multicollinearity problem, and each construct has sufficient discrimination, so the validity of the measurement model is confirmed, and the inner model analysis can proceed.

Construct reliability is an important aspect of outer model evaluation to ensure indicators consistently measure the same concept. The two main measures used are Cronbach's Alpha and Composite Reliability. According to Ketchen (2013), the minimum Alpha value is 0.70 and the ideal CR is between 0.70-0.95. CR is more accurate in the context of PLS-SEM because it considers differences in outer loading between indicators.

Table 5. Cronbach's Alpha and Composite Reliability

Variable	Cronbach's alpha	Composite reliability	Description
Work Area Efficiency	0.929	0.955	Reliable
Service Innovation	0.882	0.927	Reliable
Shipyards Satisfaction	0.953	0.966	Reliable
Service Quality	0.984	0.986	Reliable
Service Loyalty	0.925	0.947	Reliable

Based on Table 5, all constructs in the model are declared reliable because the Cronbach's Alpha and Composite Reliability values exceed the minimum threshold. Work Area Efficiency ($\alpha=0.929$; $CR=0.955$), Service Innovation ($\alpha=0.882$; $CR=0.927$), Shipyard Satisfaction ($\alpha=0.953$; $CR=0.966$), Service Quality ($\alpha=0.984$; $CR=0.986$), and Service Loyalty ($\alpha=0.925$; $CR=0.947$). The test results show excellent internal consistency and trustworthiness.

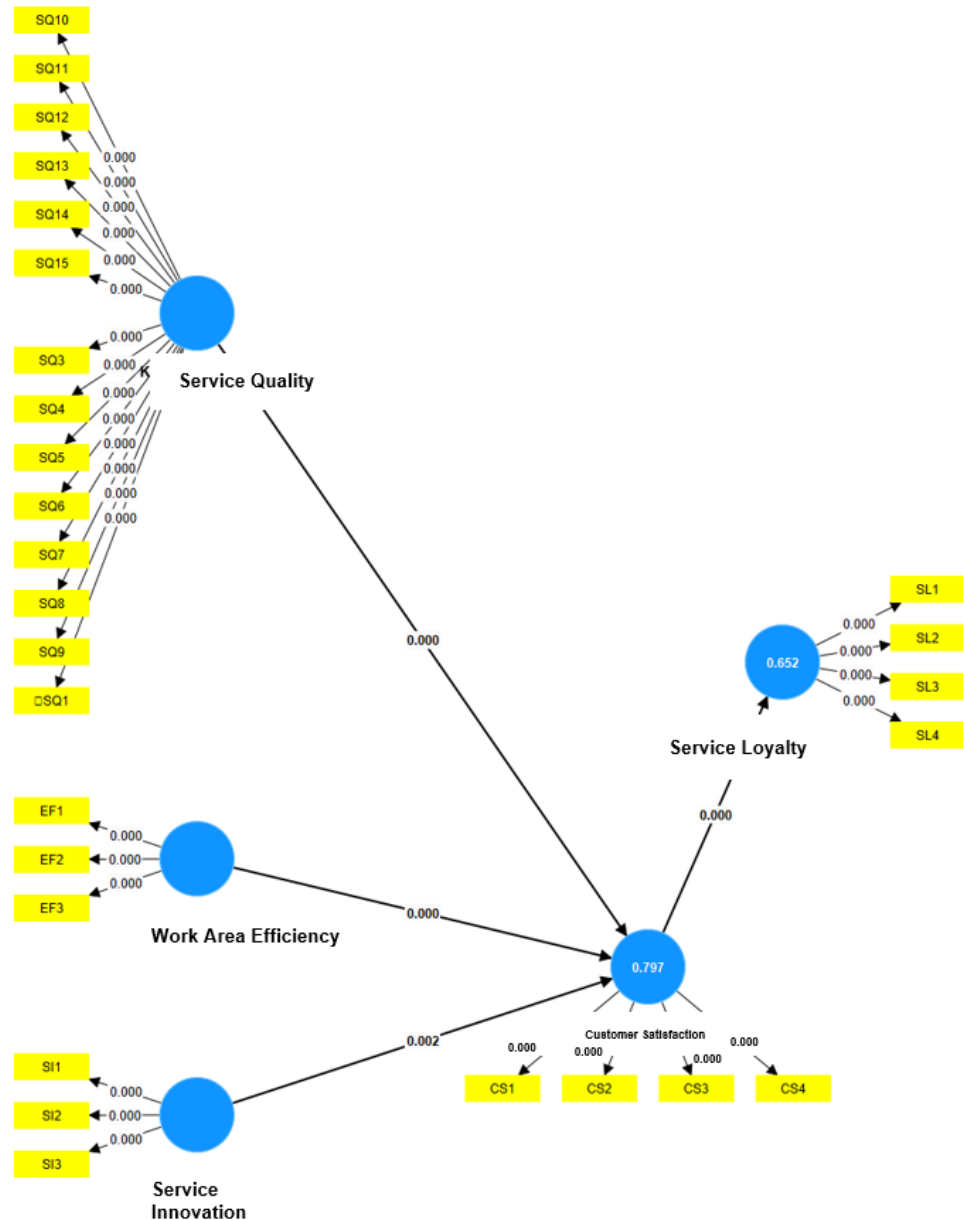


Figure 4. Inner Model

The structural model in Figure 4 includes five latent constructs: Service Quality, Work Area Efficiency, Service Innovation, Shipyard Satisfaction, and Service Loyalty, with Shipyard Satisfaction and Service Loyalty as endogenous constructs that are influenced by exogenous constructs through directed paths. All paths between constructs are statistically significant with a p-value of 0.000, except Service Innovation to Shipyard Satisfaction ($p = 0.002$), which remains below the significance threshold of 0.05. This model is suitable for hypothesis testing and further analysis.

The coefficient of determination (R^2) test is used to determine how much variance in endogenous constructs is explained by exogenous constructs in the structural model.

According to Hair et al. (2022), an R^2 value close to 1 indicates a high prediction, close to 0 means low, with categories of 0.25 weak, 0.50 medium, and 0.75 strong.

Table 6. Coefficient of Determination (R^2)

Variable	R-square	R-square adjusted
Shipyards Satisfaction	0.797	0.793
Service Loyalty	0.652	0.65

Based on Table 6, the Shipyards Satisfaction construct has an R^2 value of 0.797, meaning that 79.7% of its variability is explained by Service Quality, Work Area Efficiency, and Service Innovation, indicating a strong model explanatory power. The Service Loyalty construct has an R^2 value of 0.652, meaning 65.2% of its variance is explained by Shipyards Satisfaction, which also acts as a mediating variable. The R^2 value is classified as moderate to strong, so the model is considered adequate for hypothesis testing and subsequent analysis of managerial implications.

The predictive relevance (Q^2) method is used to measure the predictive ability of the structural model on endogenous constructs. According to (Ketchen, 2013), the Q^2 value is obtained through a blindfolding procedure, and if $Q^2 > 0$ then the construct has predictive relevance, while $Q^2 \leq 0$ indicates otherwise.

Table 7. Predictive Relevance (Q^2) and Effect Size (f^2)

Variable	Predictive Relevance (Q^2)		Effect Size (f^2)	
	Service Loyalty	Shipyards Satisfaction	Service Loyalty	Shipyards Satisfaction
Work Area Efficiency	0	0.274	-	-
Service Innovation	0	0.118	-	-
Shipyards Satisfaction	0.685	-	1.873	-
Service Quality	0	0.482	-	-
Service Loyalty	0.521	-	-	-

Based on Table 7, the Shipyards Satisfaction construct has a Q^2 value of 0.685 and Service Loyalty of 0.521, both of which are greater than zero, thus indicating adequate predictive relevance. These results indicate that the model not only explains the variance of the endogenous constructs statistically (through R^2) but is also able to predict these variables practically, strengthening the validity of the structural model in the context of this study. The effect size test (f^2) is used to measure the contribution of exogenous constructs to endogenous variables in the structural model. According to Cohen and Wills (1985), f^2 is categorized into small (≥ 0.02), medium (≥ 0.15), and large (≥ 0.35), with values calculated from changes in R^2 when exogenous constructs are excluded.

Based on Table 8, the Service Quality construct has an effect size (f^2) of 0.482 on Shipyards Satisfaction (large category), followed by Work Area Efficiency with f^2 of 0.274 (medium category), and Service Innovation with f^2 of 0.118 (small category). On the Service Loyalty construct, Shipyards Satisfaction showed a very large influence with an f^2 of 1.873. This finding confirms that the contribution of each construct is uneven, with Shipyards Satisfaction as the key factor in shaping Service Loyalty. The path coefficient test through the bootstrapping procedure in PLS-SEM is used to test the significance of the relationship between latent variables, with the main indicators being the original sample (O) value, t-statistic, and p-value. According to Ketchen (2013), the relationship is considered statistically significant if the t-statistic > 1.96 (at the 5% significance level) and the p-value < 0.05 .

Based on Table 8, all relationships in hypotheses H1-H4 are significant. H1 shows that Service Quality has a positive effect on Shipyards Satisfaction (coefficient 0.466; t-statistic 4.013; p-value 0.000). H2 shows Work Area Efficiency has a significant effect on Shipyards Satisfaction (coefficient 0.342; t-statistic 3.725; p-value 0.000). In H3, Service Innovation also has a significant effect on Shipyards Satisfaction, although smaller (coefficient 0.205;

t-statistic 3.065; p-value 0.001). H4 shows that Shipyard Satisfaction strongly influences Service Loyalty (coefficient 0.807; t-statistic 16.127; p-value 0.000). All path relationships in the model are statistically significant.

Table 8. Directional Bootstrapping Path Coefficients

H	Hypothesis	Original Sample (O)	Sample Mean (M)	Standard Deviation	T-Statistics	P-Values
H1	Service Quality - > Shipyard Satisfaction	0.466	0.477	0.116	4.013	0.000
H2	Work Area Efficiency - > Shipyard Satisfaction	0.342	0.334	0.092	3.725	0.000
H3	Service Innovation - > Shipyard Satisfaction	0.205	0.198	0.067	3.065	0.001
H4	Shipyard Satisfaction -> Service Loyalty	0.807	0.803	0.05	16.127	0.000
H6	Work Area Efficiency - > Service Loyalty	0.276	0.268	0.076	3.62	0.000
H7	Service Innovation -> Service Loyalty	0.165	0.159	0.055	3.008	0.001
H5	Service Quality - > Service Loyalty	0.376	0.382	0.096	3.931	0.000

All three indirect hypotheses (H5, H6, and H7) show significant results. H6 shows that Work Area Efficiency affects Service Loyalty through Shipyard Satisfaction (coefficient 0.276; t = 3.620; p = 0.000). H7 shows Service Innovation also has an indirect effect (coefficient 0.165; t = 3.008; p = 0.001). H5 shows Service Quality has a greater indirect effect (coefficient 0.376; t = 3.931; p = 0.000). These results reinforce the role of Shipyard Satisfaction as an effective mediator in the structural model of the study.

DISCUSSION

This study set out to examine how service quality, work area efficiency, and service innovation influence service loyalty through shipyard satisfaction in the context of the shipyard industry in Batam. As one of Indonesia’s strategic maritime hubs, Batam relies heavily on the smooth functioning of shipyards to support the national maritime economy. PT Biro Klasifikasi Indonesia (BKI) Batam Branch, as the national classification body, plays a central role in ensuring ship quality and safety, yet faces practical challenges such as inefficient work areas and limited surveyor resources. Against this backdrop, the findings provide valuable insights into the drivers of satisfaction and loyalty that can strengthen BKI’s services and, more broadly, Indonesia’s maritime competitiveness.

The results show that service quality exerts the strongest influence on shipyard satisfaction (H1). This highlights that clients place the greatest value on reliable and professional services from BKI. In the context of ship supervision, quality translates into accurate inspection, timely certification, and adherence to international standards loyalty (Ketchen, 2013; Jahmani et al., 2020). When BKI delivers consistently high service quality, shipyards gain confidence in regulatory compliance and operational safety, thereby increasing satisfaction. This finding aligns with Ali et al. (2021) that service quality has significance impact on customer satisfaction.

Work area efficiency (H2) is also shown to significantly affect satisfaction, underscoring the importance of resource utilization and workflow management. A coefficient of 0.342 indicates that operational efficiency is nearly as important as service quality in shaping perceptions. In BKI’s case, limited surveyor resources and the complexity of new ship supervision can create bottlenecks, leading to dissatisfaction. By improving scheduling, optimizing field assignments, and reducing idle times, BKI can increase throughput without sacrificing quality. This efficiency is particularly critical in

Batam, where high ship traffic demands a responsive and well-coordinated supervision process.

Service innovation (H3), while showing a smaller effect, remains an important factor in enhancing satisfaction. The coefficient of 0.205 suggests that innovation, such as adopting digital reporting systems, remote inspections, or environmentally friendly certification methods, adds value but is not yet the main driver of satisfaction. In the Batam context, shipyards may prioritize tangible and immediate benefits such as efficiency and reliability, but innovation ensures long-term adaptability. This research aligns with Mahmoud et al. (2017) and Nwachukwu and Vu (2022) that service innovation has a significant effect on customer satisfaction.

The findings also emphasize the central role of satisfaction in driving service loyalty (H4). With the strongest coefficient (0.807), satisfaction clearly acts as the critical bridge between service attributes and repeat client engagement. For BKI, this means that loyal clients are more likely to continue using its classification services, recommend them to other shipyards, and maintain trust despite operational challenges. Loyalty is vital in the shipyard industry because it reduces switching risks and supports long-term collaboration, both of which are crucial in sustaining Batam's maritime economy (Hussain et al., 2025).

The mediation analysis (H5–H7) further confirms that service quality, efficiency, and innovation influence loyalty indirectly through satisfaction. This reinforces the strategic importance of ensuring client satisfaction as the primary mechanism for cultivating loyalty. Among the three predictors, service quality again shows the strongest indirect effect, suggesting that investments in maintaining and improving quality should be prioritized. Satisfaction fully mediates the effect of quality, efficiency, and innovation on loyalty, in line with the Disconfirmation of Expectations theory and the innovation-loyalty link (Kiumarsi et al., 2020; Kosasih et al., 2024). Efficiency and innovation, while also significant, operate as complementary levers that enhance satisfaction and, by extension, loyalty. Operational efficiency supports the findings of Ummah et al. (2017) and Gazi et al. (2025).

Taken together, these results highlight practical implications for BKI Batam. Improving service quality and efficiency can directly address the challenges of limited surveyor resources and inefficient work areas, while innovation offers pathways for long-term sustainability. For policymakers, the findings suggest that strengthening institutional support for classification services is essential to bolstering Batam's role in Indonesia's maritime economy. Ultimately, by prioritizing satisfaction as the central outcome, BKI can build stronger client loyalty, which in turn contributes to more resilient and competitive shipyard operations.

CONCLUSION

This study examined the influence of service quality, work area efficiency, and service innovation on service loyalty through shipyard satisfaction in the context of the shipyard industry in Batam. The results show that all proposed hypotheses (H1–H7) are supported. Service quality emerged as the strongest driver of shipyard satisfaction, followed by work area efficiency and service innovation. Furthermore, satisfaction was found to have a strong and significant effect on service loyalty, confirming its role as an effective mediator. These findings highlight the importance of maintaining high-quality services, improving operational efficiency, and pursuing innovation to sustain client trust and loyalty.

Theoretically, this study reinforces the role of satisfaction as a mediator between quality, efficiency, and innovation on loyalty, and expands the application of the Disconfirmation of Expectations and CMR Theory in a maritime context. This conceptual model can also serve as a reference for future research in multi-location technical service sectors with resource constraints and can be further developed by incorporating variables such as brand trust and switching costs.

Based on the research results, it is recommended that PT BKI Batam Branch improve service quality through the reliability and responsiveness of surveyors, such as punctuality and technical communication skills. Work area efficiency also needs to be improved

through the clustering of surveillance locations and a workload-based scheduling system. Service innovation must be strengthened through digital technology, such as inspection schedule tracking, automatic notifications, and real-time reporting dashboards. In addition, ongoing training for surveyors is essential to ensure they have the technical, communication, and digital skills to compete globally. Despite these contributions, the study has limitations. The sample was restricted to four companies within two segments, which may not fully represent the diversity of shipyard operations in Batam or Indonesia as a whole. The reliance on survey data also limits the depth of insight into organizational practices and client expectations.

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