



CRITICAL DETERMINANTS OF UNCERTAINTY IN INDONESIAN'S CONTAINER SHIPPING INDUSTRY

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Abstract

The current research explores the aspects contributing to uncertainty in Indonesian container shipping from the viewpoints of shipping lines and freight forwarders. The data exhibited a non-normal distribution with a total of 338 respondents, 172 from shipping lines and 166 from forwarders, hence a non-parametric methodology was implemented (the Friedman and Mann-Whitney U tests). Notably, schedule precision emerges as the prime performance determinant for both shipping lines and freight forwarders, closely shadowed by safety and security, with no significant divergence in their perceptions of these factors ($p\text{-value} > 0.05$). However, forwarders attribute remarkably greater importance to administrative technical hurdles owing to their extensive involvement in documentation and licensing, diverging explicitly from the view of shipping lines ($p\text{-value} < 0.05$). Other aspects such as container conditions, external influences, and loading/unloading processes revealed no substantial variance. The study recommends harmonized administrative practices to boost collaboration and streamline processes, potentially enhancing global supply chain dependability. Through a shared-focused approach and improved administrative practices, the container shipping industry can reduce risks, bolster efficiency and strengthen the reliability of global supply chains.

Keywords: container shipping, uncertainty factors, shipping liners, forwarder, non-parametric analysis

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INTRODUCTION

In Indonesia, the container shipping industry is marked by its complexity, driven by factors such as technological adaptation, safety standards, infrastructure, and corporate image. PT Pelindo Terminal Petikemas, as a major player in the marine logistics sector, experience how these factors interplay to influence operational efficiency and strategic orientation. The transition from paper based to electronic system and the emphasis on Rubber Tyred Gantry (RTGC) Cranes' efficiency exemplify efforts to reduce uncertainties in container delivery. Such operational changes, alongside strategic enhancements like digital asset management and employer branding, are vital for maintaining competitiveness within Indonesia's bustling maritime logistics landscape. Research on RTGC performance indicated that one of the main topics was on container reception and delivery process; the result of the research indicated that if reception and delivery was executed on time it was also one of the main contributor to TOS crane performance, therefore this means any abnormalities on this procedure could easily trigger uncertainty on its expected delivery time (Cantias et al., 2019). Moreover, as detailed in the study concerning online delivery orders, the transition from paper-based to electronic systems for the management of receipt of delivery orders and container interchange receipts aims to reduce uncertainty by quite literally optimizing processes to facilitate the flow of imported goods. However, in certain sectors, persisting with human methodologies may create uncertainty to some degree regarding delivery periods (Prastyorini & Syaputra, 2020). Moreover, environmental concern, particularly those impacting the construction industry, pose significant uncertainties, affecting project schedules and logistics (Ignatius et al., 2024). This study seeks to examine the views of organizations uncertainty, including logistical complications, regulatory changes, unpredictable operating costs, and external factors like weather conditions and geopolitical risks.

Given the differing focusses of Shipping lines and freight forwarders, their perceptions of what primarily driven uncertainty may vary. Shipping lines typically prioritize aspects such as fuel expenses, route optimization, and port timetables, whereas freight forwarders may emphasize port congestion, customs requirements, and availability of inland passage. This study aims to provide deep insight into how different logistics chain parties perceive uncertainty in container shipping, fostering the development of tailored risk management solutions that effectively address the specific needs and challenges of each type of organization. The transition from exploring the operational factors influencing container shipping in Indonesia to broader examination of the literature, it become clear that the uncertainties discussed are not isolated to local contexts but are echoed globally across the logistics sector. While discussing strategies for uncertainty management in shipping and logistics, it is beneficial to draw parallels with other industries. For instance, a systematic literature review on delay mitigation strategies within the construction industry reveals various approaches that could

potentially be adapted to maritime logistics to enhance efficiency and reduce disruptions (Abd Aziz et al., 2022).

Following this introduction, the paper is organized as follows to further elaborate on container shipping uncertainties. In the Literature Review the existing research are elaborated and illustrated how global and local factors are interacting by affecting operation efficiencies and creating uncertainties in the maritime logistics sector. We now move to the Research Methodology section, where the mixed methods used to collect and analyze data are described, which are an integrated part of the framework to understand the dynamics at play. The implications of the data are then critically analyzed in the Analysis and Discussion section, translating passive information into a meaningful overview of the management and mitigation of operational, environmental, and/or technical challenges. Lastly, the Conclusion section summarizes these insights and provides recommendations for industry stakeholders, as well as potential avenues for further research. The structured nature of umbrella reviews allows for the identification of key issues and may contribute to a more thorough exploration of each issue, thereby facilitating a better understanding of the challenges in container shipping and potentially more targeted solutions.

LITERATURE REVIEW

The issue of uncertainty and its effects on the dispatching of containerized cargo is a complex problem that needs to be addressed through multiple lenses, including operational, environmental, and technical perspectives. These uncertainties can impact service providers as well as consumers in terms of the efficiency and reliability of container delivery. As studied under exchange economies, the uncertain delivery in markets suggests that the voting power of agents could affect delivery in a more general sense, emphasizing the ability of agents to distinguish between products. This notion is pertinent as uncertainties in the maritime container supply process, exacerbated by global issues, lead to disruptions and delays, causing substantial financial losses for logistics companies (Shin et al., 2024). Especially for Shipping liner and Freight forwarder which affected those uncertainty. The shipping industry can be substantially impacted by the uncertainty surrounding liner shipping container operations, which can affect both operational efficiency and supply chain reliability. The unpredictability of shipping schedules, with over 40% of vessel arriving late, exacerbates this issue, leading to the rising costs for shippers and consignees and the increased level of safety stock (ITF, 2022). Container accidents, frequently attributable to controllable human factors such as improper loading, lead to operational disruptions and financial losses, underscoring the necessity of following to safety protocols to mitigate these risks (Babu & Aithal, 2023). Human factors are among the most common causes of operational disruptions that contribute to financial losses and can be prevented by following to safety

protocols. Container shipping's uncertainty significantly impacts goods forwarders, as it paves a way for many aspects of their operations and decisions. This uncertainty could lead to increased time costs and pressure on the global supply chain, since delayed container shipping would precipitate asymmetrical responses, as longer delays increase supply chain pressure but shorter delays do not alleviate it as rapidly (AÇIK, 2023; Jia et al., 2020). Moreover, the structural transformations in the container shipping sector, including the exit of shipping lines and the establishment of strategic alliances, have engendered additional uncertainty. These alterations require ocean freight forwarders to focus more intently on cargo claims, operational dynamics, and risk management to maintain competitiveness and responsiveness to shippers' logistical requirements (Lu & Wu, 2022).

On this matter, the fluctuating global fuel prices have one of the biggest impacts on operational costs, whereas these changes in circumstances demand a model to ensure the viability of the routes deployed (Huang et al., 2024). Forecasting periods for shipments is a critical aspect as unforeseen disruptions such as inclement weather, port congestion, and geopolitical tensions can delay shipments and necessitate near-real time ship schedule retrieval technologies to mitigate the impacts (Elmi et al., 2022; Mike, 2022). The need to continuously adjust shipping networks and reposition fleets along the regional coastlines in response to continuous changes in container demand volumes and uncertain voyage durations leads to administrative and procedural uncertainties (Kuhlemann et al., 2021). External factors like political instability and the lingering impact of the COVID-19 pandemic also complicate shipping operations as they affect demand patterns and create supply chain disruptions. Technologically advanced ships' increasing vulnerability to cyberattacks poses further safety and security challenges that can affect shipping schedules and operations (Mike, 2022).

Uncertainty affects the loading and unloading operations due to port capacity and variation in handling times at ports, which can cause significant delays (Ksciuk et al., 2023). The imperative to develop infrastructure is a costly and lengthy process that is compounded by the limitations of port capacity (Mike, 2022). A recent study on Malaysian logistics and infrastructure management indicates similarities with Indonesian condition both address logistics uncertainty, while Tarudin et al. (2023) discuss the strategic planning needed for the green logistics adoption and emphasize that some sustainable practices could reduce uncertainty in container shipping. This reference is essential as it corresponds with the operational and environmental solutions that may be implemented in Indonesia to improve the predictability and dependability of shipping operations. The unpredictability of container slot reservations resulting from fluctuating demand can cause revenue losses and suboptimal ship capacity utilisation, necessitating the implementation of strategic booking and reservation

fee models to enhance profitability (Guo et al., 2021). Emerging shipping routes, such as the Northern Sea Route, allow uncertainties about meteorological and oceanographic conditions in these regions, which can affect the stability of such ways and the tendency of shippers to use these ways (Li et al., 2022). The strategic sourcing of liner services further complicates the process of considering service schedules and their impact on supply chain resilience in the face of demand uncertainties (Lee et al., 2021). Since liner services may also have a considerable impact on how the supply chain withstands uncertainties. The container shipping industry must navigate an intricate web of uncertainties and challenges that require them to implement innovative strategies and agile approaches to maintain functional efficiency and competitiveness within a rapidly changing world. Therefore, this study aims to identify and analyse in depth the most significant uncertainty factors, as well as their impact on the operational performance of both parties. This analysis is expected to provide clearer insights into the variables that affect container shipping, so that it can help industry players in developing risk mitigation strategies and planning that are more adaptive to global dynamics.

RESEARCH METHODOLOGY

In this study, was employed a mixed-methods approach (qualitative & quantitative) to analyze uncertainty in Indonesia's container shipping sector, as depicted in the figure 1. According to statistical principles (Memon et al., 2020), ten standardized factors were pre-identified for shipping liners and forwarders (10 factors) subsequently setting the minimum required number of 100 respondents per sector. Case studies and surveys were used to collect data through INAPORTNET, with purposive sampling for active users. Uncertainty is shaped by factors such as safety/security, schedule reliability, container condition, enable-costs, regulatory and non-regulatory import barriers, process, port capacity, exogenous, and loading/unloading. So, these independent variables influence perceived uncertainty in shipping operations. The selection of factors was driven through expert input, literature review, and preliminary data analysis. To test for robustness and compare uncertainty perceptions between shipping liners and forwarders, statistical methods including normality tests, validity tests, the Friedman test, and the Mann-Whitney U test were used

Upon conducting the Friedman test to compare the perceptions of uncertainty factors, the study proceeded to analyze the similarities and differences in perception between the groups. This further analysis was critical in identifying specific areas of consensus and divergence in views on operational uncertainties. The findings from these analyses were then meticulously summarized, highlighting the implication for the shipping industry. This comprehensive assessment not only detailed the individual and collective impacts of these factors but also provided actionable insights into addressing the

underlying causes of uncertainty in container shipping operations. The test's results are expected to provide broader insights into the major drivers of uncertainty in container shipping and explain possible differences in the perception and striving for those challenges between both types of organizations.

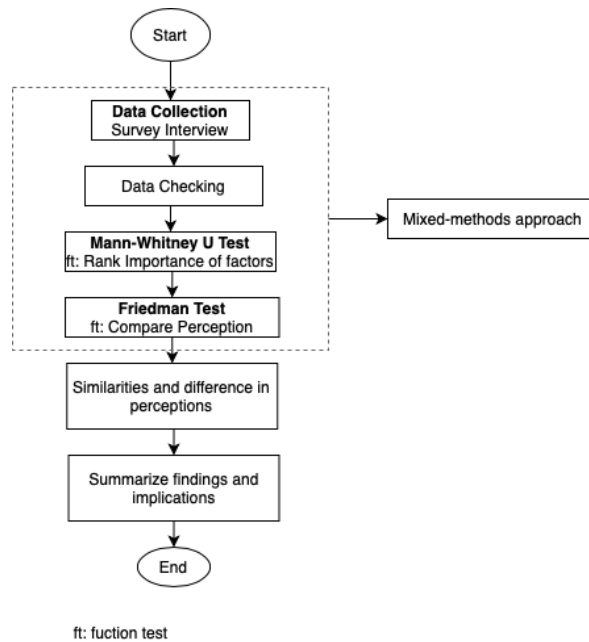


Figure 1: Nonparametric Statistical Tests

Mann-Whitney U

Building upon the principles of the Mann-Whitney U test as explained by Hascheck et al. (2013), a non-parametric method ideal for non-normally distributed data and small sample size, was employed in our study to compare the perceptions of shipping liner and freight forwarder companies on factors contributing to uncertainty in container shipping. Hashim Lim et al. (2023) was exploring utilize the Mann-Whitney U Test that focuses on factor influencing transport mode shift due to COVID-19, notably highlighting hygiene and comfort. This methodological similarity enriches our understanding of how non-parametric tests can effectively analyse shifts in transportation preferences under varying circumstances. The null hypothesis from this method assumed no significant difference between the group, while the alternative suggested significant perceptual difference. We aggregated response, calculated total ranks for each group using formula (1) and (2) as below:

$$U_x = R_x - \frac{nX(nX + 1)}{2} \quad (1)$$

$$U_y = R_y - \frac{nY(nY + 1)}{2} \quad (2)$$

In where R_X and R_Y are the rank sums for shipping liners and forwarders, and N_X and N_Y are their respective group sizes. Due to the large category of tied responses at least with respect to the less influential factors, the procedure for handling ties was applied in the Mann–Whitney U test and we averaged the ranks to provide a more analytical approach.

Friedman Test

In particular, the Friedman test investigates uncertainty in container transportation by breaking down uncertainties to their respective determinants that can be tracked through dataset from shipping liners and forwarders. It is a non-parametric test that doesn't assume normality of data, which is perfect as our distributions are non-normal. The formula X_F^2 for computing the test statistic is:

$$X_F^2 = \frac{12N}{K(K + 1)} \left[\sum_{j=1}^K R_j^2 - \frac{K(K + 1)^2}{4} \right] \quad (3)$$

Where N is the total subjects per group, K is the number of groups, and R_j is the sum of ranks for the j^{th} group. If the computed statistic exceeds the chi-square critical value at 0.05 **significance**, the null hypothesis is rejected, indicating significant factor differences. This study applies the **T-Friedman test** by Liu & Xu (2022) refining statistical analysis by incorporating a conservativeness parameter to address data imperfections and variance homogeneity. This enhances analytical precision, aligning statistical methods with data characteristics for better decision-making in container shipping.

ANALYSIS AND DISCUSSION

This study involved a survey questionnaire was distributed to some of shipping liner and Forwarder companies and there were 338 responds with 172 from shipping liner and 166 from forwarder. As outlined in the methodology, a minimum of 10 respondents per factor was required. With ten factors identified (Memon et al., 2020), this established a threshold of 100 respondents per sector. This approach, detailed in the methodology, helps maintain the reliability and validity of the analysis by adequately powering the statistical tests for each variable, thus preventing overfitting and ensuring stable results across predictive models. The number of respondents in this study meets these criteria, confirming the methodological soundness and strengthening the findings derived from the

data. Based on findings from previous studies, this survey analyses the factors affecting container shipping. A normality test was performed after data collection to evaluate the distribution of the data, ensuring the applicability of subsequent statistical analyses. Each attribute significantly influences the operational uncertainty in shipping, affecting everything from logistical delays to cost management and overall operational efficiency. Table 1 shows that the Kolmogorov-Smirnov normality test results of all variables show that significance values are less than 0.05. Performance distributed across multiple factors including safety, punctuality, cost and technical effectiveness display non-normal data distributions. So, to analyze further using a more flexible model to better fit the data behavior and trends a non-parametric method.

Considering the complex challenges earlier recognized this study examines ten individual factors that significantly add to the uncertainty in container shipping. As discussed previously, each of these variables plays a unique role, affecting the operational efficiency and reliability. Their safety implications are risks in manipulating and transport, possibly resulting in postponement of proceedings and added liability in common. Secondly, delays can disrupt the supply chain, and therefore timeliness is of utmost importance, along with the potential issues of cost variability, which makes financial planning challenging due to varying fuel prices and other geopolitical issues. Process inefficiencies and resource waste are a direct result of operational effectiveness, technical constraints, and efficiency levels. The unloading speed, management quality, and outside factors such as weather conditions and container conditions are also significant, pointing to the complex and interlinked nature of practical, operative and external factors governing the uncertainty in the industry. All these plays in tandem to amplify the intricacy of the container shipping sector and together elucidate the interdependence nature in logistics, operations and the external impact which results in the overall uncertainty for shipping companies.

Table 1: Normality Test

Factors	Statistic	Sig
Safety and Security	0.185	<0.001
Schedule Accuracy	0.235	<0.001
Container Condition	0.161	<0.001
Costs	0.189	<0.001
Administrative Technical Effectiveness	0.106	<0.001
Administrative Technical Barriers	0.103	<0.001
Process Efficiency	0.147	<0.001
Port Capacity Management	0.148	<0.001
Influence of External Factors	0.139	<0.001
Loading and unloading	0.154	<0.001

Given the multifaceted challenges identified within the container shipping industry, it becomes evident that traditional parametric testing methods are inadequate due to the non-normal distribution of data. As evidenced by the normality test results, the data containing these factors do not fit a normal distribution, necessitating the use of the Friedman Test. This non-parametric method is crucial for evaluating differences among the factors influencing uncertainty in container shipping. According to the results of the Friedman Test presented in Table 2, there is a significant variation in how the 338 respondents perceive these uncertainty factors. The test yields a Chi-Square value of 864.191 ($p < 0.001$), highlighting distinct priorities among the factors. Notably, schedule accuracy emerges as the most critical factor, with a mean rank of 2.85, underscoring its pivotal role in shaping operational efficiency and customer satisfaction amidst the prevailing uncertainties.

Besides the punctuality, it is believed that the safety and security factors (mean rank 3.91) and cost (mean rank 4.07) are also significant. The risk of damage to or loss of goods in transit could increase uncertainty, and variability in operating costs, such as gasoline prices and port fees, could affect a company's bottom line. In contrast, port capacity management variables (mean rank 7.37), and loading and unloading operations (mean rank 7.34) are considered less critical in generating shipping uncertainty. Process efficiency (mean rank 6.78) and influence of external factors (mean rank 6.91) are in between, but are even lower ranked than punctuality or cost. For instance, as illustrated in earlier research, the accuracy of the timetable becomes the most relevant aspect of uncertainty (mean rank 2.85), which emphasizes the more frequent concerns about being timely in shipping operations. Similarly, safety (mean rank 3.91) and expenses (mean rank 4.07) are often cited as major drivers of uncertainty, which also aligns with global research. Notably, this study finds that administrative technical issues create a much greater level of uncertainty for Forwarders (p -value < 0.05), a finding that is rarely highlighted in other research. Unlike global-studies medium-grade path forming that dominantly elaborates the operational efficiency and cost aspect, this research explicates Forwarders in Indonesia are having more ambiguity likely in documentation and license pathways. It could be more about the complex landscape of a regulatory structure within the port in Indonesian ports, whereby, the Forwarders more practically take charge of the administrative task than Shipping Liner. Moreover, port capacity management and loading/unloading processes were ranked relatively lower in importance by respondents, in contrast to previous studies that had a higher emphasis on system-failure or infrastructure/operational bottlenecks, as though van Battum et al. (2023) the bottleneck mitigation cycle for container terminals, which not only addresses single bottlenecks but also considers their interdependencies and the need for real-time application.

Table 2: Friedman Test Results for the Ranking of Container Shipping Uncertainty Factors Based on Respondents' Perceptions

Factors	Mean Rank
Safety and Security	3.91
Schedule Accuracy	2.85
Container Condition	4.38
Costs	4.07
Administrative Technical Effectiveness	5.72
Administrative Technical Barriers	5.68
Process Efficiency	6.78
Port Capacity Management	7.37
Influence of External Factors	6.91
Loading and unloading	7.34
N	338
Chi-Square	864.191
Asyp.Sig	<0.001

This discrepancy might hint at Indonesia's particular challenges, in which administrative bottlenecks and regulatory hindrances tend to trump more classical operational ones. Thus, this research not only supports a number of existing uncertainty factors, but also extends it by emphasizing administrative technical barriers which is an important but less-explored floor in the scheme of Indonesian container shipment. In Table 3, Mann-Whitney U Test compares Shipping Liners and Forwarders perception about uncertainty factors of container shipping. Most of the factors are considered common for both organizations as safety, punctuality, cost, process efficiency, and port capacity management are significant factors with $p\text{-value} > 0.05$. Significant differences, however, arise regarding administrative technical redundancy restrictions, considered more relevant to forwarders ($p\text{-value} < 0.05$), probably due to their involvement in document management and licensing. There are other variables such as container conditions, external factors, loading and unloading processes that do not show a significant difference so that in general both Shipping Liners and Forwarders have a similar perspective in dealing with shipping uncertainty, except for the administrative level.

Table 3: Mann-Whitney U Test Results on Uncertainty Factors in Container Shipping between Shipping Liners and Forwarders

Factor(s)	Mann-Whitney U	Z	p-value
Safety and Security	13,098.5	-1.320	0,128
Schedule Accuracy	19,3398	-1.005	0,219
Container Condition	12,924	-1.518	0,089
Costs	14,176	-0.113	0,632
Administrative Technical Effectiveness	13,501	-0.868	0,267
Administrative Technical Barriers	11,699.5	-2.886	0.004
Process Efficiency	13,288	-1.110	0,185
Port Capacity Management	14,022	-0.287	0,537
Influence of External Factors	13,670	-0.682	0,344
Loading and unloading	13,890.5	-0.434	0,461

The findings of this study are essentially a reflection of the operational shortcomings tackled by Mohd Fateh et al. (2023) who researched improvement in consultants and contractors communication during construction in Malaysia. Similar to that of the Indonesian scenario, Mohd Fateh et al. emphasise the need for streamlined processes and enhanced collaboration between actors to reduce uncertainty. It demonstrates that the proposed solutions to control for and/or alleviate the discovered sources of uncertainty in Malaysian construction logistics are arguably applicable in the Indonesian container shipping domain as well.

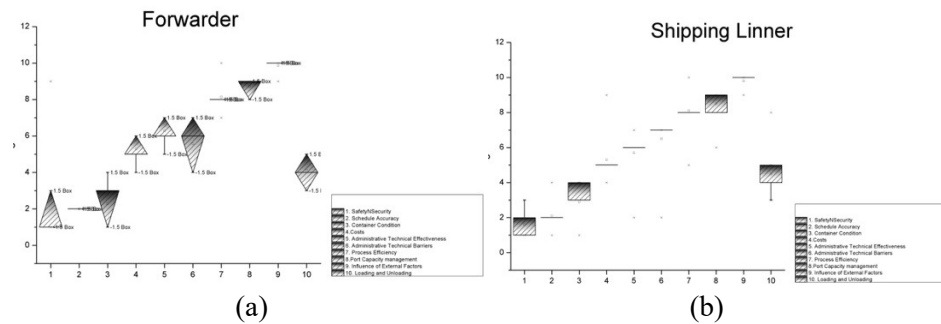


Figure 2. Distribution of Uncertainty by (a) Forwarder; (b) Shipping Liner

Figures 1 (a) and (b) show the distribution of uncertainty factors in container shipping in the views of forwarders and shipping liners, respectively. As shown with the boxplot, forwarders have a larger spread of data, especially in administrative technical barriers and port capacity governance, which points towards a more diverse experience in terms of being exposed to operational uncertainties. For shipping liners, they display a more organized and even spread, backed by safer & security and more controlled schedule accuracy. External factors and port capacity management are perceived by both groups as major sources of uncertainty. This divergence in distribution indicates that

shipping liners are relatively more stable, while forwarders are mainly driven by admin/regulatory aspects. That is the key to decreasing uncertainty and increasing certainty in maritime supply chain reliability by improving administrative efficiency, optimizing port capacity, and implementing risk mitigation.

In addition, as Table 2 the grouped boxplot which visually compares the distributions of different uncertain factors in container shipping with regard Shipping Liners and Forwarders, revealing quite similar distributions around medians. Both groups have a very similar IQR (Interquartile range), which means most of the data is found in a similar spread. Despite this, outliers and small variations in whiskers indicate that the more extreme cases are more extreme on one side than the other which can be explained by differences in operational structure, in that Shipping Liners maintain a more stable, internally influenced process whereas Forwarders are much more influenced by external and administrative factors. The diamond boxplot gives us additional indication of a relatively symmetric distribution, suggesting that the levels of uncertainty in both groups are evenly distributed without significant skew, one way or another. What this signifies is that the uncertainty is equal for Forwarders and Shipping Liners, but the reasons may be different. As a result, risk mitigation must be directed towards improving operational efficiency and regulatory management for Forwarders and Shipping Liners, whereas the priority must be in optimizing capacity management and reducing external shocks.

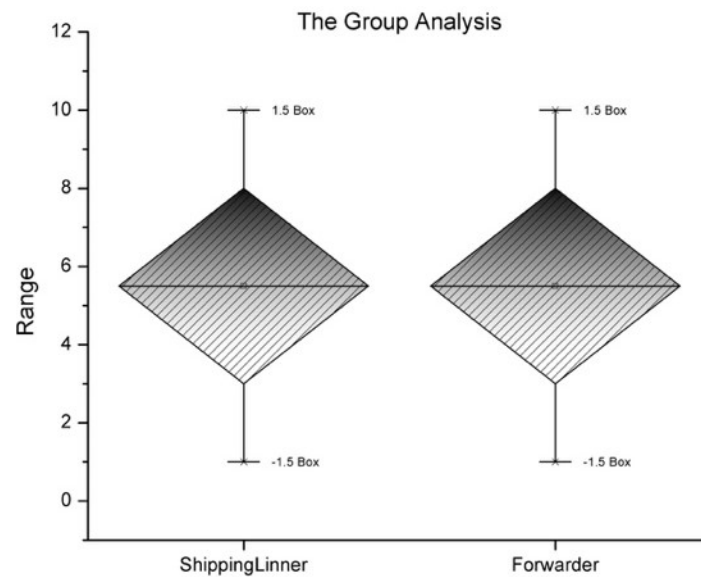


Figure 3. Distribution of Uncertainty by Group

CONCLUSION

Through this study, uncovered how great the difference is between the shipping liner and the freight payment regarding those uncertainty variables that affect Indonesian container shipping. Most respondents emphasized the fundamental nature of punctuality, saying it was more important than safety and cost combined. They are widely recognized to affect both operational efficiency and customer satisfaction of shipping industries. It would be prudent to suggest that the observed variations in effectiveness among stakeholders were perceived not as failings, but as opportunities to enhance administrative technical controls. This perspective was broadly shared across the industry, as evidenced by shipping liners and forwarders collectively emphasizing the assurance of safety, timely dispatch and receipt of shipments, improved efficiency within the booking sequence, and more strategic distribution of port capacities. Such concerted efforts were underpinned by a thorough commitment to bolstering operational integrity. Supplementary Issues Administrative and documentation issues such as forwarders' licenses are significant issues in this direction and urgently require the sector to revise its administration system to increase its overall efficiency and significantly reduce uncertainty. A consensus of views on operational issues indicates a good basis for coordination to address common issues. Nevertheless, while such differences need to be addressed each group has its challenges that need specialized approaches that cater specifically to the diversity of these groups and their work environments. Policymakers and business leaders involved in creating rules and technologies intended to reduce bureaucratic friction and improve transparency need to bear these findings in mind.

There is a lot of additional research needed into how digital solutions (e.g., blockchain, artificial intelligence) should be applied to combat some of the administrative frictions and enable data to be available and transparent in real time. Going forward, comparative studies with other states with an international maritime outlook could showcase best practices and concepts that might be transferable to the Indonesian context. This study presents some of the fundamentals that create uncertainty for container shipping and advocates for strategic reforms and technologies. Working with common and niche vulnerabilities, the industry can enable and enable practices that support resilience, reliable and ultimately stewardship of the global marketplace.

ACKNOWLEDGEMENT

The author would like to express sincere gratitude to Universitas Indonesia for the financial support provided through the PUTI Pascasarjana 2023 program, a Competitive Research Grant. This funding made the research and its completion possible.

REFERENCES

- Abd Aziz, N., Mohd Rahim, F. A., & Aziz, N. M. (2022). DELAY MITIGATION STRATEGIES AND THE IMPLICATION ON THE CONSTRUCTION INDUSTRY: A SYSTEMATIC LITERATURE REVIEW. *PLANNING MALAYSIA*, 20. <https://doi.org/10.21837/pm.v20i24.1199>
- AÇIK, A. (2023). Analyzing the impact of container shipping service reliability on global supply chain pressure: An asymmetric approach. *Marine and Life Sciences*, 5(2), 40–50. <https://doi.org/10.51756/marlife.1345168>
- Babu, B. M., & Aithal, P. S. (2023). Critical Analysis of Container Accidents in International Logistics. *International Journal of Case Studies in Business, IT, and Education*, 194–204. <https://doi.org/10.47992/IJCSBE.2581.6942.0296>
- Cantias, R., Riyanti, R., Apriyadi, D., Sirait, D. P., Bagus, C., & Dwisa, P. (2019). The Effect of Container Receiving/Delivery to the Efficiency of RTGC's Performance with the Case Study in TPS 223X Terminal Support Division PT IPC Terminal Petikemas. *Global Research on Sustainable Transport & Logistics*, 2, 133–141.
- Elmi, Z., Singh, P., Meriga, V. K., Goniewicz, K., Borowska-Stefańska, M., Wiśniewski, S., & Dulebenets, M. A. (2022). Uncertainties in Liner Shipping and Ship Schedule Recovery: A State-of-the-Art Review. *Journal of Marine Science and Engineering*, 10(5), 563. <https://doi.org/10.3390/jmse10050563>
- Guo, Y., Yan, R., & Wang, H. (2021). Maximization of container slot booking profits for carriers in the liner shipping industry. *Journal of Shipping and Trade*, 6(1), 18. <https://doi.org/10.1186/s41072-021-00100-7>
- Hascheck, M. W., rousseaux, C. G., & Wallig, M. A. (2013). *Haschek and Rousseaux's Handbook of Toxicologic Pathology* (W. M. Haschek, Ed.). Elsevier. <https://doi.org/10.1016/C2010-1-67850-9>
- Hashim Lim, N. H., Teh, B. T., Nik Hashim, N. H., Supramanian, R. K., & Baharudin, U. W. (2023). FACTORS INFLUENCING PRE- AND POST-COVID-19 TRANSPORT MODE SHIFT IN WORKPLACE TRAVEL. *PLANNING MALAYSIA*, 21. <https://doi.org/10.21837/pm.v21i29.1361>
- Huang, X., Chen, H., Zhang, J., Wang, D., Chen, J., & Luo, J. X. (2024). ROBUST OPTIMIZATION MODEL OF CONTAINER LINER ROUTES IN FEEDER LINE NETWORK. *Transport*, 39(1), 13–24. <https://doi.org/10.3846/transport.2024.20531>
- Ignatius, J., Li, R., Yin, Y., & Jia, K. (2024). Steering through the storm: Environmental uncertainty and delivery performance. *Journal of Operations Management*, 70(8), 1286–1309. <https://doi.org/10.1002/joom.1331>
- ITF. (2022). *Performance of Maritime Logistics*. <https://doi.org/10.1787/8e06fcd1-en>
- Jia, H., Lee Lam, J. S., & Tran, N. K. (2020). Spatial variation of travel time uncertainty in container shipping. *Transportation Research Procedia*, 48, 1740–1749. <https://doi.org/10.1016/j.trpro.2020.08.210>
- Ksciuk, J., Kuhlemann, S., Tierney, K., & Koberstein, A. (2023). Uncertainty in maritime ship routing and scheduling: A Literature review. *European Journal of Operational Research*, 308(2), 499–524. <https://doi.org/10.1016/j.ejor.2022.08.006>
- Kuhlemann, S., Tierney, J., Tierney, K., & Koberstein, A. (2021). The stochastic liner shipping fleet repositioning problem with uncertain container demands and travel

- times. *EURO Journal on Transportation and Logistics*, 10, 100052. <https://doi.org/10.1016/j.ejtl.2021.100052>
- Lee, C., Shu, S., & Xu, Z. (2021). Optimal Global Liner Service Procurement by Utilizing Liner Service Schedules. *Production and Operations Management*, 30(3), 703–714. <https://doi.org/10.1111/poms.13311>
- Li, M., Xie, C., Li, X., Karoonsoontawong, A., & Ge, Y.-E. (2022). Robust liner ship routing and scheduling schemes under uncertain weather and ocean conditions. *Transportation Research Part C: Emerging Technologies*, 137, 103593. <https://doi.org/10.1016/j.trc.2022.103593>
- Liu, J., & Xu, Y. (2022). T-Friedman Test: A New Statistical Test for Multiple Comparison with an Adjustable Conservativeness Measure. *International Journal of Computational Intelligence Systems*, 15(1), 29. <https://doi.org/10.1007/s44196-022-00083-8>
- Lu, H.-A., & Wu, L. X. (2022). Influence of Structural Variation of Container Shipping Industry towards Ocean Freight Forwarders. *KMI International Journal of Maritime Affairs and Fisheries*, 14(1), 55–76. <https://doi.org/10.54007/ijmaf.2022.14.1.55>
- Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling*, 4(2), i–xx. [https://doi.org/10.47263/jasem.4\(2\)01](https://doi.org/10.47263/jasem.4(2)01)
- Mike, J. (2022). *Challenges of Cargo Shipping in 2022*. UNC Dataverse, Harvard Dataverse.
- Mohd Fateh, M. A., Arshad, R. A., Ahmad Marzuki, S. M., & Yusof, M. R. (2023). IMPROVEMENTS OF THE COMMUNICATION BETWEEN CONSULTANTS AND CONTRACTORS DURING THE CONSTRUCTION PHASE IN MALAYSIA. *PLANNING MALAYSIA*, 21. <https://doi.org/10.21837/pm.v21i26.1261>
- Prastyorini, J., & Syaputra, F. A. (2020). Penukaran Delivery Order Online dan E-Container Equipment Interchange Receipt Terhadap Impor Barang Menggunakan Petikemas. *Majalah Ilmiah Bahari Jogja*, 18(1), 57–70. <https://doi.org/10.33489/mibj.v18i1.228>
- Shin, T.-Y., Kwon, M.-K., & Jeong, Y.-J. (2024). A Study on The Impact of Uncertainty on Container Supply Process Using System Dynamics. *Korean Logistics Research Association*, 34(4), 1–15. <https://doi.org/10.17825/klr.2024.34.4.1>
- Tarudin, N. F., Adlan, M. A. A., Md Hanafiah, R., Mohd Nusa, F. N., & Mohd Yusoff, Z. (2023). THE STRATEGIC HGVS PLANNING PRACTICES FOR SUSTAINABLE GREEN LOGISTICS IMPLEMENTATION. *PLANNING MALAYSIA*, 21. <https://doi.org/10.21837/pm.v21i28.1319>
- van Battum, C. H. H., Wiegman, B., Atasoy, B., van Wingerden, E., de Waal, A., & Tavasszy, L. A. (2023). Performance improvements in container terminals through the bottleneck mitigation cycle. *Maritime Economics & Logistics*, 25(1), 174–195. <https://doi.org/10.1057/s41278-022-00245-7>

Received: 2nd May 2025. Accepted: 10th September 2025