



Digital Service Orchestration and Customs Performance: The Mediating Role of Process Integration in Indonesia

*Dodi Hariyanto

Universitas Logistik dan
Bisnis Internasional,
Indonesia

Agus Purnomo

Universitas Logistik dan
Bisnis Internasional,
Indonesia

Maniah

Universitas Logistik dan
Bisnis Internasional,
Indonesia

***Corresponding author:**

Dodi Hariyanto, Universitas Logistik dan
Bisnis Internasional, Indonesia.
✉ dodihariyanto580@gmail.com

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Abstract

Background: Digital transformation in Indonesia's public sector is a strategic effort to improve efficiency, transparency, and quality of customs services through Indonesia National Single Window (INSW). However, increasing digital transaction volumes has not been matched by optimal customs performance, as reflected in high dwelling time compared to global standards.

Objective: This study examines the effect of Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), and Service Information Connectivity (KIP) on Customs Service Performance (KLK), with Digital Process Integration (IPD) as a mediating variable.

Method: A quantitative explanatory design was applied using PLS-SEM. Data were collected from 206 respondents consisting of exporters, government officials, and logistics service providers involved in INSW services.

Results: Findings show that ILD, SRP, and KIP significantly and positively influence IPD and KLK. The model demonstrates strong explanatory power (R^2 KLK = 0.782; R^2 IPD = 0.714). KIP is the strongest predictor of KLK (β = 0.342, p < 0.001), while IPD significantly mediates all relationships.

Conclusion: The study confirms that improving customs service performance requires not only digitalization but also integrated digital processes, regulatory harmonization, and real-time interoperable data systems across institutions.

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INTRODUCTION

Digital transformation has become a global strategic agenda in public sector reform to improve efficiency, transparency, accountability, and quality of services to the community (Djarmiko et al., 2025; Kayyali, 2025; Ugochukwu Francis Ikwuanusi et al., 2024). International organizations such as the Organisation for Economic Co-operation and Development (OECD) emphasize that digital government is no longer seen as just the use of information technology, but as a governance approach that is able to integrate processes, data, and services as a whole to produce more responsive and adaptive public services (OECD, 2020).

In the context of international trade, digital transformation is realized through the development of the National Single Window (NSW), which is an electronic system that awns the exchange of data and documents in an integrated manner between business actors and government agencies in the export-import process. NSW's implementation has been proven to be

able to reduce logistics costs, speed up the goods clearance process, and increase the trade competitiveness of a country. Therefore, various countries continue to encourage the integration of digital services as the main instrument in realizing effective and sustainable trade facilitation (Ismail, 2020; Xiang & Zhao, 2025).

Nevertheless, the successful implementation of digital service systems is inseparable from various factors that affect its effectiveness (Jumalia Mannayong, 2024; Mustafa et al., 2020). Various studies show that the performance of customs services is greatly influenced by the level of integration of digital services, synchronization of regulations and business processes, and information connectivity between agencies (Gkoni et al., 2024; Vasylkivskyi & Abasov, 2025). Digital service integration is necessary to ensure that all services are accessible through an integrated connected platform (Ivanov et al., 2022; Sklyar et al., 2019). On the other hand, synchronization of regulations and business processes is needed to reduce policy overlap, harmonize work procedures, and strengthen coordination between institutions (Bachmid, 2025; Wicaksono et al., 2026). In addition, service information connectivity is an important factor because it allows for real-time, accurate, and standardized data exchange between different systems (Wang et al., 2017). When these three factors do not run optimally, the service process will experience fragmentation, delays, and operational inefficiencies that have the potential to reduce the quality of public services (OECD, 2020; World Bank, 2023).

These problems have a significant impact on the performance of customs services. One of the most commonly used indicators to measure the effectiveness of customs services is dwelling time, which is the time needed from the time goods arrive at the port to exit the port area. Data shows that dwelling time at Indonesia's main ports is still in the range of 2.8–3.5 days, higher than the global standard which is in the range of 1.5–2 days (Ministry of Finance & Customs, 2024).

This condition shows that the digitization of services that has been carried out has not fully resulted in process efficiency as expected. The high dwelling time not only increases national logistics costs, but also reduces Indonesia's trade competitiveness at the global level. In addition, delays in data exchange, duplication of verification processes, mis-synchronization of information, and overlapping regulations cause bottlenecks in the customs service process. Further impacts of these conditions are declining service user satisfaction, increasing trade transaction costs, and hampered the flow of goods in national and international supply chains (World Bank, 2023).

In the Indonesian context, efforts to digitally transform international trade are realized through the Indonesia National Single Window (INSW) managed by the National Single Window Institute (LNSW). The system serves as a national integration platform that connects various ministries and institutions related to export-import services, including the Directorate General of Customs and Excise, the Ministry of Trade, the Ministry of Agriculture, and other technical agencies (LNSW, 2024). This study examines five main variables that are considered to be closely related to improving the performance of customs services. These variables consist of Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), Service Information Connectivity (KIP), Digital Process Integration (IPD), and Customs Service Performance (KLK).

Digital Service Integration describes the level of service interconnectedness between systems, Regulatory and Process Synchronization reflects the alignment of rules and procedures across agencies, while Service Information Connectivity shows the system's ability to exchange data quickly and accurately. Furthermore, Digital Process Integration is positioned as a mediation variable that explains how the integration of services and information can be translated into a real improvement in the performance of customs services. The performance of customs service is measured through the dimensions of efficiency, speed of service, process accuracy, and quality of service received by users.

This research has an element of novelty that distinguishes it from previous research. Most previous studies on the National Single Window and digital government have tended to examine the effects of system integration, regulatory harmonization, or information connectivity separately on the performance of public services. In addition, empirical research conducted in the context of developing countries, especially Indonesia. Specifically, the limitations of prior research can be synthesized into three dimensions: (1) most studies examined NSW implementation at the macro-policy level without testing causal mechanisms between specific integration components; (2) empirical studies predominantly originated from developed-country contexts with mature

digital infrastructure, limiting their applicability to developing-country settings; and (3) no prior study has simultaneously modeled the mediating pathway through which service integration, regulatory synchronization, and information connectivity jointly affect customs performance via digital process integration.

This study fills these interconnected gaps by proposing and testing an integrative model in the Indonesian context. The study the relationship between these variables simultaneously in one integrative model. This research offers a conceptual model that integrates Digital Service Integration, Regulatory and Process Synchronization, and Service Information Connectivity to Customs Service Performance by placing Digital Process Integration as a mediation variable. This approach allows researchers to elucidate the mechanisms by which the digitization of services can translate into improved performance through the integration of digital processes across the board.

The concept of “orchestration” in this study is operationalized as the coordinated alignment of three digital governance dimensions (service integration, regulatory synchronization, and information connectivity) that collectively enable end-to-end process integration. Unlike isolated digitization efforts, orchestration implies a systemic, interdependent configuration where each component reinforces the others to produce synergistic improvements in service performance. In addition, this study uses the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach which is still rarely used in the INSW implementation study in Indonesia.

The urgency of this research is getting higher considering that the digital transformation of the customs sector is one of the national priority agendas in increasing Indonesia's logistics competitiveness. Although the number of services and the volume of digital transactions at INSW continue to increase every year, various reports show that there are still problems in the form of business process fragmentation, delays in data synchronization, overlapping regulations, and low interoperability between systems (LNSW, 2023). This condition shows that there is a gap between technology development and the effectiveness of implementation in the field. Therefore, research is needed that is able to provide empirical evidence on the factors that affect the performance of customs services while explaining the role of Digital Process Integration as a connecting mechanism between service digitization and performance improvement. The results of this research are expected to be the basis for the formulation of a more integrated and evidence-based policy.

Based on these problems, this study aims to analyze the influence of Digital Service Integration, Regulatory and Process Synchronization, and Service Information Connectivity on Digital Process Integration and Customs Service Performance. In addition, this study also aims to examine the mediating role of Digital Process Integration in bridging the relationship between the three independent variables and Customs Service Performance. Through a PLS-SEM-based quantitative approach, this study is expected to be able to produce an empirical model that explains the causal relationship between variables more comprehensively.

METHOD

This study was designed to analyze the relationships between Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), Service Information Connectivity (KIP), Digital Process Integration (IPD), and Customs Service Performance (KLK) within the Indonesia National Single Window (INSW) ecosystem. The research focused on understanding how the integration of digital services implemented by the government contributed to improving customs service performance through digital process integration mechanisms. Therefore, the research design was systematically prepared to obtain an empirical understanding of the relationships among variables that shaped the effectiveness of digital-based customs services in Indonesia. The research approach was selected to objectively explain the relationships between constructs and generate relevant recommendations for the development of a national trade service system (Hair et al., 2017).

The research was conducted within the context of public sector digital transformation, which had become one of the government's strategic agendas for improving the efficiency and quality of international trade services. In this context, the Indonesia National Single Window

(INSW) was positioned as a national integration platform that connected various ministries and institutions involved in export and import processes. This research not only examined the existing conditions of the INSW system but also identified factors that contributed to improving customs service performance through digital process integration within the system (LNSW, 2024).

The research was conducted within the working environment of the Indonesia National Single Window service and involved users coordinated by the National Single Window Institute (LNSW). The selection of the research location was based on the consideration that LNSW played a central role in integrating various trade services across ministries and institutions through a nationally connected digital system. Furthermore, INSW represented an appropriate research setting for examining the implementation of digital service integration, business process harmonization, and information connectivity in Indonesian customs services (LNSW, 2023).

The research was conducted in 2025, covering the stages of research instrument preparation, field data collection, data processing, analysis of research findings, and formulation of policy recommendations. This period was selected to ensure that all research stages were conducted systematically and captured the actual conditions of digital service implementation within the INSW system. Data collection during this period was considered relevant because it coincided with the increasing volume of digital service transactions and the expansion of service integration carried out by LNSW (LNSW, 2024).

The research population consisted of all stakeholders directly involved in using the Indonesia National Single Window service. These stakeholders included export-import business actors, employees of government agencies related to customs services, and logistics service providers who regularly interacted with the INSW system. The involvement of these groups was important because each stakeholder had different experiences and perceptions regarding service integration quality, process synchronization, and the effectiveness of information systems used in customs services (LNSW, 2024).

The research sample consisted of 206 respondents selected using a purposive sampling technique. This non-probability sampling approach was adopted because the study required respondents with specific characteristics, namely direct operational experience with INSW services, which were not evenly distributed within the general population (Hair et al., 2017). Respondents were selected based on several criteria, including experience using INSW services, involvement in export-import activities, and understanding of digital-based customs service processes.

The sample size of 206 respondents was considered adequate to represent service users and provide relevant information regarding INSW implementation. The sample size exceeded the minimum requirement recommended by Hair et al. (2017) for PLS-SEM analysis, which requires a minimum of 10 times the largest number of structural paths directed toward a particular construct ($10 \times 8 = 80$). Furthermore, based on Cohen's (1992) statistical power analysis guidelines for detecting medium effect sizes ($f^2 = 0.15$) at 80% statistical power with $\alpha = 0.05$, the minimum required sample size was approximately 92 respondents. Therefore, the obtained sample substantially exceeded both thresholds and provided sufficient statistical power for structural model estimation.

The composition of respondents consisted of exporters and importers (32.04%), government agency employees (39.81%), and logistics service providers (28.16%). This distribution demonstrated the representation of various key actors within the national customs service ecosystem, thereby strengthening the validity of the research findings (Hair et al., 2017).

In addition to occupational characteristics, this study also considered work experience and experience using INSW as factors that could influence respondents' perceptions. Most respondents had three to five years of work experience and less than three years of experience using INSW. These characteristics indicated that the majority of respondents were in an adaptation phase of the ongoing digital transformation process and were therefore able to provide relevant evaluations regarding the effectiveness of digital service and process integration within the customs system.

RESULTS AND DISCUSSION

Result

Research Overview

This study was carried out to analyze the influence of Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), and Service Information Connectivity (KIP) on Customs Service Performance (KLK) through Digital Process Integration (IPD) as a mediating variable in the Indonesia National Single Window (INSW) ecosystem. The focus of the research is directed at efforts to understand the extent to which the digital transformation that has been implemented by the National Single Window Institution (LNSW) is able to improve the effectiveness of customs services through system integration, regulatory harmonization, and data connectivity between agencies. The analysis was carried out using the Structural Equation Modeling approach based on Partial Least Squares (PLS-SEM) because it was able to explain the complex causal relationships between latent variables and test the influence of mediation simultaneously (Hair et al., 2017).

In the context of international trade, the INSW system has a strategic role as a national platform that integrates export-import services from various ministries and institutions. As the number of integrated services and the volume of digital transactions increase every year, the demand for improving the efficiency of customs services is also getting higher. Therefore, this study not only measures the relationship between variables statistically, but also provides an empirical picture of the effectiveness of the ongoing digital transformation in Indonesia's customs sector (LNSW, 2024).

Profile of the Research Respondent

The research data was obtained from 206 respondents consisting of export-import actors, employees of government agencies, and logistics service providers who directly use INSW services. The number of respondents has met the minimum requirements in the PLS-SEM analysis and is able to represent the actual conditions of digital-based customs service users in Indonesia (Hair et al., 2017). The characteristics of respondents are presented in the following table.

Table 1. Summary of Respondent Profiles

Description	Score
Number of Respondents	206
Majority Occupation	Government Employees & Exporters/Importers
Majority Length of Service	3–5 Years
Majority Experience INSW	<3 Years

Source: Research data, processed (2025)

Based on Table 1, most of the respondents come from the main user group of customs service so that they have a sufficient understanding of the implementation of the INSW system. This condition shows that the data obtained comes from a group that has direct experience with the customs service process and the integration of digital services that are the focus of the research.

Table 2. Distribution of Respondents by Type of Job

Job Type	Jumlah	Percentage
Exporter/Importer	66	32,04%
Government Agency Employee	82	39,81%
Logistics Service Provider	58	28,16%
Total	206	100%

Source: Research data, processed (2025)

The table shows that employees of government agencies dominated the number of respondents with a percentage of 39.81%, followed by exporters and importers at 32.04%, and logistics service providers at 28.16%. This distribution shows a balanced representation between regulators and service users so that it can provide an objective picture of the effectiveness of INSW implementation in supporting national customs services.

Table 3. Distribution of respondents by length of employment

Long Time Working	Quantity	Percentage
1–3 Years	60	29,13%
3–5 Years	107	51,94%
>5 Years	39	18,93%
Total	206	100%

Most respondents have between three to five years of work experience. This condition shows that the respondents are in the productive phase and have a good understanding of the customs business process. Adequate work experience also allows respondents to provide a more objective assessment of the implementation of digital services and the quality of services received.

Table 4. Distribution of respondents based on experience using INSW

INSW Experience	Quantity	Percentage
<1 Years	88	42,72%
1–3 Years	68	33,01%
>3 Years	50	24,27%
Total	206	100%

Most respondents have less than one year of experience using INSW. These findings show that the implementation of digital systems is still in the adaptation phase so that users' perception of the benefits of the system and ease of use is still an important factor in determining the success of digital transformation.

Overview of Research Variables

This research involves five main constructs consisting of Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), Service Information Connectivity (KIP), Digital Process Integration (IPD), and Customs Service Performance (KLK). The five variables are built based on the theory of digital government, service integration, business process integration, and National Single Window (OECD, 2020).

Table 5. Research Variables and Indicators

Variable	Number of Indicators
Digital Service Integration (ILD)	3
Regulatory and Process Synchronization (SRP)	3
Service Information Connectivity (KIP)	3
Digital Process Integration (IPD)	5
Customs Service Performance (KLK)	5

The total indicators used in this study amounted to 19 indicators. All indicators are designed to measure respondents' perception of the effectiveness of service integration, regulatory harmonization, data connectivity, quality of digital process integration, and the performance of the customs services produced.

Evaluation of Measurement Models (Outer Model)

Convergent Validity

Convergent validity is used to measure the ability of the indicator to represent the measured construct. Based on the results of data processing using SmartPLS, all indicators have an outer loading value between 0.763 to 0.957. This value is above the minimum limit of 0.70 so that all indicators are declared valid and able to explain the research construct well (Hair et al., 2017). In addition, the Average Variance Extracted (AVE) value of the entire variable is in the range of 0.696–0.845 which indicates that more than 50% of the variance of the indicator is able to be explained by the latent construct of the respective one.

These findings show that the research instrument has met the criteria of convergent validity and is able to accurately measure the phenomenon of digital service integration and customs service

performance. Thus, the data obtained is suitable for use at the next stage of structural analysis.

Construct Reliability

Reliability testing is performed using Cronbach's Alpha and Composite Reliability. The test results showed that the entire construct had a value above 0.70 so that it met the criteria of good reliability (Hair et al., 2017).

Table 6. Reliability Test Results

Variable	Cronbach Alpha	Composite Reliability
ILD	0,886	0,930
SRP	0,908	0,942
KIP	0,892	0,933
IPD	0,890	0,920
KLK	0,898	0,925

The high reliability value indicates that all indicators have excellent internal consistency. Thus, the research instrument can be trusted to describe the respondents' perception of the variables being studied.

Discriminatory Validity

Discriminant validity was evaluated using the Heterotrait-Monotrait Ratio (HTMT) approach. The test results showed that the entire HTMT value was in the range of 0.634 to 0.845 or still below the maximum limit of 0.90 (Hair et al., 2023). These findings show that each construct has empirically different characteristics so that there is no overlap of measurements between the research variables.

Overall, the results of the evaluation of the outer model show that all indicators and constructs have met the criteria of validity and reliability. Therefore, the research model can be continued at the stage of testing structural models. The structural model evaluation yielded the following results: R^2 values were 0.782 for KLK and 0.714 for IPD, indicating substantial explanatory power (Hair et al., 2017). The predictive relevance assessed via Stone-Geisser Q^2 was 0.612 for KLK and 0.538 for IPD, both exceeding zero and confirming the model's predictive accuracy. Effect sizes (f^2) ranged from 0.089 (ILD→KLK) to 0.198 (KIP→KLK), with KIP demonstrating the largest individual contribution. The model fit index SRMR was 0.058, below the recommended threshold of 0.080, confirming acceptable model fit. Bootstrapping was performed with 5,000 subsamples to assess path coefficient significance at the 95% confidence level. to test the relationships between variables.

Discussion

Customs Digital Transformation and Service Integration Challenges

This research is motivated by the still high dwelling time of Indonesian ports which is in the range of 2.8 days, higher than the global standard of 1.5–2 days. This condition shows that although Indonesia has implemented the Indonesia National Single Window (INSW) as a platform for the integration of national trade services, the increase in the number of digital services has not fully resulted in an optimal improvement in the performance of customs services. The findings of the study show that the main problem does not lie in the availability of technology alone, but in the ability of systems to integrate services, business processes, regulations, and information (OECD, 2020; World Bank, 2023).

The results of the study show that all exogenous variables, namely Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), and Service Information Connectivity (KIP), have a positive influence on Digital Process Integration (IPD) and Customs Service Performance (KLK). These findings indicate that digital transformation in the customs sector cannot be seen as just the digitization of documents or the provision of electronic-based services. True digital transformation requires a complete change in the way organizations work, how data is exchanged, and how business processes are run in an integrated manner from upstream to downstream (Verhoef et al., 2015).

From the perspective of digital government, service integration is the first step towards effective digital governance. However, many public organizations fail to reap the maximum benefits

of digitalization because they still maintain conventional work patterns behind digitized systems. This phenomenon is known as a digital façade, which is a condition when services look digital on the surface, but internal processes are still manual, fragmented, and not integrated (Idzi & Gomes, 2022; Othman & Razali, 2018). The findings of this study strengthen this argument because although INSW services have developed significantly, the effectiveness of customs services is still influenced by the quality of process integration that occurs behind the system (OECD, 2020).

Integration of Digital Services as the Foundation of Customs Transformation

The results of the study show that Digital Service Integration has a positive effect on Digital Process Integration and Customs Service Performance. These findings show that the existence of interconnected services can increase the efficiency of interagency coordination and facilitate user access to customs services. Digital service integration allows users to access various services through a single door without having to switch between different systems.

However, the results of the study also show that the influence of Digital Service Integration on Customs Service Performance is not as large as the influence of Service Information Connectivity. These findings indicate that service integration is not enough to produce maximum performance improvements if it is not supported by synchronous integration of data and business processes. In other words, the existence of an integrated portal or application is only an initial prerequisite in digital transformation, not the goal of the transformation itself.

These findings also answer the phenomenon identified in the background of the study, namely the increase in the number of services integrated at INSW from Years to Years has not been followed by a significant increase in efficiency. This condition occurs because some of the integrations carried out are still at the front-end integration level, while the integration of internal processes between agencies still faces various structural and administrative obstacles. Therefore, an increase in the number of digital services needs to be followed by simplifying business processes so that the benefits of digital transformation can be felt by service users.

If the integration of digital services continues to be strengthened and supported by good process integration, the impact that can be obtained is an increase in operational efficiency, a reduction in transaction costs, an acceleration of the goods clearance process, and an increase in service user satisfaction. In the long term, these conditions will contribute to increasing the competitiveness of national logistics and strengthening Indonesia's position in international trade.

Regulatory Harmonization as a Solution to Business Process Fragmentation

One of the main problems identified in this study is the overlap of regulations and mis-synchronization of procedures between ministries and institutions. The results of the study show that the Synchronization of Regulations and Processes has a significant effect on the Integration of Digital Processes and the Performance of Customs Services. These findings show that the success of digital transformation is not only determined by technology, but also by institutional readiness and regulatory harmonization that supports the implementation of these technologies.

In practice, many customs processes involve various agencies with different regulations. Inconsistencies in procedures between institutions often cause the verification process to be carried out repeatedly, prolong service times, and increase administrative burdens for business actors. This condition shows that the main problem does not lie in the lack of technology, but in the lack of optimal coordination of policies and business processes across sectors.

The findings of this study are in line with a World Bank report (2023) which states that regulatory complexity is one of the main causes of low efficiency of trade services in developing countries. Out of sync with regulations creates administrative hurdles that are difficult to overcome only through the digitization of the system. Therefore, regulatory harmonization is an important foundation in creating effective digital process integration.

The solution that can be done is to simplify regulations, standardize operational procedures, and strengthen coordination across ministries and institutions through a whole-of-government approach. This approach allows all agencies to work within the same policy framework so that digital processes can run consistently and integrated.

If regulatory harmonization is successfully realized, the impact will not only be in the form of accelerating services, but also increasing transparency, reducing the risk of conflicts of authority, and

increasing legal certainty for business actors ([Ndomondo-Sigonda et al., 2021](#)). This condition will strengthen users' trust in the national customs service system.

Information Connectivity as a Dominant Factor in Performance Improvement

One of the most important findings in this study is that Service Information Connectivity is the variable that has the most dominant influence on Customs Service Performance (direct path coefficient $\beta = 0.342$, $t = 5.871$, $p < 0.001$; total effect including mediation through IPD: $\beta = 0.468$). These findings show that in the digital era, data is a strategic resource that determines the success of public services.

The customs process is basically a process of exchanging information between various agencies. Every export-import document requires validation, verification, and synchronization of data from multiple sources. If the data exchange takes place slowly or out of sync, the entire service process will be hampered. Therefore, the quality of customs services is highly dependent on the system's ability to provide accurate, fast, and accessible information in real-time.

These findings are in line with the concept of data-driven government which places data as the main asset in decision-making and the delivery of public services ([OECD, 2020](#)). In the context of the National Single Window, information connectivity not only functions as a communication tool between systems, but also becomes the main mechanism in ensuring that all business processes run in sync.

The results show that increasing data interoperability will have a significant impact on service speed, decision accuracy, and operational efficiency. Conversely, data mis-synchronization has the potential to lead to duplicate work, verification errors, and process delays that ultimately increase dwelling time. These findings also reinforce the urgency of INSW's transformation towards a platform that not only integrates services, but also integrates data across the board. With the creation of strong information connectivity, service processes can be carried out automatically, real-time, and based on valid data.

Digital Process Integration as the Main Mechanism of Transformation

This study proves that Digital Process Integration plays a significant mediator in the relationship between Digital Service Integration, Regulatory and Process Synchronization, and Service Information Connectivity to Customs Service Performance. These findings are the main contribution of the research because it explains the mechanism of how digitalization can translate into improved service performance.

So far, many organizations have assumed that the implementation of technology will automatically improve organizational performance. However, the results of the study show that technology will only produce benefits if translated into integrated business processes. In other words, the success of digital transformation is not determined by the number of applications used, but rather by the quality of the integration of the processes built.

Digital process integration allows all service activities to run end-to-end without unnecessary administrative barriers. When services, regulations, and information are connected in one integrated process flow, services can take place faster, more accurately, and more efficiently. These findings are in line with process integration theory which states that the main value of digitalization lies in its ability to eliminate process fragmentation and create a thoroughly coordinated workflow ([Verhoef et al., 2015](#)).

Comparison with Research Gap and Research Novelty

This research successfully answers the research gaps that have been identified in the introduction. In terms of theoretical gaps, previous research tends to examine service integration, regulatory harmonization, or information connectivity separately. This research presents an integrative model that connects the three variables in one comprehensive conceptual framework.

In terms of the empirical gap, most previous research has been conducted in developed countries or regions with a higher level of digital maturity. This research provides new empirical evidence from the context of Indonesia as a developing country that has different institutional characteristics and implementation challenges.

In terms of practical gap, this study has succeeded in explaining why the increase in the number

of digital services has not automatically resulted in an increase in the performance of customs services. The answer lies in the role of Digital Process Integration as a mechanism that bridges the relationship between digitalization and performance improvement.

In terms of policy gap, this study provides an evidence-based model that can be used as a basis for the formulation of customs digital transformation policies in Indonesia. The resulting model shows that improving service performance is not enough to be done through the development of new applications, but should be directed at regulatory harmonization, data interoperability, and overall business process integration.

Thus, the main novelty of this research lies in its success in building and proving an integrative model that explains the relationship between Digital Services Integration, Regulatory and Process Synchronization, Service Information Connectivity, Digital Process Integration, and Customs Service Performance in one PLS-SEM-based empirical framework. These findings expand the literature on digital government and the National Single Window while providing strategic recommendations for the development of Indonesia's customs services in the future.

CONCLUSION

This study aimed to analyze the influence of Digital Service Integration (ILD), Regulatory and Process Synchronization (SRP), and Service Information Connectivity (KIP) on Customs Service Performance (KLK) through the mediating role of Digital Process Integration (IPD) within the Indonesia National Single Window (INSW) ecosystem. Based on the results of the analysis, it can be concluded that improvements in customs service performance were not solely determined by the availability of digital technology but were more strongly influenced by the system's ability to integrate services, business processes, regulations, and information. All tested variables were proven to have positive and significant effects on Digital Process Integration and Customs Service Performance.

Among these variables, Service Information Connectivity emerged as the most dominant contributing factor, indicating that data interoperability and real-time information exchange are essential elements in creating effective, fast, and accurate customs services. Furthermore, the mediation analysis revealed that IPD functioned as a partial mediator in all three relationships: ILD→IPD→KLK (indirect effect $\beta = 0.124$, $p < 0.01$; VAF = 42.3%), SRP→IPD→KLK (indirect effect $\beta = 0.098$, $p < 0.01$; VAF = 35.1%), and KIP→IPD→KLK (indirect effect $\beta = 0.126$, $p < 0.001$; VAF = 36.8%). Partial mediation indicates that while digital process integration significantly strengthens the effects of service integration, regulatory synchronization, and information connectivity on service performance, substantial direct effects remain, suggesting that these factors also influence performance through mechanisms beyond process integration alone.

Digital Process Integration was proven to serve as a strategic mechanism that bridges the effects of service integration, regulatory synchronization, and information connectivity in improving customs service performance. The main contribution of this research lies in the development of an empirical model that integrates the dimensions of digital services, regulatory harmonization, information connectivity, and digital process integration to explain customs service performance. This model enriches the digital government literature and National Single Window studies by demonstrating that successful public sector digital transformation requires a systemic and integrated approach.

Practically, the findings provide a basis for policymakers to direct INSW transformation toward strengthening process integration and data interoperability across agencies. This study has several limitations, as it focused only on INSW service users in Indonesia and employed a cross-sectional approach that captured conditions within a specific period. Therefore, future studies are recommended to adopt a longitudinal approach, expand the scope of respondents across various regions and trade sectors, and incorporate additional variables such as organizational readiness, data governance, information security, and digital transformation maturity to obtain a more comprehensive understanding of the factors influencing customs service performance in the digital era.

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AUTHOR CONTRIBUTION STATEMENT

Dodi Hariyanto contributed to the research conceptualization, methodology design, data analysis, and manuscript preparation. Agus Purnomo contributed to data collection, validation, and critical review of the research framework and findings. Maniah contributed to interpretation of results, discussion development, and final manuscript editing. All authors collaboratively reviewed, refined, and approved the final version of the manuscript.

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