DIJDBM: Dinasti International Journal of Digital Business Management
E-ISSN: 2715-4203
P-ISSN: 2715-419X
https://dinastipub.org/DIJDBM dinasti.info@gmail.com +62 811 7404 455
DOI:https://doi.org/10.38035/dijdbm.v6i5

The Effect of the Digitalization System and Clearance in Process on Service Quality and its Implications on the Accountability of Loading and Unloading Services at Cirebon Port

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Abstract: Digital transformation in the port sector is a strategic step to improve efficiency, transparency, and accountability in services. One concrete example of this transformation is the implementation of the Si-PDKT (Ship Document Inspection System) application, which is applied by the Cirebon Class II KSOP. This application aims to accelerate the clearance in process for ships and supports the improvement of service quality and accountability in loading and unloading services. However, in practice, various obstacles are still found, such as limitations in system integration, human resource readiness, and resistance to new technology usage. This study aims to analyze the effect of the digitalization system (X1) and the clearance in process (X2) on service quality (Y) and its implications for the accountability of loading and unloading services (Z) at Cirebon Port. The approach used is explanatory quantitative with data collection through questionnaires from port service users. Data analysis is carried out using Structural Equation Modeling (SEM) with the SmartPLS software, complemented by SWOT analysis to identify strengths, weaknesses, opportunities, and threats in the implementation of the Si-PDKT application. The results of the study show that the digitalization system and the clearance in process have a positive and significant impact on service quality. Furthermore, service quality acts as a mediating variable that strengthens the influence of the digitalization system and clearance in on the accountability of loading and unloading services. The SWOT analysis also reveals that the application of Si-PDKT has great potential to be optimized, especially through improved system integration, human resource training, and adaptive regulatory support. This research provides strategic contributions to the development of smart port-based port services and serves as a reference for KSOP and other port stakeholders in formulating policies to improve public services that are efficient and accountable in the digital era.

Keyword: Digitalization System, Clearance In, Service Quality, Service Accountability, Si-PDKT..

INTRODUCTION

As a collection port, Cirebon Port holds a strategic position in supporting logistics flows in West Java and western Central Java. Its role is crucial in supporting the distribution of goods, particularly for industry, trade, and the needs of communities in the hinterland. However, in recent years, the ship clearance process—particularly Clearance-in—has faced significant administrative and technical challenges.

One of the main obstacles lies in the service process, which has not yet been fully digitized. Document verification procedures are still carried out manually, communication between units is slow, and the lack of transparency in document flow results in longer-than-expected ship waiting times. This inefficiency not only disrupts the smooth flow of logistics but also leads to dissatisfaction among port service users.

Based on the 2022 operational report of the Cirebon Class II Port Authority (KSOP), the average clearance time for merchant vessels is 6 to 12 hours, with an average of 9 hours. During peak hours, delays can exceed 24 hours. The impact of these conditions is delayed loading and unloading activities, longer berthing times, increased ship operating costs, and decreased service satisfaction levels. This indicates that service efficiency issues need to be addressed immediately through system innovation.

The distribution of clearance times also shows significant variation. Data from the Cirebon Port Authority (KSOP) in 2022 indicates that approximately 65% of ship clearances were completed within the normal timeframe (6–12 hours), 25% experienced delays of 12–24 hours, and 10% were delayed by more than 24 hours. This figure confirms that repeated extreme conditions, particularly during high ship volumes, have proven incapable of meeting the need for fast and transparent service.

As an improvement effort, the Cirebon Port Authority (KSOP) developed the Si-PDKT (Arriving Ship Document Inspection System) application, which began trials in 2023. This application is expected to simplify the clearance process, accelerate document validation, and provide transparency in the process. The digitization of services through Si-PDKT also aligns with the smart port vision, which requires ports to be efficient, modern, and information technology-based.

An internal survey conducted in mid-2023 showed that user acceptance of Si-PDKT remained mixed. Sixty-eight percent of respondents expressed satisfaction with the app's speed and ease of use, while 32% complained about technical challenges such as slow access, the lack of automatic notifications, and limited technical support for input errors. This data indicates that while the app provides benefits, improvements are still needed in both technical aspects and service support.

When it comes to public services at ports, service quality is a key indicator that users pay close attention to. Quality dimensions such as service speed, information accuracy, system accessibility, and staff responsiveness to issues are key benchmarks. In the digital era, service quality depends not only on system sophistication but also on the overall user experience.

In addition to quality, service accountability is also a fundamental principle in bureaucratic reform. Accountability encompasses process transparency, officer accountability, and the system's ability to digitally record and track all service activities. In the context of loading and unloading, accountability is closely linked to reporting and documentation systems. The Si-PDKT application is expected to support the principle of accountability through application status tracking features, automatic notifications, and an auditable service track record.

However, the success of digital service implementation is determined not only by the availability of the application but also by the readiness of other supporting factors. Human resources (HR), service procedures, and managerial support play a crucial role in ensuring the system's effectiveness. Previous studies have shown that digital transformation without enhanced HR competency and improved work culture tends to result in a suboptimal system.

Therefore, evaluation of Si-PDKT implementation must consider both technological factors and organizational and human aspects.

This research addresses this need by focusing on the impact of the digitalization of the Si-PDKT system and the clearance-in process on service quality and its implications for the accountability of loading and unloading services at the Port of Cirebon. A quantitative approach based on field data was chosen to ensure more objective and measurable results. Furthermore, this research is expected to provide academic contributions to the development of digital public service theory and practical contributions to the Cirebon Port Office (KSOP) in developing strategies for sustainable information technology-based service improvement.

METHOD

This research design uses a quantitative approach with a survey method, where the questionnaire is the main instrument in data collection. This approach was chosen because the study aims to obtain answers that can be measured numerically from respondents. The type of research used is explanatory research, with the aim of explaining the causal relationship between the independent variables, namely the Si-PDKT application digitalization system (X1) and the clearance process on board (X2) to the dependent variable, namely the accountability of loading and unloading services (Z) through the intervening variable, namely service quality (Y). In addition, the study is also equipped with a SWOT analysis as a strategic approach to identify strengths, weaknesses, opportunities, and threats in the implementation of the Si-PDKT digitalization system.

The research population includes all parties involved in the ship clearance service process at Cirebon Port, both from within the Cirebon Class II KSOP and external service users such as ship agents, shipping companies, and ship document processing companies. The population is divided into two large groups, namely internal KSOP employees who are directly involved in the use of the Si-PDKT application, and external parties consisting of leaders, supervisors, and captains of service user companies. From a total population of 171 respondents, the sample size calculation was carried out using the Taro Yamane formula (1973) with a precision level of 5%, resulting in a sample size of 120 respondents.

The sampling technique in this study used a combination of purposive sampling and simple random sampling. Purposive sampling was used to ensure that respondents met certain criteria, including: (1) having interacted directly with the ship clearance process at Cirebon Port, (2) using or being connected to the Si-PDKT application, and (3) having at least six months of experience in ship arrival service activities. Once the criteria were met, simple random sampling was used to randomly select respondents from the eligible population, so that each member of the population had an equal chance of being selected.

Data processing and analysis were conducted using two approaches: descriptive statistics and inferential statistics. Descriptive statistics were used to describe the characteristics of the research data based on distribution, mean, and standard deviation. Meanwhile, inferential statistics were used to test the established hypotheses using the Structural Equation Modeling (SEM) method using SmartPLS 4.0 software. SEM analysis included testing the outer model (construct validity and reliability), the inner model (relationships between variables), and hypothesis testing to determine the significance of the influence of independent variables on the dependent variable, both directly and through intervening variables.

RESULTS AND DISCUSSION

Based on the results of data processing on 120 respondents, it was obtained that the majority of respondents were male, as many as 100 people or 83.3%, while women were 20 people or 16.7%. In terms of age, the most respondents were in the range of 31–40 years, namely 59 people or 49.2%, followed by 21–30 years old as many as 48 people or 40.0%, and the remaining 13 people or 10.8% were over 41 years old. Meanwhile, the latest educational

characteristics showed that respondents with a Bachelor's degree dominated as many as 57 people or 47.5%, followed by Diploma as many as 40 people or 33.3%, High School as many as 22 people or 18.3%, and only 1 person or 0.8% had a Master's degree. These results illustrate that the research respondents were generally dominated by productive-aged men with a higher educational background (Bachelor's degree), which is relevant to their role in the ship clearance service process at the Port of Cirebon.

Measurement Model (Outer Model)

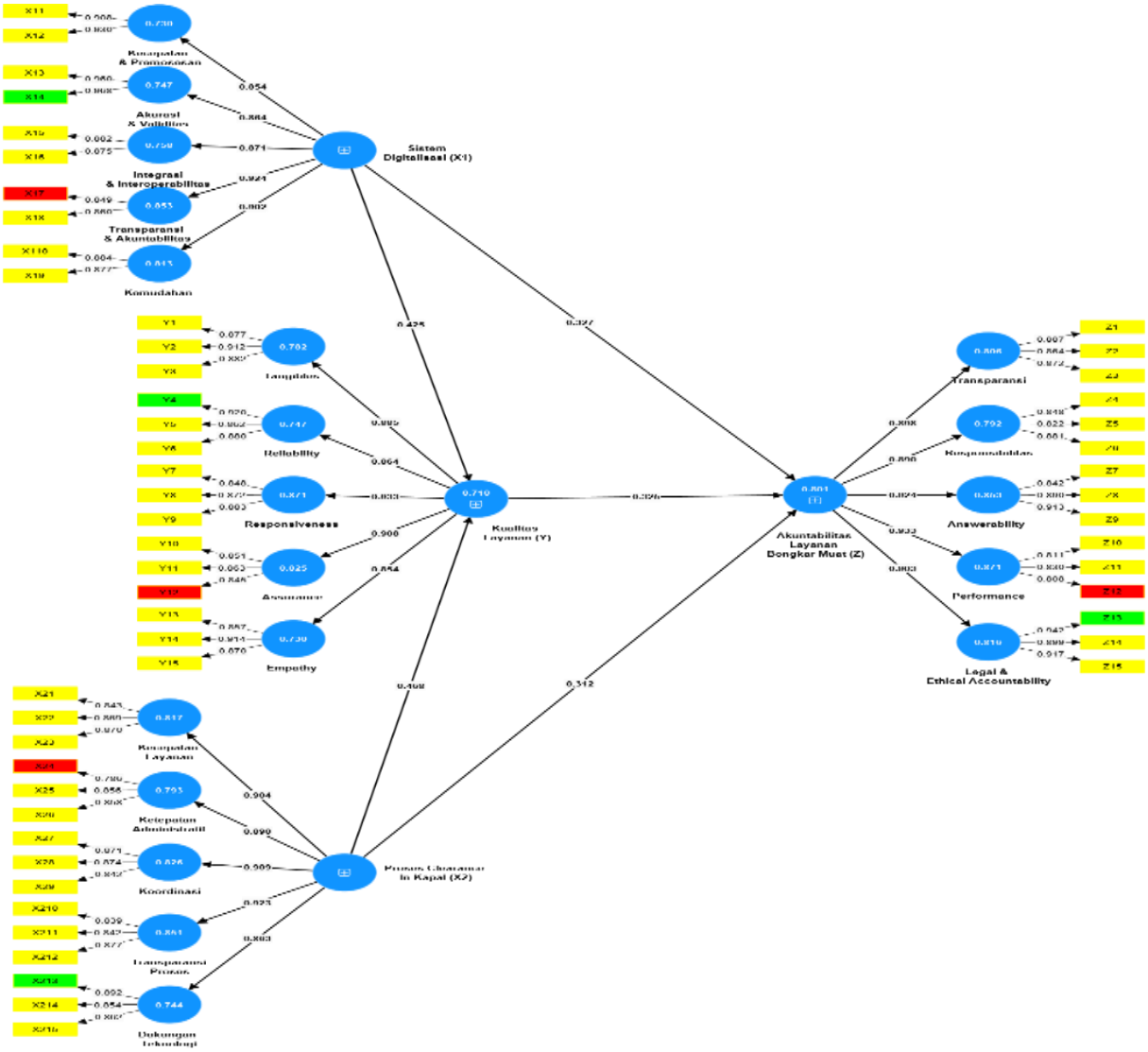


Figure 1. Outer Model (PLS Algorithm)

Convergent Validity

The results of the convergent validity test show that all indicators of the Digitalization System (X1), Clearance Process in Ships (X2), Service Quality (Y), and Accountability of Loading and Unloading Services (Z) variables have loading factor values above 0.6 and AVE more than 0.5, so they can be declared valid. The dimension with the highest contribution to the Digitalization System is Transparency & Accountability (0.924), while the lowest is Accuracy & Validity (0.864). In the Clearance in variable, Coordination is the strongest dimension (0.909), while Technology Support is the lowest (0.863). For Service Quality, Responsiveness occupies the highest position (0.933) and Tangibles the lowest (0.885). Meanwhile, in Accountability, Performance is the strongest dimension (0.933) and Legal &

Ethical Accountability is the lowest (0.903). This proves that the indicators used can explain the latent variables well, although some aspects still need strengthening.

Average Variance Extracted (AVE)

Based on the AVE analysis results, all research variables have values above 0.50, namely the Digitalization System (0.629), Clearance in (0.590), Service Quality (0.606), and Accountability (0.624). These values prove that each construct is able to explain more than 50% of the variance of its indicators, so that the model can be declared valid by convergent validity. Thus, the indicators used in this study are suitable for measuring latent constructs and can be continued to the next testing stage.

Reliability Test

The results of the reliability test indicate that all research variables have met the reliability requirements, with a Composite Reliability (CR) value of more than 0.70 and a Cronbach's Alpha of more than 0.60. The Digitalization System (X1) obtained a CR value of 0.936 and Alpha 0.934; Clearance in (X2) obtained a CR of 0.951 and Alpha 0.950; Service Quality (Y) obtained a CR of 0.954 and Alpha 0.953; and Accountability (Z) obtained a CR of 0.957 and Alpha 0.957. Thus, all latent variables were declared reliable, which means that internal consistency between indicators is well maintained and this research model can be trusted for use in further analysis.

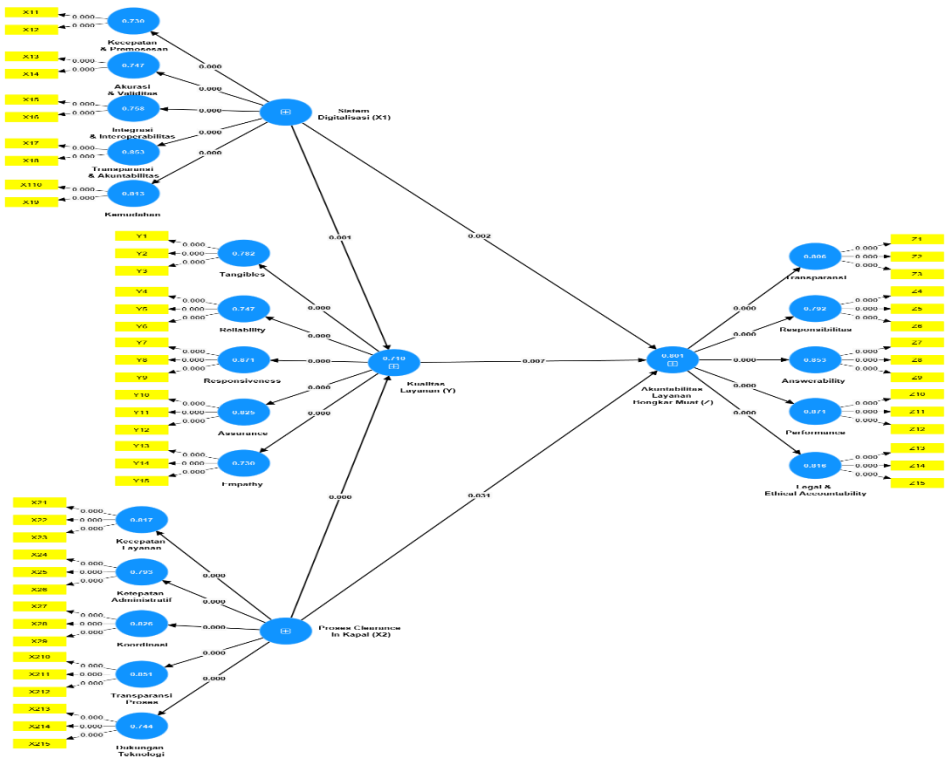
Structural Model(Inner Model)

Q-Square Test

The Q-Square test results show that the Service Quality (Y) variable has a value of 0.423 and the Loading and Unloading Service Accountability (Z) has a value of 0.493. Both values are in the range of 0.25–0.50, indicating a moderate predictive relevance. This means that this research model is quite capable of predicting the dependent variable, although there are still other factors outside the model that can influence variations in Service Quality and Loading and Unloading Service Accountability.

R-Square Test

Based on the analysis results, the Service Quality variable (Y) obtained an R-Square value of 0.710, which means that 71.0% of the variation in Service Quality can be explained by the Digitalization System (X1) and the Clearance Process in Ships (X2), while the remaining 29.0% is influenced by other factors outside the research model. Meanwhile, the Accountability of Loading and Unloading Services (Z) has an R-Square value of 0.801, which indicates that 80.1% of the variation in accountability can be explained by the Digitalization System, Clearance Process in Ships, and Service Quality, with the remaining 19.9% influenced by other variables outside the research. This value indicates that the model has strong explanatory power



Hypothesis Testing

Hypothesis testing through bootstrapping analysis showed that all tested path coefficients met significance criteria, with T-statistics greater than 1.96 and P-values less than 0.05. This indicates that every relationship between exogenous and endogenous variables in the research model was statistically significant

Table 1.Hypothesis Test Results

Hypothesis	Influence	Original sample (O)	T statistics (|O/STDEV|)	P values	Note
H1	Digitalization System (X1) → Service Quality (Y)	0.425	3,452	0.001	Significant Influence
H2	Clearance Process in Ship (X2) → Service Quality (Y)	0.468	3,911	0.000	Significant Influence
H3	Digitalization System (X1) → Accountability of Loading and Unloading Services (Z)	0.327	3,052	0.002	Significant Influence
H4	Clearance Process in Ship (X2) → Accountability of Loading and Unloading Services (Z)	0.312	2,161	0.031	Significant Influence
H5	Service Quality (Y) → Service Accountability _Loading and Unloading (Z)	0.325	2,676	0.007	Significant Influence
H6	Digitalization System (X1) → Service Quality (Y) → Accountability of Loading and Unloading Services (Z)	0.138	2,199	0.028	Significant Influence
H7	Clearance Process in Ship (X2) → Service Quality (Y) → Accountability of Loading and Unloading Services (Z)	0.152	2,007	0.045	Significant Influence

The results of the study indicate that the digitalization system has a significant positive impact on service quality at the Port of Cirebon. With a path coefficient of 0.425, a T-Statistic of 3.452, and a P-Value of 0.001, the first hypothesis is proven to be accepted. This confirms that the greater the implementation of the digitalization system, the higher the service quality perceived by users. Digitalization facilitates faster data processing, reduces administrative errors, and creates transparency in services. This finding is in line with Azizah et al. (2024) who found that digitalization accelerates port services and increases efficiency. Research by Reza & Shinta (2021) also confirms that digital systems contribute significantly to user satisfaction, which directly improves service quality.

Furthermore, the on-board clearance process also has a significant positive effect on service quality, as evidenced by a path coefficient of 0.468, a T-Statistic of 3.911, and P-Values of 0.000. An efficient and timely clearance process plays a crucial role in accelerating ship document processing, reducing waiting times, and improving user experience. These results reinforce the view that inter-agency coordination and accurate document validation are key pillars in creating quality services. Sutanto (2020) emphasized that implementing an information system in the clearance process accelerates document validation and reduces delays. Research by Kwartama & Putra (2021) also confirmed that efficiency in service can significantly increase user satisfaction.

In addition to impacting service quality, the digitalization system also has a positive effect on the accountability of loading and unloading services. With a path coefficient of 0.327, a T-Statistic of 3.052, and a P-Value of 0.002, the third hypothesis is accepted. Digitalization encourages the creation of traceable audit log files, so that every step of the service can be accounted for. This increased accountability is important because it ensures that procedures are carried out according to operational standards. Research by Wang et al. (2023) supports this finding by showing that digitalization increases efficiency and accountability at ports. A similar sentiment was expressed by Tan et al. (2025) who emphasized that the implementation of digital technology supports better accountability in port services.

Other findings indicate that the on-board clearance process also significantly impacts the accountability of loading and unloading services, with a path coefficient of 0.312, a T-Statistic of 2.161, and a P-Value of 0.031. An efficient clearance process not only speeds up document processing but also ensures that each stage is carried out according to standard procedures, thus increasing transparency and accountability. Research by Amsyari et al. (2024) supports these findings by stating that digitalization and integrated systems can improve port performance and accountability. Meanwhile, Lis Lesmini et al. (2022) also found that an efficient clearance process is closely related to increased service accountability at the port.

This study also found that service quality positively influences the accountability of loading and unloading services. With a path coefficient of 0.325, a T-Statistic of 2.676, and a P-Value of 0.007, the fifth hypothesis is accepted. Service quality, which includes speed, accuracy, and transparency, directly contributes to increased accountability. When users feel well served, they are more confident that the service is carried out professionally and according to standards. Yusuf & Hasan (2023) confirmed that service quality has a significant impact on satisfaction and accountability in logistics services. Reza & Shinta (2021) also confirmed that good service quality will influence the level of accountability in port services.

Further findings indicate that the digitalization system not only directly but also indirectly influences the accountability of loading and unloading services through service quality. With a path coefficient of 0.138, a T-Statistic of 2.199, and a P-Value of 0.028, the sixth hypothesis is accepted. This indicates that service quality acts as a mediator in the relationship between digitalization and accountability. The better the service quality produced by digitalization, the higher the accountability achieved. These results are in line with Wang et al. (2023) who stated that digitalization increases efficiency and accountability, and Tan et al. (2025) who

emphasized the importance of service quality in strengthening digital technology-based accountability.

The on-board clearance process was also shown to have an indirect effect on accountability through service quality, with a path coefficient of 0.152, a T-Statistic of 2.007, and a P-Value of 0.045, thus accepting the seventh hypothesis. Efficiency in clearance was shown to improve service quality, which ultimately strengthened stevedoring accountability. This relationship shows that service quality is an important mediating pathway between the clearance process and accountability. Amsyari et al. (2024) found that clearance efficiency improves port performance and accountability, while Lis Lesmini et al. (2022) emphasized that coordination and regularity in clearance can improve both transparency and service accountability.

In addition to the path analysis, this study also conducted a SWOT analysis, which showed that Cirebon Port has dominant internal strengths, with a score of 3.36, above the average of 2.50. Key strengths include good service quality, high accountability, and effective implementation of digitalization. However, there are weaknesses such as suboptimal digital features and several indicators with low scores. Externally, the greatest opportunities come from the development of advanced digital technology and cross-agency collaboration, with a score of 1.94. On the other hand, threats to be aware of include the risk of digital system disruption, regulatory changes, and logistics crises, with a score of 0.90. These results indicate that available opportunities outweigh existing threats, making a digitalization strengthening strategy a priority.

Based on the SWOT analysis, the recommended strategy is to leverage internal strengths to seize external opportunities (SO strategy). Developing Si-PDKT with AI and Big Data technology can help predict loading and unloading flows and strengthen operational decision-making. Furthermore, system integration with national logistics and an app-based user satisfaction improvement program can significantly improve service quality. ST strategies are also relevant, for example, by establishing a digital backup system to anticipate technical disruptions and strengthening inter-agency coordination to address external threats such as bad weather or logistics crises. With these steps, the Port of Cirebon can leverage internal strengths, mitigate weaknesses, and optimize opportunities, thereby sustainably improving service quality and stevedoring accountability.

CONCLUSION

The results of the study indicate that the digitalization system has a significant positive impact on service quality at Cirebon Port. With a direct effect coefficient of 0.425, a T-statistic of 3.452, and a P-value of 0.001, the first hypothesis is proven to be accepted. This means that the better the implementation of digitalization, the better the quality of service provided. This is reflected in the speed, accuracy, and transparency of services, with dominant indicators being automatic document validation and system integration between agencies, both of which play a significant role in increasing the speed and accuracy of the service process.

Furthermore, the on-board clearance process has also been shown to have a positive effect on service quality. With a direct effect coefficient of 0.468, a T-statistic of 3.911, and a P-value of 0.000, the second hypothesis is accepted. An efficient and timely clearance process has been shown to accelerate the processing of ship documents, reduce waiting times, and increase user satisfaction. The dominant indicators supporting this effect are proper document verification and good coordination between relevant agencies, resulting in smoother port operations.

Other results indicate that the digitalization system contributes positively and significantly to the accountability of loading and unloading services. The direct effect coefficient of 0.327, the T-statistic of 3.052, and the P-value of 0.002 confirm that the third hypothesis is accepted. The implementation of digitalization encourages the creation of an auditable digital footprint, thereby ensuring transparency. The dominant indicators, namely

audit log files and inter-agency connectivity, are the main keys that enable more accountable monitoring of loading and unloading activities.

The on-board clearance process also significantly impacts the accountability of loading and unloading services. With a direct effect coefficient of 0.312, a T-statistic of 2.161, and a P-value of 0.031, the fourth hypothesis is accepted. An efficient and coordinated clearance process ensures that each step is carried out according to clear procedures, thereby increasing service accountability. The dominant indicators, such as monitoring clearance status and implementing standard procedures, ensure the timeliness and clarity of the loading and unloading service flow.

Service quality has also been shown to significantly influence the accountability of loading and unloading services. A direct effect coefficient of 0.325, a T-statistic of 2.676, and a P-value of 0.007 confirm the acceptance of the fifth hypothesis. Improved service quality, demonstrated through aspects of speed, accuracy, and transparency, directly contributes to accountability. The dominant indicators in this regard are officer responsiveness and a clear service schedule, which enhances service accountability.

In addition to its direct impact, the digitalization system also has an indirect impact on the accountability of loading and unloading services through service quality. With an influence coefficient of 0.138, a T-statistic of 2.199, and a P-value of 0.028, the sixth hypothesis is accepted. This means that the implementation of digitalization not only plays a direct role but also strengthens accountability by first improving service quality. The dominant indicators in this pathway are automatic document validation, which speeds up the process, and officer responsiveness, which improves accountability through better service quality.

The same thing is seen in the on-board clearance process, which has an indirect influence on the accountability of loading and unloading services through service quality. With an influence coefficient of 0.152, a T-statistic of 2.007, and a P-value of 0.045, the seventh hypothesis is accepted. Efficiency in clearance is proven to improve service quality, which in turn improves the accountability of loading and unloading services. The dominant indicators that play a role in this mechanism are proper document verification and officer responsiveness, which synergistically increase service reliability.

Overall, the implementation of the Si-PDKT application at the Class II Cirebon Port Authority (KSOP) demonstrated several significant strengths, particularly in terms of effective digitalization. The speed and accuracy of ship document processing improved, transparency and accountability in services were more assured, and inter-agency coordination became more robust. Good service performance and high accountability are key hallmarks of the application's success. However, weaknesses remain, such as suboptimal digital features, which could potentially hinder smooth operations, and several indicators with lower-than-expected scores.

Based on the SWOT analysis, the Si-PDKT application has significant potential for development, particularly through the use of AI and Big Data technologies, which can enhance the ability to predict loading and unloading flows and make operational decisions. Integrating the application with national logistics and programs to improve user satisfaction are also important strategies for enhancing port competitiveness. However, threats such as digital system disruptions, changes in port regulations, inter-port competition, and external factors like bad weather or logistics crises must be carefully addressed.

To optimize the implementation of Si-PDKT, strategies include developing interactive features based on smart technology, providing digitalization training for officers, and developing contingency plans for emergencies. Furthermore, establishing a regulatory adaptation team will expedite compliance with new regulations, while a digital backup system will maintain smooth operations in the event of disruptions. By leveraging existing strengths and managing available opportunities, the Port of Cirebon can strengthen its competitiveness and ensure efficient, accountable, and sustainable loading and unloading services.

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