Technology-Enabled Strategy for Optimizing 40-Foot Container Utilization in Export Logistics: An AHP Case Study of a Shipping Sub-Agent Company in Semarang

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Abstract. Objective of the research: the aim of this study is identify the causes of the shortage of 400-foot containers in export logistic. This study also explore the shipping sub agent company strategies in Semarang. This study determine the most important solution through a technology based approach to improve container use. Method of the study: descriptive case study used in this research. The data collection done by interview, observation, documentation and Analytical Hierarchy Process (AHP) questionnaires. The result: the shortage of 40-foot is caused by several factors such as unequal distribution of container, the change of demand, operational challanges, container mismatch and inefficient operation. Several strategies is already applied by the company. The strategies are forecasting container demand, external depots, repositioning containers, use the alternative way by 20-foot containers, providing cost subsideis and mantaining the relationship with the principal and containers supplier. Digital container data monitoring is the highest priority solution with 0,4799 weight based on the AHP analysis. A spreedsheet-based monitoring prototype was develop based on the finding. The prototype are historicla data record, import and export gap analysis, forecasting, container monitoring, stock planning and dashboard for the data visualtitation. Practical contribution: the practical conribution give by providing a simple digital monitoring tool. It can help to improve the visibility of the data, earlier detection for container shortage and support operational decision making. For logictic professional, the prototype can improve data literacy skill. This is usefull for support green skill development in vocational science education.

Keywords: Analytical Hierarchy Process; container utilization; digital monitoring; export logistics; green skill; vocational education

1 Introduction

Ports is an important place for export logictic because its connect with container terminal, shipping company and international trade. Export process depend on the avalability the right container before shipment. This situation happen in one of the export city in central Java, Semarang. The export goods is already ready but sometimes the container is not arrive yet at the terminal. The impact of this problem is not only the avalability of the container. The customers need to get the infromation from the company if the shipment delay that was not planned before.

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The 40-foot container is one of the most used container among many types of export containers because it can carry more cargo in one shipment. This is can reduce the cost of transportation for each cargo. The shortage of 40-foot is not only a number of container. It related to how many containers are distribute, how fast the empty container coming back from the previous shipment and event the available container that still suitable for shipping. Container availability is regulated by Ministry of Transportation Regulation No. PM 25/2022 (on Container Seaworthiness and Verified Gross Mass (VGM)) [5], the avalilable container cannot be used directly. It must meet the operational requirement before it can be user.

40-foot containers are usually difficult to find while 20-foot are still available in large number based on the observation at freighr sub agent in Semarang. Several ways has been done by the company to solve this problem. Container stock manually check, coordinate with terminal and shipping company, predict the container demand, change the shipping schedule and event sometimes use the 20-foot container if it needed. These strategies are still reactive. Sometimes the inventory data is updated too late and not match with the real condition. The forecasting mostly not based on record data but depend on staff experience.

Currently, while there have indeed been many studies exploring digitalization issues in port operations, empty container transport, and logistics decision-making [6]–[11], applied research combining structured strategy selection methods with specific technology-based monitoring designs tailored for shipping subcontractors remains relatively rare. This study aims to fill this gap by following these steps: (1) identifying the causes of the 40-foot container shortage; (2) evaluating the strategies currently implemented by the company; and (3) using the Analytic Hierarchy Process (AHP) to prioritize solutions and implement them into a spreadsheet-based operational monitoring prototype.

2 Literature Review

2.1 Container Availability and Export Logistics Performance

Success in export logistics is generally measured in terms of cost control, delivery reliability, and customer satisfaction. From a transportation geography perspective, the movement of goods results from the interaction between production areas, transportation hubs such as ports and container depots, and destination markets. The efficiency of this interaction depends on the transportation network's ability to ensure the timely movement of cargo and supporting logistics resources, including containers [3]. The avalaibility of container is the main part of transportation process. The cargo cannot be shipped even if its already ready if the container is not avalilable. This problem also can affect truck operation, port planning and depot schedule. Prevoius study found that port activities and connection with inland area have a strong impact on economic aspect. That is why repeated container shortages at the company can also affect the wider region [4].

2.2 Causes of Container Shortage and Repositioning Practices

The shortage of empty containers is related to imbalance between import and export activities based on the previous study. Other causes are the changing of demand and disruption in vessel schedule [8], [9]. As an example, during pandemic COVID-19, shipping faced many problems. This is made the container circulation slow and caused container shortage in many places [10]. This kind of problem is already studied in shipping companies and national trade activities. This problem also can happen in one feight sub-agent company when the container arrival, booking request and container yard readiness do not match each other.

2.3 Digital Monitoring and AHP in Logistics Decision-Making

A complex information system does not always need for digital monitoring. A simple spreadsheet can also be useful if it records containers movement, compares demand with available containers and give an early warning before a container shortage happen. Based on the previous research, the decision in container terminal are connected each other [6]. For improve the operation, better planning and systematic management is needed [7]. Using data consistenly can help manager to find the problem easier and make the right decision [11].

Not only based on cost, the Analytical Hierarchy Process (AHP) method can help to compare several criteria at the same time [14]. Prevoius studies have used AHP in logistic such as choosing freight forwarders. It proves that AHP is suitable for making decision with many criteria in supply chain operations [15]. AHP is used to rank the best strategies to improve availability of 40-foot containers in this study.

2.4 Digital Literacy and Green Skill in Vocational Applied Science

Applied education focus on skills can be used directly in the workplace. Data literacy is one of this skills. The meaning of data literacy is the ability to read, organize and use operational data. This skill can help company to use resources efficiently and reduce waste in operation especially in transportation and logistic. To improve operational efficiency can use the monitoring tool that changes scattered inventory data into useful planning information. It can also support the skill of vocational students need after their graduation.

3 Research Method

Decriptive qualitative and Analytical Hierarcy Process (AHP) used in this research. Explaining the operational condition at the sub-agent company done by qualitaive method. It also identified the causes of the 40-foot container shortage and decribe the company that used by company. To calculate the priority of each strategy, the AHP method was used. The assesment was based on the criteria found from the field finding. The data collection done by interview, direct observation, review of the document and AHP pairwise comparison questionners. The informan were selected because they were the part of export operation, container stock monitoring and shipping cmpanies. The

company name was written as “a shipping sub-agent company in Semarang”to keep the privat information.
The process of qualitative material is by reducing, display and making conclusion. The result then used to build the AHP hierarcy that shown in Table 1. The paire answer by the respondence then combine using the geomtric mean based on the AHP method. Then the result arranged into reciprocal comparison matrices. Priority weights were obtained through matrix normalization and row averaging, and consistency was verified using the Weighted Sum Value, the maximum eigenvalue (λ max), the Consistency Index (CI), and the Consistency Ratio (CR); a matrix was accepted once its CR fell below 0.10 [14].

Table 1. AHP decision structure

AHP Element	Description
Goal	Determine the priority strategy for optimizing 40-foot container utilization in export logistics through a technology-enabled approach
Criteria	Operational cost, time efficiency, customer satisfaction, SOP simplicity
Alternatives	20-foot container substitution, repositioning acceleration, rescheduling negotiation, digital container monitoring

4 Result and Discussion

4.1 Causes of 40-Foot Container Shortage

Based on interviews and field observations, it was found that there are five factors that often cause a shortage of 40-foot containers at the company. First, a distribution imbalance occurs when 40-foot containers are concentrated in locations different from where export demand is highest. Second, demand fluctuations occur around peak export periods, when order volumes increase faster than the return flow of empty containers. Third, operational constraints include congestion at container depots and limited transportation slots for container transfers. Fourth, container mismatches occur when available stock does not match the size or condition required for a shipment. And finally, operational inefficiencies refer to delays in inventory updates and coordination gaps between sub-agents, depots, and shipping principals. Overall, these five factors indicate that the shortage is not merely a matter of a lack of containers, but is more closely related to timing, location, and the availability of information regarding container inventory.

4.2 Existing Company Strategies

Prior to this study, the company had implemented several measures to manage the risk of container shortages. These included forecasting container demand primarily based

on experience from previous peak seasons. Additionally, coordination with external depots was used to check container availability. Next, container repositioning was arranged with shippers when local container stock was insufficient. Finally, cargo was split into two 2×20-foot containers when possible, resulting in certain cost savings. For companies, maintaining relationships with principals and container suppliers is considered a long-term safeguard that increases the chances of priority allocation during periods of limited availability. While these strategies are indeed useful, they largely serve only to respond to shortages after they occur, rather than anticipating them early on.

4.3 AHP Criteria Priority

Table 2. Pairwise comparison matrix of criteria

Criterion	C1	C2	C3	C4	Weight	Rank
C1 Operational cost	1.0000	0.3021	0.6389	1.7783	0.1800	3
C2 Time efficiency	3.3098	1.0000	1.6818	1.6549	0.4029	1
C3 Customer satisfaction	1.5651	0.5946	1.0000	2.0000	0.2634	2
C4 SOP simplicity	0.5623	0.6043	0.5000	1.0000	0.1538	4

The consistency ratio of this matrix is 0.0542, below the 0.10 threshold, indicating that respondent judgments were coherent enough to proceed to the next stage of calculation. Time efficiency carries the highest weight at 0.4029, which suggests that the ability of a strategy to shorten the gap between a problem appearing and a decision being made matters more to respondents than any other consideration. In export operations, a delay in knowing whether a 40-foot unit is available can cascade into late booking confirmation, late stuffing preparation, and late notice to the customer. Customer satisfaction follows at 0.2634, reflecting how directly export clients feel the consequence of container uncertainty. Operational cost and SOP simplicity remain relevant but are treated as secondary to the need for a fast response.

4.4 AHP Alternative Priority

Table 3. Alternative weights under each criterion and final score

Code	Alternative	C1 Cost	C2 Time	C3 Customer	C4 SOP	Final score	Rank
A1	20-foot substitution	0.1108	0.0777	0.0905	0.2625	0.1154	3
A2	Repositioning acceleration	0.3054	0.3258	0.3175	0.1439	0.2920	2
A3	Rescheduling negotiation	0.1108	0.1091	0.1299	0.0950	0.1127	4
A4	Digital container monitoring	0.4730	0.4874	0.4621	0.4987	0.4799	1

Final score of "Digital Container Monitoring" is 0.4799 and as ranked first. This strategies was regarded as essential in four evaluation. The company have more time before the shipping schedule if they have early information about container stock, demand and possible shortage. This is give a change for company to rearrange container allocation, give the information to the customers about the delay and prepare the other alternatives. The second rank is "Repositioning Acceleration" with 0.2920 score. This is also an important strategy because it can increase the chance of getting a 40-foot container. The succesful of this strategy is depend on other factors. The factors include approval from the principal and the availability of space in depot. It can be manage better if the company has an early monitoring data. The third rank is the use of two 20-foot containers with a weight of 0.1154. This alternative way can be use when a 40-foot container is not avalilable. It also increase the work for loading, unloading and document processing. This strategy only deals with the impact of the container shortage and does not help prevent the problem from happening.

4.5 Consistency Test

Table 4. Consistency ratio of AHP matrices

Matrix	λ max	CI	RI	CR	Status
Criteria	4.1462	0.0487	0.90	0.0542	Consistent
Alt. under cost	4.0042	0.0014	0.90	0.0016	Consistent
Alt. under time	4.0667	0.0222	0.90	0.0247	Consistent
Alt. under customer	4.0184	0.0061	0.90	0.0068	Consistent
Alt. under SOP	4.0368	0.0123	0.90	0.0136	Consistent

All the matrices has a CR value below 0.10. The range of CR value start from 0.0016 for the operational cost alternatives to 0.0542 for the criteria matrix. This means that pairwise comparison is constant and the final ranking can be use with confidence.

4.6 Discussion: Toward a Technology-Enabled Strategy

The same conclusion show in Section 4.1 and the AHP ranking Section 4.4. The completely unavailable of 40-foot containes is not the main problem. The company is too late to identify the risk of container shortage so the action is cannot take earlier. Sometimes the agent is still checking container avalilable, discuss the option with costumers and repositioning the containers while the cargo is already ready for stuffing. Also in that time the problem has already affected the port operation.

To solve this problem, technology-based monitoring can be use by combine the historical data, current container stock and one system short-time demand. This information can be check regulerly by the staff. This system does not replace strategies but help the company to make faster and better decission because of earlier information. This are similar with prevoius studies about decission making and data based planning in container operation [6], [7], [11]. This is also support the idea about smooth cargo movement through the port depand physical assets but also on how well companies manage their operational information [3], [4]. Spreadsheet is the good choice for this kind of companies. Spreadsheet does not need a large investment but it can efficience the data inventory.

4.7 Spreadsheet-Based Monitoring Prototype

Spreadsheet-based monitoring develop to support company in making decission based on AHP result. This is made not to replace the existing sytsem but to organize the data the saparated data that already exist. This can make company easly to find the problem and improve the planning.

Table 5. Components of the monitoring prototype

Component	Function in decision support
Historical data recording	Keeps a record of past container demand and availability so recurring shortage patterns can be identified
Forecasting	Projects near-term 40-foot container needs using recorded demand as a reference
Import-export gap analysis	Compares container inflow against outflow to reveal a developing imbalance
Actual monitoring	Tracks current stock condition, container readiness, and demand updates as they occur
Inventory planning support	Signals a warning when projected demand is likely to exceed available stock
Dashboard visualization	Summarizes key indicators in one view so staff can assess the situation quickly

The prototype help the highest rank strategy by making container stock easier to monitor. It also help to make a faster repositioning process because the problem found earlier. The staff also can get a better information to delivered to the consumers. The company can use spreadsheet immadiately without creating a new system. When the company is ready, it can also develop into a more integreted dashboard.

5 Practical/Theoretical Contribution

This study a low cost and simple monitoring for industrial aspect. The tool help to detect container shortage earlier, improve the data visibility and making the decission about container allocation. Small shipping companies can use this tool wothout spending a lot of money to make a new information system.

This prototype also demonstrates advantages in improving resource utilization efficiency by enhancing visibility into inventory and demand, thereby reducing unnecessary transshipments, temporary substitutions, and non-productive waiting times, and promoting more efficient use of transportation resources. From an educational perspective, the data literacy required to build and operate such tools is precisely the core competency that graduates of applied science programs are expected to develop. In this context, the prototype integrates real-world logistics operational challenges with environmental literacy, structured data processing, predictive analytics, and evidence-based decision-making, all of which are core competencies that professional higher education seeks to cultivate in future logistics professionals.

6 Conclusion

This study aims to identify the causes of the shortage of 40-foot containers at a shipping sub-agent company, evaluate the measures the company has taken to address it, and determine which strategies should be prioritized moving forward. The findings indicate that the container shortage is caused by distribution imbalances, demand fluctuations, operational constraints, container mismatches, and operational inefficiencies, and that the company's current responses such as forecasting, depot coordination, repositioning, substitution with 2×20-foot containers, cost-difference subsidies, and relationship management, are indeed beneficial but are largely reactive in nature.

The main criterion is time efficiency with a wieght of 0.4029. the first priority strategy is digital container with a final weight is 0.4799. This strategy ranked higher than repositioning acceleration using two 20-foot container as a replacement and rescheduling negotiation. This study develop a spreadsheet-based monitoring prototype to apply these priority. The prototype have six components such as historical data record, import and export gap analysis, forecasting, inventory planning and dashboard for visualitation of the data.

Companies are encourage to record inventory in more organized way. Historical data should be use more consistance when forecasting container demand. To handle container storages, company need standart procedure so it can be respond quickly and effectively. The testing of prototype in daily company operation is a need for future study.

The prototype can be develop into an application that is connected with depot data system and company main data system.

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References

1. Verschuur, J., Koks, E.E., Hall, J.W.: Ports' criticality in international trade and global supply-chains. Nature Communications 13, 4351 (2022). https://doi.org/10.1038/s41467-022-32070-0
2. UNCTAD: Review of Maritime Transport 2024. United Nations Conference on Trade and Development, Geneva (2024).
3. Rodrigue, J.-P.: The Geography of Transport Systems. 6th edn. Routledge, London (2024). https://doi.org/10.4324/9781003343196
4. Merk, O.: The Competitiveness of Global Port-Cities: Synthesis Report. OECD Regional Development Working Papers, no. 2013/13. OECD Publishing, Paris (2013). https://doi.org/10.1787/5k40hdhp6t8s-en
5. Indonesia, Ministry of Transportation: Regulation No. PM 25 of 2022 on Container Fitness and Verified Gross Mass. Ministry of Transportation of the Republic of Indonesia, Jakarta (2022).
6. Stahlbock, R., Voß, S.: Operations research at container terminals: A literature update. OR Spectrum 30(1), 1–52 (2008). https://doi.org/10.1007/s00291-007-0100-9
7. Weerasinghe, B.A., Perera, H.N., Bai, X.: Optimizing container terminal operations: A systematic review of operations research applications. Maritime Economics & Logistics 26(2), 307–341 (2024). https://doi.org/10.1057/s41278-023-00254-0
8. Toygar, A., Yildirim, U., İnegöl, G.M.: Investigation of empty container shortage based on SWARA-ARAS methods in the COVID-19 era. European Transport Research Review 14, 8 (2022). https://doi.org/10.1186/s12544-022-00531-8
9. Abdelshafie, A., Hamza, H., El-Tawil, A.: Repositioning and optimal re-allocation of empty containers: A review of methods, models, and applications. Sustainability 14(11), 6655 (2022). https://doi.org/10.3390/su14116655
10. Mahmud, R., Zheng, F., Løff, I.B., Munim, Z.H.: The container shipping crisis during COVID-19 disruption: Consequences and lessons learned from news analysis. Journal of Shipping and Trade 10, 29 (2025). https://doi.org/10.1186/s41072-025-00220-4
11. Heilig, L., Stahlbock, R., Voß, S.: From digitalization to data-driven decision making in container terminals. In: Böse, J.W. (ed.) Handbook of Terminal Planning, 2nd edn., pp. 125–154. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-39990-0_6

12. Chandler, A.D.: Strategy and Structure: Chapters in the History of the Industrial Enterprise. MIT Press, Cambridge, MA (1962).
13. Taha, H.A.: Operations Research: An Introduction. 10th edn. Pearson, Harlow (2017).
14. Saaty, T.L.: The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill, New York (1980).
15. Mohsen, B.M.: Multi-criteria decision system for the selection of a freight forwarder using AHP. Procedia Computer Science 220, 135–144 (2023). https://doi.org/10.1016/j.procs.2023.03.020

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